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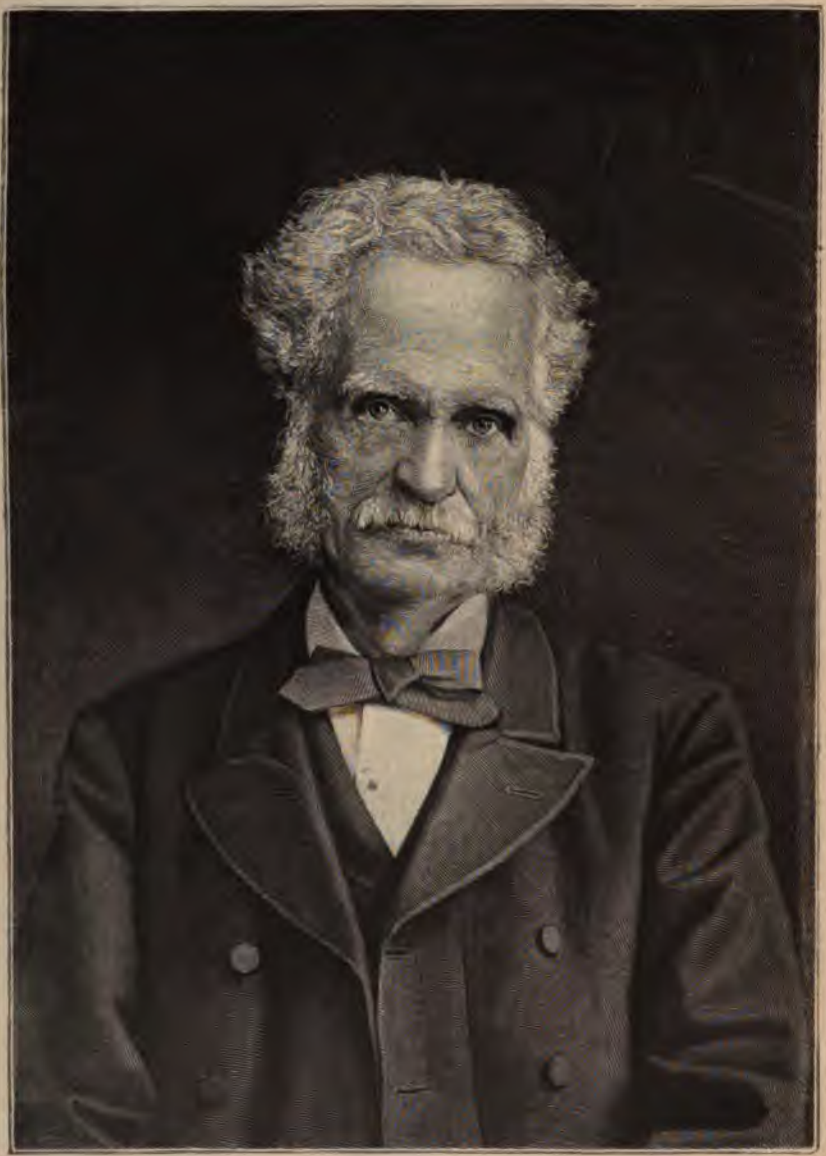

HENRY W. BATES.

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EURASIA.

BY SARA JEANNETTE DUNCAN.

NOTE.—"*Cutcha*"—inferior. "*Burra lord sahib*"—Great lord sahib—the viceroy. "*Dall*"—pulse. "*Dhoty*"—loin-cloth. "*Jat*"—race. "*Syce*"—groom. "*Qui hai!*"—call to servants—"Whoever is there?"—facetious name for old Anglo-Indians. "*Baboo*"—educated Bengali. "*Bearer*"—personal servant. "*Kitmutgar*"—table-servant. "*Mussalchi*"—washer of dishes. "*Talub*"—wages. "*Tum bai-adab hai*"—"You are without respect." "*Dursie*"—native tailor. "*Belati*"—foreign. "*Gharries*"—carriages.

FROM a back window of my tall house in Calcutta I see her nearly every day, the lady who may personify Eurasia. She is amply qualified to do it; Nature in molding her permitted her to lack no characteristic that could contribute to make her a generous racial type. She is cast upon the comfortable lines common to her people—lines that could not be indicated in avoirdupois under two hundred-weight. They are more evident to me than even this statement of fact can make them to the public, since Mrs. De Souza—her name is De Souza—is usually clad, when she comes under my observation, in a casual calico dressing-gown, which leaves little of her benevolent person to be invented. The dressing-gown is open at the throat on account of the temperature, but in compensation there is a great deal of it at the other end; it is *en traine* and has a flounce. Once, doubtless, it ministered to her vanity, for even at that age—she is turned fifty—and at that weight, Mrs. De Souza and vanity are not incompatible. There is Mrs. De Souza's complexion, for example—she has always been very properly vain of that. It is quite an exceptional complexion, oatmeal in tone. Eurasia, which verges from that to mahogany, considers Mrs. De Souza "fair," and her claims to social privileges rest very much upon this opinion. She and her family live in a small, flat-roofed, "*cutcha*"-built habitation, much stained and faded, standing flush with one of the many narrow streets that creep and wind among all Calcutta's tall houses, even to the skirts of the stately residence of the "Burra lord sahib" himself. It is very hot, stifling, in those crooked little streets; the pleasant south wind does not always blow through to sweeten them, and they bear much need of sweetening. They cause Calcutta's Municipal Council more anxious hours than is the province of thoroughfares, on account of the prosperity of bacilli in their midst; and though the Municipal Council conspired all day, and sat up all night, taking measures of reprisal, the bacilli would still be glad and the inhabitants would still decrease. Not appreciably, however; there are far too many of them. Such numbers of little open shops, uninviting little shops, where rice and *dall* and sticky brown sweetmeats are piled up in earthen bowls to catch all the uncleanness of the roads! Such numbers of proprietors to each little shop, who sit on their dusty thresholds, as often as not with their glistening bare backs turned to custom, gossiping about the monsoon, taking turns at the gurgling cocoanut of the hubble-bubble! And then the comers and the goers, turbaned and bareheaded, dressed in the flowing robes of the Prophet or the simple *dhoty* of the coolie-lok, all upon the various interminable little businesses by which they gain leave to live—to say nothing of Mrs. De Souza's own family, which is large, or of her social connection, which stretches, interspersed by the little shops, all the way down the street. But I must deny myself the pleasure of referring to Mrs. De Souza further in this personal strain. It is, after all, contrary to the ethics of good neighborhood that I should take any great advantage of an upper window, in spite of the generous publicity of my neighbor's domestic arrangements, which seem to invite both inspection and report. I must hurry unflinchingly on to say that Mrs. De Souza inhabits another world than the little Anglo-Indian one, a world with mysterious affinities and attractions, however, both for ours and for the great dusky tropical swinging sphere of the pure "native." Nobody knows it very well that I have heard of; indeed, it would require some courage to profess familiar acquaintance there; but it is quite within reach of astronomical observation, which is not compromising.

Eurasia has no boundaries. It lies, a varying social fact, all over India, thick in the great cities, thickest in Calcutta, where the conditions of climate and bread-winning are most suitable; where, moreover, Eurasian charities are most numerous. Wherever Europeans have come and gone, these people have sprung up in weedy testimony of them—these people who do not go, who have received somewhat in the feeble inheritance of their blood that makes it possible for them to live and die in India. Nothing will ever exterminate Eurasia; it clings to the sun and the soil, and is marvelously propagative within its own borders. There is no remote chance of its ever being reabsorbed by either of its original elements; the prejudices of both Europeans and natives are far too vigorous to permit of much intermarriage with a *jat* of people who are neither one nor the other. Occasionally an up-country planter, predestined to a remote and "jungly" existence, comes down to Calcutta and draws his bride from the upper circles of Eurasia—this not so often now as formerly. Occasionally, too, a young shopman with the red of Scotland fresh in his cheeks is carried off by his landlady's daughter; while Tommy Atkins falls a comparatively easy prey. The sight of a native with a half-caste wife is much rarer, for there Eurasian as well as native antipathy comes into operation. The whole conscious inclination of Eurasian life, in habits, tastes, religion, and most of all in ambition, is toward the European and away from the native standards. On the whole, Eurasian prejudices against the natives are probably stronger than European ones, and more unreasoning. The claims of that cousinship must be more than ignored, they must be trampled upon. But, in the matter of marrying and giving in marriage, Eurasia is more than sufficient unto itself, and has been for so many generations that both the native and European characteristics of the type have become largely merged in its own.

There are twenty thousand Eurasians in Calcutta to one third that number of Europeans. Even that does not represent the proportion fairly, for the census-taker probably finds it easier to obtain the true age of unmarried ladies than the confession "East Indian" if "European" can be written with the least shadow of acceptance. They are not hermetically sealed up in offices and closed *gharries* and darkened drawing-rooms during the heat of the day, like the Europeans; they take their walks abroad careless of the sun, in straw hats and such other ephemeral millinery as pleases them. Always they wear *belati*-cut clothes; it is the dear privilege of the poorest and blackest. They share the tram-car with the natives and they walk to their business, distinguished in this way from the sahib, who does neither. Thus one meets them in crowds, but not always thus. Quite often it is in a luxurious landau behind a fair pair of horses, with a coachman on the box and two *syces* behind, that one has the opportunity of observing Eurasia, lying back among its cushions. For Eurasia has its nabobs, and the Red Road knows them as well as it knows the judges of the High Court of Calcutta, or the members of his Excellency's Council. Once a year, only once, at the state ball at Government House, it is possible, if one looks very carefully, to detect a slight Oriental darkness under the powder on some otherwise unimpeachable cheeks. It is the annual opportunity of rich East India to proclaim itself connected, however remotely, with "society." Society looks on and smiles and covertly inquires, "How many annas, do you suppose, to the rupee?" This is a euphuism expressive of proportion—of Aryan proportion. For the rest, the attitude of society may be expressed by an inveterate shrug. It is not invidious or actively contemptuous; it represents the acceptance of the inevitable, and the determination—if that is not too energetic a term—to have as little to do with it as possible. Society recognizes that Eurasia has certain claims—to charities and commissions of inquiry, to humane treatment, to commiseration, to good advice. It holds meetings, raises subscriptions, discusses the Eurasian problem in the newspapers, and supplies inquiry commissioners from among its most honorable and distinguished. But the claims of Eurasia upon society must be made distinctly *in forma pauperis*; it is only the lower classes who have any. For the well-to-do in the landaus society has only a somewhat amused and cynical toleration, and does not dream of bowing. The attitude is natural enough. For the claims of that cousinship also must be more than ignored—they must be trampled upon.

I have hinted at the amplitude of Mrs. De Souza—it is largely characteristic of Eurasia, more marked, perhaps, in the women than in the men. The dusky chin has a tendency to grow early double—the comfortable shoulder to shake prematurely in the plenitude of what one might call semi-tropical nature. This sometimes carries with it a perfunctory jollity of appearance, the look of well-being that goes inseparably with solid development, the cheerfulness of curves. The prevailing Eurasian expression, however, is not one of exhilaration, at least in Bengal. The Bengali is not merry, and his paler-faced connections have inherited his unsmiling look at life. The few whose color is of a Mongolian strain are gay by contrast, but East India generally is of a sad countenance—languor, lethargy, and depression being oftener written there than anything else. There are easy physical reasons for this. The Eurasian is a poor creature among men. Th[illegible] death-rate of the community is tabulated with that of the E[illegible]ropean element, so can not be ascertained accurately, but it[illegible] known to be high. He is an easy victim to all the diseases t[illegible] follow poverty and crowded living. He has not such immu[illegible] as is enjoyed by the Bengali by virtue of simpler conditio[illegible] life; his habits and requirements are of the complex Euro[illegible] order, that bring, inadequately gratified, swift conseque[illegible] which he lacks the strength of the European to combat. [illegible] he is not abnormally fat, the Eurasian is apt to be painful[illegible] with high, narrow, Aryan shoulders, a contracted chest, and a stoop. He almost invariably inherits the straight black hair, soft dark eye, flat cheek-bones, and full curved lips of his Indian fore-bears, with varying shades of complexion, from what is distinguished with difficulty from the sahib's to what might easily pass for the pure native's. Occasionally, with one parent or even both of dark color, one sees the anomaly of a little fair-haired, blue-eyed child, a whimsical legacy from a bygone generation. Here the "tar-brush" is more painfully in evidence. There is a dinginess about the yellow curls and a dullness in the blue eyes, a smudginess in the general effect, as if Nature had finished her work with a dirty palette. And the brothers and sisters of the pitiful little freak may be as brown as shisham-wood.

It will be seen that it would be easy, if desirable, to convict Mrs. De Souza of her mixed origin in a variety of ways, however "fair" her comely visage. But there remains her East-Indian voice and "accent." It is so marked that if we met Mrs. De Souza in London or New York, more elaborately costumed perhaps than she appears from my window, it would throw about her speech the halo of amused interest which a foreigner's always evokes. We would guess at her nationality; though, unless we were retired Anglo-Indians, we would never hit it. To the rest of us she might have been originally French, or Spanish, or almost anything. It would be only the old "*Qui hai*" who could detect and pounce upon the dulcet "chi-chi," the language of Eurasia. It is English, of course—soft, rapid, nervous English. It is so quick, that the words seem to click against one another as they come; but they never run together; on the contrary they are extraordinarily distinct. There is little disagreeable twang, but there is a great deal of unlooked-for inflection; a rising and falling of tone where we would go monotonously on, which gives almost a picturesque effect to the words, until one tires of it. The sentences are apt to terminate with a certain abruptness; there is absolutely no drawl at the end of them. An odd importance, which is yet not emphasis, is given to the final syllables we tend to slur, and there is an almost invariable tendency to double final consonants. "Kindlee step thiss way," says the young woman behind the counter. "Thiss is verree prittee—and *chip* too *on*lee *one* rupee ae yard." The baboo speaks English in exactly the same way, and it is the common fear of the "country-bred," the pure European born and brought up in India among the hills, to acquire it. It is fatally easy to imitate, though extremely difficult to transfer to print, and makes one reason the more why Anglo-Indian children should be early sent home to be educated. Pleasant enough while it is novel, it soon becomes objectionable to European ears, doubtless as a matter of association, for in itself it is artless babble enough. Nor is there in it the remotest flavor of cockneyism. The dwellers in Eurasia, poor souls, are born much too far from the sound of Bow Bells. It abounds in odd words and phrases, some of them distinctly related to the native tongues, some of them pure English with a local application. To see a friend off is to "carry her to the station," whether walking or driving. When the *syce* is ordered to unharness his animal he is expressly told to "open out the horse"; while "of course" is to Eurasian what "indeed" is to Virginian, the common accompaniment of every yea and nay.

It is a hard saying, but it suffers little contradiction, that morally the Eurasians inherit defects more conspicuously than virtues from both the races from which they spring. Drunkenness is not common among them, nor is brutality. As boys they do not rob birds' nests or torment animals or fight, and they never grow up into sportsmen. The more aggressive vices do not flourish among them. But their indolence and unthrift are proverbial, as are their cupidity and instability of character. It is characteristic that the truth is not in them, and they have a marvelous ingenuity in manipulating the lie. In this their knowledge of the sahib's sympathies enables them to outdo the Bengali, though their methods are much the same. With beggars a favorite instrument of extortion is a death-certificate—a mother, a daughter, a baby lies dead at home; the funeral is a cruel, pressing, immediate necessity; a little money to meet the emergency is but a small demand upon common humanity. If you are unbelieving, the notice is shown to you in the morning paper—"Suddenly, of cholera, Mabel, infant daughter of Charles and Mary De Rosario"—with convincing tears. It is probable, however, that the death-certificate is well-nigh worn out in the service of misfortune, and that the tearful applicant for means to bury her never saw the infant daughter of Charles and Mary De Rosario. The social evil among the lower classes is very hideous. They seem to have a code of their own, which is capable of infinite infraction, and they touch a level of degradation which is far lower than any reached by the pure heathen about them. This is apparently an ineradicable thing, for it has its root in physical inheritance and its reason is racial.

Life under however modest conditions is impossible to Europeans in Calcutta under a certain income. This is perfectly understood by all employers of European labor, which is used for this reason only in posts of superintendence and responsibility. The European's food and lodging must be of a certain quality; he must have a certain number of servants and certain opportunities for recreation and change to make existence tolerable. The Eurasian will support life, however, upon means of almost vanishing proportions. With anything between one and two hundred rupees a month—the rupee being equal to about one shilling and fivepence—he is fairly comfortable, and a person of respectable position. He can afford to occupy the whole of a small house in a back street, to feed and clothe his family tolerably well, and, with the assistance of one of the charitable educational institutions of Calcutta, to educate them. But the Eurasian is improvident to the core, and will marry, taking no thought for the morrow, upon from thirty to forty rupees a month. The young lady of his species is charming in her way, which the young gentleman naturally finds a very captivating way. She develops early all the arts of beguilement; her eyes are liquid brown, her cheeks soft and round, her figure slim and graceful. Her prettiness is weak and transitory, but she possesses it long enough to insure the reward of her desirability. The matter is submitted to her mother, not her father—in Eurasian households the sway is maternal—and the affair is arranged upon the basis of family community. The young man agrees to live with his mother-in-law, to hand over to her his entire monthly *talub*, and to be provided for, with his wife, much as she thinks fit. His earnings go into a general fund, controlled by the mother-in-law, who is not unfrequently blessed with several married sons and daughters in circumstances that keep them under her roof. She feeds them all and clothes them all, dispensing such luxuries as she may. They increase, but not in riches, and when the multiplication reaches a figure quite disproportionate with that which represents the collective income, the family go over in a body to swell the great piteous majority which forms the Eurasian problem. Their accession to it is often hastened by a peculiarity of temperament on the part of the wage-earner, who is apt upon the slightest provocation to throw up his situation, no matter with what difficulty it has been procured or can be duplicated. His vanity and love of display tempt him to curious extravagances. On the occasion of a wedding or a christening he will spend his last *pice* with a generous trust in Providence for the commonplaces of food and drink in the days that come after. His family affection is a marked characteristic. Parents cling to their children with a degree of sentiment apt to be common among people who have too many, and often this attachment stands with foolish obstinacy in the way of the welfare of its object.

Notwithstanding their lack of thrift and strength, the most obvious reason for the great poverty and distress among the Eurasians lies in the tremendous competition of the natives. There is almost no department of labor in which it is not felt. The East Indian is particularly fitted by nature and inclination for minor clerkships; and here he finds in the baboo, who also loves an office seat and a pen, a formidable rival. The baboo is cheaper, his attainments are quite as good, and it is to be feared that the sahib prefers his services also because he can be "jumped upon" with a better conscience. In small shopkeeping the native undersells the Eurasians because he can underlive them, and has almost the whole of the trade of Calcutta which is not controlled by larger European firms, in his hands. A few of the women are employed as nurses in European families, but a Eurasian nurse is an expensive luxury, as she must be fed as well as paid at a higher rate than an *ayah*, while she often demands a native servant to assist her. Here, however, she offers a *quid pro quo*—her services are more valuable than an *ayah's*. The Eurasian has no chance against the native, however, in any other department of domestic service. The native is fitted by nature and education to serve the sahib; the position is one of dignity, and rather enhances the respect he receives from his fellow, however high his caste. He does, as a rule, only one thing, whether it is the work of a bearer or a *kitmutgar*, or a *mussalchi*, or a *syce*, and, as its performance leaves him ample leisure to attend to his private comfort, he does it well. His whole habit of mind, moreover, is one of deference to his superiors; his own self-respect is bound up with it; "*Tum bai-adab hai!*" is a keen reproach. No European would dream of employing a Eurasian servant in preference for reasons of pure comfort. But, curious as it may seem, Eurasia scorns household service, and declines to compete with the native on what is so obviously his own ground. In fact, however poor, the Eurasian reckons one or two servants among the necessities of his own existence. The beggar of this race will approach your gates in a *palki* borne by four of his muscular Bengali cousins. The Eurasian "lady" who implores a little pecuniary assistance often sends her appeal by a peon—and on scented paper. Poor Eurasian lady! she is denied even the resource of her sex the world over—her needle—for the *durzie* sews better and cheaper than she.

It goes without saying that the East Indian is unable t work all day in the sun with the scantily clad coolies at the roa side or the docks, even if a man with any strain of Europea blood in him would consent to give the strength of his arm und such conditions for fourpence a day. Behind "*belati*" coun he holds his own, and so does she, by reason of their supe knowledge of the wants and tastes of the sahib and the mem hib. The railways are an invaluable source of employmen them, and they are found more useful than the natives in tions of minor responsibility—in warehouses, docks, and t toms. A small and very respectable proportion of them a employment as teachers; and some make their way to t country tea and indigo plantations, where a certain num ceed, though the race has not the physical qualifications to make such a resource general. And, of course, there are the saving few, who make their business successful whatever it is, and rise to positions of moderate affluence and general respect. In spite of all this, however, the Eurasian element of the population of Calcutta has become so large, and the problem presented by its condition so pressing, that a special commission has recently been appointed by Government to inquire into its circumstances and devise some means to make them less distressing. Among other remedies it is proposed to utilize Eurasian youths for military purposes, and to make certain Government appointments more easily accessible to them. But the problem will doubtless always remain a problem, presented by the remorseless operation of natural and economic laws, and only tampered with, more or less futilely, for the sake of a common humanity by the efforts of philanthropy.

Now that I have finished my imperfect sketch, the ink in which I have drawn it seems too black. After all, there is a great deal of red blood in Eurasia; sometimes, indeed, the admixture of the other color is so slight as to completely impose upon society, knowing as society thinks itself. In the heart of Eurasia—a heart which has yet to be bared to us by the scalpel of modern fiction—surely may be found much that is worth adding to the grand total that makes humanity interesting. On the other side of a prejudice, well founded and well built, who knows what fruits may drop and what flowers grow? Nothing is more certain than that we can not see over it.

I met Mrs. De Souza only this morning, in the bazaar. She was buying fruit and vegetables, and she argued with great fluency and decision about their price. The brown Bengali vendors of these things quailed before her; she understood to a thread the construction of the web of their duplicity. In the end, she got all she wanted at about two thirds of the price I should have been obliged to pay—and I know the bazaar. It is the *dustur,* the impenetrable, unassailable *dustur,* for the *kala mem* to pay less for everything. She was accompanied by two Miss De Souzas, who did not pay much attention to the fruit and vegetables. Very smart were the Miss De Souzas, all in pink and blue, for it was Sunday morning, and on Sunday morning Eurasia is *en promenade* at the bazaar. Also I saw two very elegant young men, with dapper sticks and fresh ties, looking smilingly in their direction. And just outside, high in a swaying sago palm, three hoarse old crows told each other what would certainly happen.

THE NATURAL OR SCIENTIFIC METHOD IN EDUCATION.*

By WESLEY MILLS, M. A., M. D., F. R. S. C.,
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EDUCATIONAL methods seem to have been devised in the past more to meet the real or fancied requirements of practical life than with any clear reference to the constitution of the human mind, and this has been owing in no small measure to the reflex influence of public opinion. The school was, and by many still is, regarded as a place where that is to be learned, and pretty much that only, which it is thought will enable the pupil to earn a livelihood or prove successful in the struggle for material things; and of course, so far as it goes, this view is of vital importance. Unhappily, it overlooked the highest purpose of life, and so regarded it is a severe commentary on the character of our age. It has proved a short-sighted policy. It has defeated even its own ends. That can only be a sound theory of education which takes into account, what Nature herself always does, the organism and the environment. Why is our age so advanced in science? The human brain is essentially the same sort of a mechanism it always was, within the knowledge of men. The change is due to difference in method. The moderns have achieved their great results by the scientific method, the Baconian method of induction, or, as we usually say now, the experimental method.

Education has given us the results of a series of experiments, and we are trying others to-day; and at this point I would like to insist that educational questions can only be settled by experiment. Many theories that looked fair have proved delusive when actually tested by experience. But one thing is perfectly certain: any theory or any practice which does not square with the organi zation of man and the nature of his surroundings or environmer will be a failure just in so far as it falls short of meeting bot The difficulty is to know the nature of our own organization, a knowing that, to adapt it to our environment, or, as we usu say, to our circumstances. Allow me to use the term envi ment because it applies to other animals than man, and I de to give my treatment of the subject as broad a basis as pos From the time that men began to think they studied thems and long ago the Greek wisely asserted that to know one was the sum of all wisdom; and, of course, in the widest for a man to know himself is to comprehend his relations entire universe.

* The main portions of an address delivered under the auspices of the Royal Canada, at its annual meeting in Ottawa, in May, 1892.

Why are we then, after all those ages, still at work on the problem? Why have we made so many blunders as the history of educational methods shows? Are we in any more hopeful position to solve the question to-day than ever before? Without in any way underestimating the efforts of the past, or being over-sanguine as to a complete and speedy realization of perfection in education, I venture to think that we are now at last, if not actually on the right road, at least getting closer to it. We have begun to apply the inductive or scientific method to education because we apply it to ourselves. Modern physiology and psychology are, I venture to think, destined to revolutionize our edu-

Fig. 1.—Outer Surface of Cerebrum (after Exner). The shaded portion represents the motor area in man and the monkey—i. e., the area which most observers believe to be associated with certain voluntary movements of the limbs, etc.

cational methods. Certainly, until we study closely the physical organization, and especially the brain of man, we are far from scientific theory and practice in education, because without this a true psychology is impossible. In other words, educating the mind wisely depends on understanding its nature. This can only be accomplished by a study of our physical organization also, especially of that organ through which the mind expresses itself. So far as we know, brain processes and mind processes are always correlated. Cut off the blood-supply from the brain and the subject becomes unconscious, because thereby the subtle molecular processes or movements that we term functioning suffer to such a serious extent. When we speak of mental weariness we really refer to brain weariness, or more accurately to alterations in the delicate machinery of brain-cells. The brain itself is affected by the condition of the rest of the organism. A man with wearied muscles, or blood starving for oxygen, can not think well.

These illustrations may suffice to explain my general attitude, that to study educational methods scientifically we must betake ourselves to an examination of the human brain. Fortunately, within the last twenty years brain physiology has made great

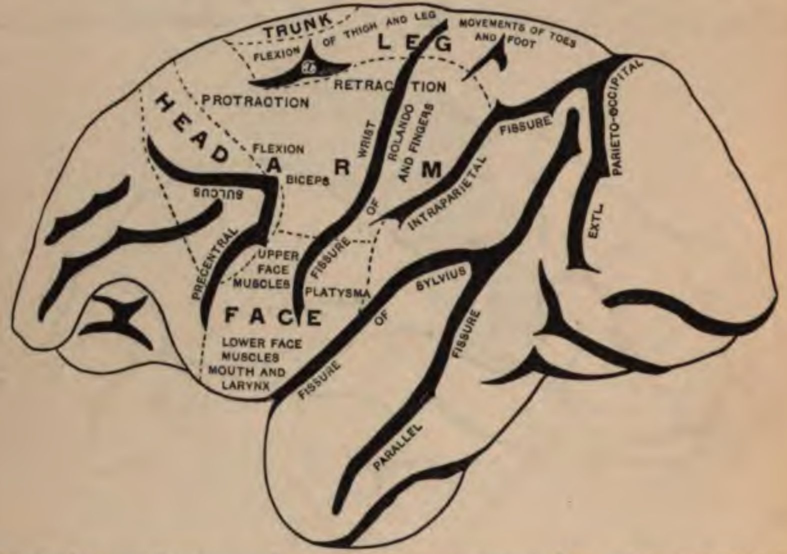

FIG. 2.—LATERAL SURFACE OF BRAIN OF MONKEY, DISPLAYING MOTOR AREAS (after Horsley and Schäfer).

progress, owing to the investigations of anatomists, physiologists proper, pathologists, and practicing physicians. The chief advance has been in the direction of extension and accuracy of knowledge as to the function of the gray matter on the surface of the brain, the so-called cortex. The functions of nearly every region of this cortex are now known approximately, and as regards some areas with great accuracy; so much so that surgeons have, in consequence of a diagnosis of the site of an irritation or of pressure, been enabled to cut down on the very spot affected and so relieve the patient.

The region which we least know is just that about which the phrenologists have had so much to say, and mapped out to their own satisfaction with great precision. Of this region physiologists can as yet draw conclusions only by a sort of process of exclusion.

We know very definitely the *motor area* concerned in voluntary movement, and we know approximately, but with less accuracy, the *sensory area*—i. e., the region essential to sensory processes. It will be seen from the accompanying diagrams that all the posterior half of the brain surface is, we may say roughly, sensory; and that it has been provisionally subdivided into regions for vision, hearing, tasting, etc.* If the surface at these points were crushed, pressed upon, replaced by a foreign growth, or removed by accident, there would be a corresponding mental loss—blindness, deafness, etc.

It is important to notice what a large part of the cortex is concerned with sensory processes, for it suggests in the strongest way that sensation must play some very great part in our mental life, and this modern psychology now most clearly recognizes. In fact, the extent of our sensory activity determines in great meas-

FIG. 3.—MEDIAN SURFACE OF BRAIN OF MONKEY (after Horsley and Schäfer). Figs. 2 and 3 may be said to embody the views of Horsley and Schäfer more especially in regard to motor localization.

ure the degree of our consciousness, for there are all degrees of consciousness, from a maximum down to such a condition as we find in sleep, which has its degrees also.

The case of the boy that had but one seeing eye and one hearing ear, and who could at any time be put to sleep—i. e., rendered unconscious—by closing up the avenues of sense, is very instructive.

It will further be noticed that localization of function conse-

* The figures in this article are taken from Mills's Comparative Physiology. D. Apple- New York, 1890.

quent on this anatomical delimitation of brain areas is very important. Apart from this it is not possible to conceive of that restriction of the attention to one kind of sensory impressions that is essential to clear perceptions. All teachers know the importance of securing attention; but, unfortunately, this is too often confounded with a constrained attitude and other non-essential accompaniments.

But a sound physiology and psychology should correspond to Nature. About the best way to test them will be to ascertain how they fit into human nature before it is influenced by any methods whatever, for all methods are liable to hamper and modify. It is hopeful to notice that so many psychologists of the modern school are turning to infant psychology, or the study of the mental development of the very young child, which is of course closely related to its physical development. The behavior of the infant is in accordance with the brain structure and function of which I have been speaking.

The infant from birth is the subject of almost constant movements during the waking hours of its life—movements which are spontaneous and not voluntary. Some of these movements, at all events, are reflex—i. e., the nervous discharges from the central cells of the brain and spinal cord which cause them are not due to the will, but to some sort of external stimulus; and so great is the tendency to these nervous discharges in the young animal that but the slightest stimulus is required. Some of these movements may be considered a continuation of those of the pre-natal period.

It is doubtful if the newly born infant executes any voluntary movements, because will proper it does not then seem to possess.

Though the child at this stage neither sees nor hears probably in the true sense of the term, it is not uninfluenced by light and sound. Gradually it gets clear perceptions from all its senses, and then it becomes more than ever a reflex mechanism, its nervous system being responsive to all external things, and its motor system *expressing* this condition. In other words, sensations are streaming in through all the avenues of sense, and these have their outward expression in movements by which, as from the first, the muscular sense on which all exact voluntary movement depends, and the cutaneous sense, the most fundamental of all, and that on which the perfection of all the others depend, are exercised.

At first, sounds though heard can not be localized. Objects are perceived by the eye, but the infant has no idea of their distance. It will reach for a light across the room as readily as it were but a foot away.

It is clear that the human being at this stage is on a par w other young animals. Each is a vegetative, reflex, receptive organism. The brain of the infant grows rapidly within the first few months. It no doubt develops equally fast. Already used groups of cells learn to function more perfectly, and new groups take up their duties. Movements become gradually more and more voluntary, more under control, and more definite. Sensory impressions become more and more clearly sensory judgments. To illustrate: The lamp that excited the young infant represents after a few months not merely brightness but an object of definite size and shape, owing to the additions and corrections following from a combined use of the senses. And this process will continue throughout life if not checked.

Both common observation and the closest scientific study have made it plain that youth is the period of sense ascendency. From

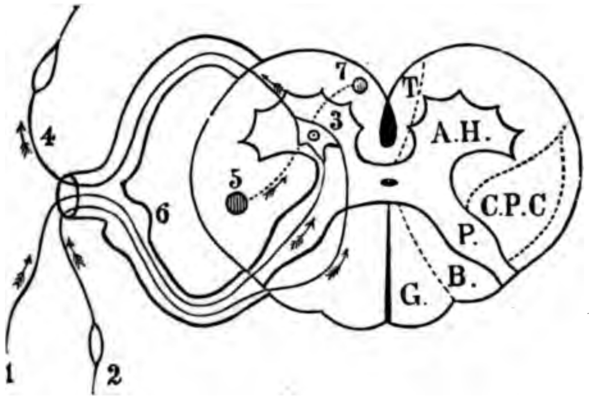

FIG. 4.—DIAGRAMMATIC REPRESENTATION TO ILLUSTRATE THE REFLEX ARC (Bramwell and Ranney). 1, 2, sensory fibers; 3, motor cell of anterior horn; 4, motor fiber connected with 3 and passing out by anterior root of muscle; 5, fiber joining ganglionic cell (3) with crossed pyramidal tract, C. P. C.; 6, ganglion on root of posterior spinal nerve; 7, fiber joining 3 with Türck's column, T. Fiber 2 is represented as passing through Burdach's column to reach the cell, 3.

this, most important conclusions follow, which we can not ignore without paying a heavy penalty. Attention has been called to the infant in order to show that, prior to all school education, Nature asserts herself and points the way in which the human brain and mind develop. Any education that overlooks these facts is directly against the organization we possess, and must be more or less of a failure. How far our methods have been and are in harmony with them I shall presently attempt to show.

For the moment let me follow the child out of the stage of infancy into that of school age. The boy of five, let us suppose, is sent to school a perfect stranger to books and the usual educa-
ment. Everything on the road to school attracts him
t likely enough he may arrive late. When

at school the teacher may find him so restless that the question of keeping him in order so that he shall not disturb others is a matter of serious difficulty. So long as he can be kept in action things go well enough, but to keep this activity within conventional bounds is the problem.

Very often repressive measures that quite paralyze his nature are resorted to in order to adapt his organism to the environment instead of the reverse being attempted. It is forgotten too often that if this young creature were not active, even restless, impulsive, inattentive—i. e., ever ready to secure some new impression—he could not develop after Nature's plan. We are at the outset in possession of some principles by which to test our methods. So far as the soundest physiology and the most recent psychology go, there seems to be but one way to develop this boy's intellect, and that way is along the path that is clearly indicated—the development of the brain and at this period the senses to the fullest extent. Now, as this implies not only seeing, hearing, smelling, and tasting, but feeling in the widest signification of the term—i. e., the muscular as well as the cutaneous sense—we must not only permit of movements but develop them. Smelling and tasting are in human beings of subordinate importance. But vision, to a less degree hearing, and the compound musculo-cutaneous sense, are of vital moment in all sound development.

It is by the development of these senses, together with smell, that the lower animals attain that perfection which in all respects is not equaled by man. But in delicacy and co-ordination of muscular movements, in perfection of visual and auditory discrimination, man is far ahead of the rest of the animal creation. Color-vision and nice discrimination of tones and form are peculiar to man. The painter and the musician have a perfection in the one case of vision and in the other of hearing unknown to any other animal; indeed, only in a feeble measure realized by their fellow-men.

We recognize in the brain of man a *motor area*—i. e., a portion of the surface (cortex) indispensable for voluntary movements of the arm, leg, trunk, indeed for voluntary movements generally.

It is, however, found that if, owing to disease, the path of sensory impressions is interrupted or imperfect, accurate voluntary movements are impossible. A person affected in this way is no only incompetent to do the work of an artisan, but he can no co-ordinate or harmonize his muscular movements to any usefu end; so that it is now clear that practically all movements dependent on sensation; while, again, sensation is much curta in essential directions (musculo-cutaneous) if movements be free, extensive, and accurate.

The development of the motor and sensory areas of the brain are in a measure dependent on each other, and that great region in front, which probably functions in all the higher mental processes, must evidently be hindered in its growth and development if the region back of it is defective. It is impossible to have thought without the material for thought; and this can, so far as all perceptions of *matter* are concerned, be derived chiefly, if not wholly, through the sensory and motor areas working together. This furnishes a physiological basis for the discussion of manual training and all kindred subjects.

These views have received recent confirmation by an examination of the brain of the late celebrated Laura Bridgman, who was defective in all the senses except the tactile and the muscular sense, while absolutely wanting in vision and hearing. Her brain was found much smaller in the sensory areas and its nervous cells few and undersized, owing to disuse, leading to atrophy and failure of development. Experience proves conclusively that all those mental processes on which reflection and judgment depend are in their natural order later of development. Now it is, in my opinion, of great moment to observe in education the natural sequence of development, as any attempt to reverse Nature's order is sure to result in serious harm. We can not bring about in a boy of sixteen a development which should have been begun at five; and this lies at the very root of the question of science in schools, and all others bearing on education. Some have been wondering what all this has to do with science in schools; but I hope to show before I conclude that, according to the homely adage, the longest way around is sometimes the shortest way home.

If my conclusions have thus far been sound, we should be a long way on the road to solving the most important part of any educational problem, viz., the nature of the human brain and mind. The other part of the problem, how best to adapt to the environment, or fit the environment to the mind, is subordinate, though sometimes practically difficult.

It is plain that we must cultivate the senses, and that at the period when they are most susceptible of it, in early youth; that to do this we must not neglect the use of the muscles, or more correctly neuro-muscular activities, for muscular movement of course implies the co-operation of the central nervous system, including the sensory brain areas.

The highest aim of science is to reach great general laws like that which marks the triumph of the science of the nineteenth century, the most important of which is the law of the conservation of energy. But, before any law can be established, a vast number of facts must be gathered. Facts, as regards natural science, mean phenomena, what is cognizable by the senses and the senses alone. It is hopeless for the most gifted human being to attempt to realize the taste of an apple if he has not had the actual experience. It is idle to read a poem on a sunset to the man that never saw light. We will all admit this; but do we not ignore this very plain conclusion in our teaching? In even the best schools, pure abstractions, or the use of words that can convey no definite meaning because not founded on any sensory experience to the learner, are still too common. Words have but one use—to express knowledge, not to impart it. I greatly wish I could adequately impress this simple truth on those I address, especially the young teachers before me.

How often do we forget that one may have a vast amount of real knowledge of a subject who has never read a page written upon it; while no amount of verbiage can supply those sensory impressions which are essential to all real understanding of the properties of matter! The very first advance the infant makes toward knowledge, real knowledge, is when it first looks out on the world or moves its tiny limbs.

Now, if we would but imitate Nature, or rather assist and not impede her, all would be well. It is a source of great gratification to me that I am in this connection able to refer to one educational method that does almost perfectly realize the true ideal —the kindergarten. The kindergarten was the invention or discovery of a man that got very near to Nature; and had we, led by the light of his genius, but followed, happy would it have been for our education since that time. It is humiliating to think of the long period of stupid blundering through which we have passed. Schools and colleges alike have till recently repressed and dwarfed rather than developed man's intellect in the natural way. It were not possible but that Burns's satire should apply, speaking of colleges, "They went in sturks and came out asses."

Think of what we have passed through! Arithmetic without any basis of concrete perception or practical application; geography, confined to knowing right and left, up and down, in and out, on a flat surface or "map," with certain names attached to these forms that suggested no realities; reading that was necessarily uninteresting and lifeless because the things described were not within the child's experience, and so were not realized; grammar —that last straw to break the long-suffering learner's back—grammar that was the worst bore of all, because introduced a[t] a period when the mind was unfitted for abstractions and became divorced from all that was real and practical.

Is it any wonder that farmers and business men compla[in] that such an education was no fitting preparation for real l[ife]

I complain because it was worse. It was a fearful injustice to that noble organization with which we are endowed. The case has improved in a fair proportion of our schools, but we are far, far from the true way still. We are also deluded by the spirit of our age, that aims too much at quantity and too little at quality. In elementary schools especially the culture and the method are, beyond all comparison, of more importance than the facts learned.

Given a youth developing aright, and we find him continuing that natural and happy life he began as an infant. He exercises his senses on the world around him, and is learning under guidance to group his facts—that is, his sensations—and to deduce general laws. This is science, and should be pleasant to every normally constituted human being, and experience proves that such is the case.

The students at our colleges are beginning themselves, after having had a taste of real knowledge, to cry out for more practical work and fewer formal lectures.

You will perceive that the conclusions drawn apply more or less to all studies, even purely literary ones. Literature abounds in descriptions of Nature. These must mean more to him who has actually observed than to the closet student. Much of all poetry, notably such as Scott's, for example, is but feebly realized by those unfamiliar with Nature; to put it otherwise, by those who have not had the sensory impressions essential to realization.

It must now appear that in the true sense education is simply furnishing an environment which is favorable to the development or unfolding the organization of the child. I use the term organization rather than mind because it seems to me that as a human being is a complex, we can never in actual practice consider one part of a child's nature absolutely apart from another. There is no such thing as mental development apart from moral and physical effects; and all experience goes to show that, when any part of the organization of a human being is ignored, the very ends aimed at in any one direction are but imperfectly attained. It has been shown that the infant develops through movements. The boy develops through rambles in the fields or through his games, and the methods are after Nature, though not as perfect when the subject is not under guidance, as he always should be—to an extent not sufficient, however, to interfere with spontaneity. The sooner we get rid of the idea that education is imparting instruction, and that teachers exist to hear lessons, the sooner will we be prepared to enter on the right path.

It has of late years dawned on a few minds that this natural development, which is in a hap-hazard way accomplished by the child in its sports, might be carried out in a systematic way by what is termed manual training, and I allude to the subject in this address because it seems to me to be in the main so perfectly in harmony with our most recent knowledge in brain physiology and in psychology. Just as the child begins life by investigation with its senses and its muscles, so must this method be followed to the end. This is the scientific method—i. e., it is founded on science. The aimless movements of the infant must be gradually replaced by movements with a definite purpose, and its chance sensations by sensations gathered with a definite object. Rightly understood these objects constitute the *raison d'être* or purpose of manual training, laboratory work, and all kindred methods. It would appear that we can not follow Nature's method without combining muscular movements and the use of the senses. Naturally these develop together, as has already been shown.

What shall we say, then, of educational methods—a fearful abuse of the term—which, instead of permitting of this free and natural development, directly thwart it? In the past the whole development of the child has been sacrificed in no small degree to the three Rs. One might be led to suppose that life was made up of reading, writing, and arithmetic. As a matter of fact, they enter but little into it. Life is made up of feeling, thinking, and acting, which only incidentally involve the three Rs.

The germ or principle of manual training, like that of nearly everything else that is good in education, is found in the kindergarten. All that we have in our modern laboratories, colleges, workshops, etc., exists in that wonderful method.

For a beautiful and successful illustration of the natural method applied in a somewhat different way, I refer you to the January and February numbers of The Popular Science Monthly of the present year.

When once we grasp the true conception of education by realizing that the very object of existence is to attain, as nearly as possible, to a perfect development, which, of course, implies the discharge of all duties and obligations, many problems can be speedily solved in a general way. Much judgment and skill will always be required to accomplish the end in view with the means at hand; or, to put it in a more scientific way, to adapt the organism an
the environment to the best advantage. It has been abundantl
proved, by the history of education and human affairs as a whol
that with a theory utterly wrong people do not generally fall upo
right methods of action; and they never do so when work is t
be systematically performed, as in the case of our education
this country for the last thirty years at least. My own elem
ary education was conducted in what was at that period co
ered the best school in one of the most progressive cities ed
tionally in this country, yet in the light in which I now
would have been a great deal better without much of wh

then considered education. I have for a long period been trying to undo the harm wrought and make up for what was omitted at the most impressionable period of life, and I feel to this day that I have not wholly got rid of some of the evil effects. There was not only no science in the course, but the very methods used were radically opposed to science and to such knowledge of our organization as I am endeavoring to show is now well enough established. There was no freedom; the senses were utterly neglected; and human nature could not develop by such methods as were in vogue.

But many will no doubt think the case overdrawn, and point to the fact that development has actually gone on satisfactorily, and that our present standing in science and other subjects is a proof of it. Happily, it is not possible for Nature to be wholly repressed. We develop in spite of bad methods. The boy develops out of school if not in it. The great mass are educated by their work and other associations that make up their every-day life. Some of the best-educated people have never been inside of a school.

The great fertilizing ideas of our age, coming from the mint of genius and embodied in a way that appeals to all and in a measure educates all, have been at work. Who can estimate how great a part such a man as Edison, to mention a single instance, has played in the true education of our period? I purposely now select a practical man rather than a pure scientist. The great difficulty that most teachers would mention, I suppose, in the way of accomplishing their ends is in getting children interested, for children work when they are stimulated by interest. Yet this difficulty is not experienced with the kindergarten method at the beginning, nor in any serious degree with wisely devised laboratory work later at college. Why is a boy more interested in his sports than in his studies? Partly, at all events, because the former are better suited to his nature, to his development, than his studies as sometimes conducted.

Introduce scientific methods, and introduce science itself according to the laws that underlie our organization, and you will revolutionize our schools. To hope for this at once, even if the object were clearly perceived by all immediately concerned in education, would be Utopian; but success comes to those who strive persistently and wisely with a true ideal clearly in view.

I should like it well understood that the same methods that apply to what is usually termed science are also adapted for all other subjects. We use at least some of the same faculties, and it is the same mind that is engaged, whether with literature or science. I have already endeavored to show that one who pursues literature can not afford to dispense with the early training of the senses.

Having thus cleared the way and erected a platform on which to stand, or, in other words, supplied some tests for all educational methods, the subject of science in schools may be discussed, I hope, intelligently, without dwelling on the subject at great length. As before indicated, the principal questions in regard to science in schools are: When? What? How? How much?

When? As the first step in the knowledge of any branch of science is the gathering of sensory impressions or the noting of phenomena, you will at once infer my answer to this question, which is, as soon as the child begins school life. Of course, then and for some time after, little more can be done than to teach the learner to use its senses and to gather and compare sensory impressions, notably but not exclusively those of vision. This must be continued all through the educational career of the child, for we must ever learn in this way; and the exigencies of practical life constantly demand just such use of our eyes, ears, and hands as is implied in the correct method of studying science.

What? The course of studies proper for school life is a perennial theme of teachers' conventions. But is it not clear that the same end may be attained in many different ways? I do not see that any absolutely rigid course of studies should ever be mapped out, for the simple reason that the whole environment of the child must be taken into account—all the circumstances of the case. Always the most important factor in this environment is the teacher himself.

It is doubtful whether it would be wise to attempt to teach to very young children, with the preparation that most teachers can bring to the work, any branch of science as such; but there is no reason why the school life should not be full of object-lessons. But I mean real object-lessons on those things that have a practical bearing. We accomplish the purpose of education just as well by reference to real every-day life as to objects in which children can have no interest out of school, and which do not and will not make any part of their real world.

At a later age it becomes necessary to decide between, say, botany, zoölogy, physics, and chemistry. But, before referring to these, allow me to put in a plea for a sensible method of teaching geography. It is well to bear in mind that geography really is a science, though what it is in many schools it would be ha[illegible] to designate by any name. This I do know: it is often v[illegible] wretched stuff.

Why not introduce a child to geography by taking him i[illegible] the school-yard or its neighborhood, and there, after rain, ma[illegible] mimic lakes, bays, rivers, etc., or availing of those already m[illegible]

Why not get the points of the compass fixed in the natural way by reference to those great guides which alone are of any service to a mariner or explorer? Why not draw a map of the yard, and thus beget some real, tangible notion of the purpose of a map?

As all sciences involve the same methods and employ the same faculties, the choice of one to be studied in any particular case should be determined by such consideration largely as the location of the school, the qualification of the teacher, the extent of the equipment, and perhaps the tastes of the pupils. That branch will produce the best results which is most pleasurably and thoroughly pursued.

All pupils should at some period learn something of physics, though not necessarily mathematical physics. All require some knowledge of the properties of matter as such, and some idea of the forces and mechanism by which the results of industrial life, as well as those of Nature, are accomplished. Practical physics, as illustrated by what is going on around us, and by simple apparatus devised by scholars and teachers, will often serve every purpose. The cost of a chemical equipment depends on the size of the class and the extent of the work. Chemistry is more suitable for more advanced pupils and the better endowed schools.

But of far more importance than all other questions is *How?* We may have a teaching of so-called science that is a mockery of the reality.

It is surely now clear that any mere book teaching is worse than useless. It leads to no real knowledge, can give no healthy training of the faculties, and can lead to no sound development. He who can teach only by the book had better not begin. For pupils just commencing science it is doubtful whether it is not better for a while to avoid the use of text-books altogether. From first to last the student should be an *investigator*. This implies a great deal. It means that he shall desire to know and aim to learn the facts by one method and one only, viz., by seeking for them, as all that have ever found did, by the use of his natural faculties—i. e., by the use of his senses. All that any one can ever really know of any branch of science, let me repeat, is what he acquires by his senses—by feeling, seeing, etc. Whatever subject is pursued, this must ever be kept in mind. The teacher's guidance is invaluable in saving the pupil's time, economizing his energy, assisting in the comparison of results, and aiding in all the higher mental processes that lead to those generalizations which constitute the essence of science. But no teacher can be eyes and hands for any pupil, and to deprive the student of these organs, as all book teaching pure and simple does, is to cut at the very root of all true progress in development.

Nor should the investigating spirit be confined to the school and school hours. The pupil should be encouraged to observe on his own account and without guidance, and report the results. It is wonderful how much enthusiasm may be aroused in this way. The spirit spreads to the home circle, and the school becomes a quickening leaven to the whole community.

Every class and every school should have its museum. Of all kinds of mere hoarding, museum hoarding is the least objectionable. But the class museum especially should be the receptacle for objects that the pupils bring, thinking them especially suitable to illustrate certain points that have arisen. Sometimes the students prove so enterprising that the teacher's knowledge is severely taxed. But no teacher should be ashamed to admit ignorance. He may assume the attitude of an investigator *with* his pupils; indeed, that is the safest and healthiest way to put the matter. He is then an example of what he would have his pupils become.

It would be well that every school should have a library of books of reference on the subjects of science taught, and indeed on all subjects. The Encyclopædia Britannica is invaluable. Such a use of books as a last resort to aid in settling doubtful points is perfectly legitimate.

If any subject can not be taught by the natural method, that is sufficient to render it unsuitable for any particular class or school.

Physiology and hygiene are of great importance for medicine. All liberally educated people should understand these subjects. No graduate of a college should, in my opinion, obtain his degree without giving evidence of a practical knowledge of the general structure and functions of his own body. No doubt it would be well for the great masses to know the laws of life, and the dangers that beset them from mistakes and excesses. But physiology is perhaps the most difficult of all sciences, certainly the most difficult to teach well in schools. If it be not practical, based on actual observation, it may prove worse than useless. Book physiology is rubbish, utter rubbish. No doubt much useful hygiene may be taught in a practical way, by example rather than by precept; but the attempt to teach scientific physiology to very young pupils can, with few exceptions, end only in failure, and probably in much confusion and misconception. Physiology has been largely introduced into our schools. It would be interesting to know how many of the teachers have themselves a practical knowledge of the subject, and how many of the pupils really understand what they commit to memory. But all teachers, whether required to give instruction on this subject or not, should have a sound, practical knowledge of it, because of its great importance in school life.

There is no science which does not permit of simple experiments that may be introduced into any school. The pupils will delight in these, and they will prove a source of strength, pleasure, and inspiration. I am not, of course, to be understood as claiming that every fact that a child shall take cognizance of shall be gained through observation and experiment; but this is the ideal, and the nearer it is approached the better.

I again repeat that it is not the extent of ground covered, but the method, that is important. Let us not over-examine our pupils. How much in education is sacrificed to examination!

It has often occurred to me that if, in all schools, large and small, there was a certain portion of the time of each week set apart for the development of the general intelligence and moral life of the pupils in such way as the teacher saw fit, irrespective of any rigid course or time-table, it would be well. It should not be difficult to devise safeguards against the abuse of this by unworthy teachers. Readings, talks, short lectures, experiments, excursions, or any means the teacher may devise in harmony with the principles that underlie our organization, will aid in accomplishing the purpose in view. I do not refer to science alone, but to literature, and all that leads to a healthy development. Such a plan wisely put into practice gives tone to the entire school.

There is no limit to the means by which the great aim of education may be accomplished. As I have endeavored to show, the high purpose of education is development according to the laws of Nature as they are unfolded to us by the observations of every-day life, and especially by the study of brain physiology and of psychology. Those methods that harmonize with our organization are successful; all others fail. The child that is educated according to these laws is healthy, happy, and progressive. He leaves school not only uninjured in mind and body, but with the abounding physical and mental vigor that should characterize youth. His tendencies are toward investigation and application. He thirsts to know, and he understands how to enlarge the bounds of his knowledge. He desires to apply, and he can apply. His moral impulses are toward progress, harmony, and freedom of thought and action, and according to his natural endowments does he influence the world more or less, but always for good.

A NUMBER of members of the American Association while in Rochester paid a visit by invitation to the library of the late Lewis H. Morgan. The room, fifty feet by thirty, is finished in oak and black walnut, and is described as a "perfect *thesaurus*" of relics, buckskin suits, ancient weapons, and other objects of interest to the archæologist and anthropologist. Mr. Morgan was chief in one of the tribes of the Iroquois, and his suit of buckskin was shown, packed away as he had left it.

ON POSTURE AND ITS INDICATIONS.

By T. LAUDER-BRUNTON, M. D., F. R. S.

IN a former paper * I observed that I thought medicine lost a great deal by its practitioners either not recording their experience at all, or not recording it in such a form as to be readily available for their fellow-practitioners, or with sufficient precision to be really useful. As examples of vagueness and precision I instanced a verbal description of a face as commonly given, and a sketch containing all the features more or less precisely drawn. In the present paper I have tried in a very imperfect way to indicate the common postures which one meets with daily, either in patients or others, and to discover the reason why those postures are assumed. I have not attempted to draw the figures, for this would have been beyond my powers, and probably also

Fig. 1.

Fig. 2.

beyond the powers of many medical men. I have simply indicated the position by a few simple lines such as any one can draw. This method is one which was employed with great success by the late Prof. Goodsir more than thirty years ago in illustrating his lectures on anatomy. In a few lines he conveyed the impression of the agility of the cat as compared with the heavy movements of the ox or of the elephant, and the absence of detail fixed the minds of his students all the more firmly on the main facts which he wished them to carry away. As we walk along the streets and notice the difference of attitude in the passers-by, some with head erect and agile steps convey to us at once the idea of energy and activity (Fig. 1), while others with hanging heads and bended knees suggest the ideas of languor, weakness, and depression (Fig.

* On the Method of Zadig in Medicine. The Lancet, January 2, 1892.

2). It is a matter of ancient observation that such an attitude as this is associated with weak circulation, and it is probably more than three thousand years ago that the injunction was given: "Strengthen ye the weak hands and confirm the feeble knees; say to them that are of a fearful heart, Be strong, fear not" (Is. xxxv,

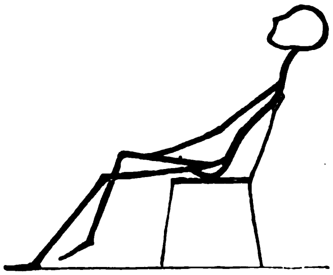

FIG. 3.

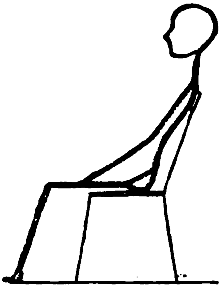

FIG. 4.

3, 4).* When the heart is stimulated by joy or hope, the attitude again becomes erect, and the gait brisk and elastic. It is by no means easy to distinguish exactly between the part played in this change by the motor cells of the nerve-centers and by the circulatory apparatus, for the activity of the motor cells on which muscular action depends is itself influenced to an enormous extent by the circulation of blood through the nerve-centers. We find an example of this in the attitude unconsciously assumed by any one engaged in conversation or argument. So long as he takes only a listless interest in the subject under discussion he may lie back

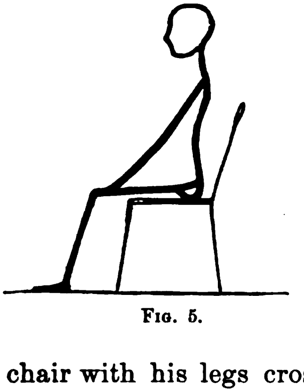

FIG. 5.

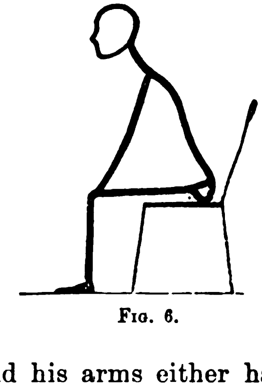

FIG. 6.

in the chair with his legs crossed and his arms either hanging down or his hands laid loosely in his lap (Fig. 3). As his interest increases his attitude becomes more erect (Fig. 4), and he sits straight up, with his hands folded or laid upon his knees instead

* Also, "Lift up the hands which hang down, and the feeble knees, and make straight paths for your feet" (Heb. xii, 12).

of hanging listlessly down (Fig. 5). As the interest increases still further the body is bent forward at an angle and the hand is very probably placed firmly on the thigh (Fig. 6). If he becomes excited in the heat of argument, the body is bent forward at a somewhat acute angle and the hand is stretched out in front and somewhat upward, as if to help the words which flow from his lips to drive the thoughts which are rapidly evolved from his brain into his opponent's mind (Fig. 7). In this position the flow of blood through the arterial system onward to the brain as well as its return backward through the veins seems to be particularly easy (Fig. 8).

Fig. 7.

This position is not only assumed during the heat of argument whether the speaker be sitting or standing, but when one is led to assume it unconsciously it seems to give rise to a rapid and sometimes almost uncontrollable flow of ideas. Thus it occasionally becomes a cause of remorse to devout souls, who during the attempt to pray in church in this attitude are sadly distracted by crowds of ideas which at once disappear on the assumption of an easy sitting posture. The circulation in the cerebral vessels and the current of ideas in the brain are very delicate things and may be modified by very slight causes; thus, an attitude with the head drooping slightly more than that indicated in Fig. 6, and with the chin supported upon the hand, is the one frequently assumed in deep thought, with concentration of ideas upon a single subject, and no desire for immediate expression (Fig. 9). The touch of

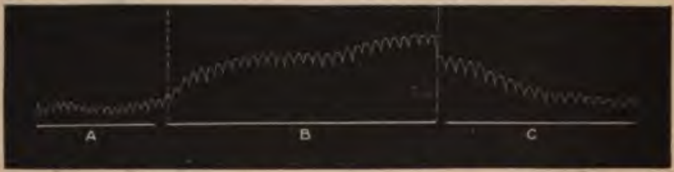

Fig. 8.—Tracing from the Brain. A, in upright position; B, with head inclined forward.

the hand upon the head seems to have a directing power over the thoughts which one would formerly have been inclined to deny, but such experiments as those of Tesla and Crookes with electric currents of very high tension give a visible illustration of phenomena previously unknown and seemingly incredible. For in these experiments a person who has put himself into the electric field renders vacuum tubes containing various substances fluorescent, and fills them with a glow of colored light by simply waving his hands over them. The tubes, which were previously dark, owe their luminosity only to the approximation of his hand, yet he himself does not feel that any special power has gone out of him. The contact of the hand with the temples seems as if it could hardly by any possibility modify the circulation in the brain or the feelings of the individual, and yet it appears to have

Fig. 9.

Fig. 10.

an actually soothing effect and to be a real physical solace in cases of grief and depression (Fig. 10). At the same time the greater droop of the head possibly provides for a better supply of blood to the sensory parts of the brain in the posterior part of the head, and thus to a certain extent counteracts the general weakness of the circulation. In the case of excitement (Fig. 7), the head being more raised, if a straight line were drawn through the axis of the body so as to represent the line of the aorta and carotid arteries, it would come out at the anterior part of the head, and blood driven onward in this line would supply nutriment rather to the motor than to the sensory centers.

In cases where the circulation is exceedingly weak and syncope is threatened, a most useful plan is to make the patient put his head down between his knees (Fig. 11), so that an ample supply of blood shall reach the cerebral centers. Long ago, before the introduction of anæsthetics, a common plan of rendering patients senseless previously to the performance of an operation was to lay the patient flat upon his back and then suddenly hoist him to a standing posture by six strong men who held him by the arms, three on one side, and three on the other. The brain being thus, as it were, lifted away from the blood, became so anæmic that it ceased to act before the circulation could adapt itself to the new posture.

Fig. 11.

An experience of my own once showed me how very dependent the brain is upon the supply of blood. I was called upon one night after a long day's work to write an article immediately. I sat down with pen, ink, and paper before me, but not a single idea came into my head, not a single word could I write. Lying back, I soliloquized: "The brain is the same as it was yesterday, and it worked then; why will it not work to-day?" Then it occurred to me that the day before I was not so tired, and probably the circulation was a little brisker than to-day. I next thought of the various experiments on the connection between cerebral circulation and mental activity, and I concluded that if the blood would not come to the brain the best thing would be to bring the brain down to the blood. I laid my head flat upon the table, and at once my ideas began to flow and my pen began to run across the paper. I thought, "I am getting on so well, I may sit up now," but the moment I raised the head my mind became an utter blank, so I put my head down again flat upon the table and finished my article in that position.

Stimulation of some branch or other of the fifth nerve seems to increase the circulation in the brain, and those who are making their utmost calls upon their mental powers are accustomed to stimulate this nerve in one way or another. The late Lord Derby used to eat brandied cherries, and an experiment of Marey's (Fig. 12) proves that mastication will accelerate the flow of blood through the carotid artery, and serves to show the wisdom of an editor whom I knew who used to eat figs while writing a leading article, and even of those who indulge in the practice so disagreeable to their neighbors of chewing tobacco. Others stimulate the gustatory branches of the fifth nerve by the sweets which they suck, or by the smoke of a cigar or cigarette, while a rustic called upon suddenly to answer a question will probably excite the cutaneous branches of this nerve by scratching his head, and a man of more culture may stroke his mustache or beard, press his forehead or eyes, or, like many Germans, smite his nose with the forefinger.

Fig. 12.—Tracing of the Rate of Circulation in the Carotid. (After Marey.)

A similar reason may be given to explain the habit of snuffing, formerly so much in vogue. The gentle titillation of the nasal mucous membrane by the snuff probably serves to stimulate the cerebral circulation, and the increased arterial tension due to the efforts of sneezing so increases the cerebral nutrition that difficulties seem at once to disappear, and obscurities of mental vision are so rapidly removed that snuff is said in popular language to "clear the head." The practice of snuffing has fallen to a great extent into disuse, but it may still be occasionally employed with advantage in cases of severe and persistent headache, where other remedies fail to relieve. Even where such a strong irritant as snuff is not resorted to, smelling salts (sal volatile) or aromatic vinegar may give considerable relief in headache if frequently inhaled.

While stimulation of the fifth nerve as just described tends to keep people awake and increase their mental activity, gentle, rhythmical stroking of the head tends, on the contrary, to make them fall asleep, and brushing the hair has this effect on many people to such an extent that the movements of the hair-dresser's fingers over the scalp, and rhythmical click of the shears, will

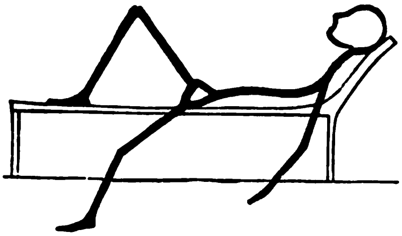
Fig. 13.


Fig. 14.

send some people to sleep, even at the risk of having their hair shorn to a much greater extent than would be at all pleasing to them on awakening. A gentle rubbing of the scalp, as if to loosen it upon the skull, also tends not only to soothe irritability, but to relieve and to prevent headaches.

External temperature has a powerful effect in determining posture. On a hot summer's day the natural tendency is to lie down with the head slightly raised, the arms hanging loose, and one leg extended, while the other perhaps is drawn up, as in Fig. 13. The physiological reason for this posture is that in it the greatest extent of cooling is attained, for it insures the greatest possible exposure of the largest vascular district in the body—viz., the intestinal vessels—to the cooling influence of the external air. This is aided by the loss of heat due to the evaporation of sweat. By the slight raising of the head and the drawing up of one leg, the abdominal parietes are rendered loose, and the intestines tend to fall sideways, and the abdomen tends to become flattened from before backward. The greatest extent of cooling surface is thus obtained, and the temperature of the body is kept as low as possible.

An entirely opposite attitude is assumed when the external air is cold (Fig. 14). The thin abdominal walls being insufficient to protect the intestinal vessels from the cooling influence of the external air, the legs are drawn up until the thick muscles of the thigh form a warm covering to the abdomen and thus prevent loss of heat from the intestinal vessels. Many people are unable to get to sleep when they are at all cold; and Rosenthal has shown that this attitude is commonly adopted by men, dogs, and other animals when preparing to sleep, so as not only to maintain the bodily temperature during sleep, but to allow the intestinal vessels to dilate and accommodate a mass of blood which would otherwise be driven into the cerebral circulation, stimulating it to functional activity and keeping the person or animal awake.

The attitude of the body may be altered permanently by occupation or disease in such a way that one accustomed to pay attention to this subject can frequently make out, with a little trouble, a good deal regarding the patient's history and illnesses. Thus, a chronic cough has the effect of inflating the chest and rounding the back, so that one might almost guess from the figure (15) that the person so shaped was liable to chronic bronchitis. The more tightly a bladder is blown up with air the more tense does it be-

Fig 15.

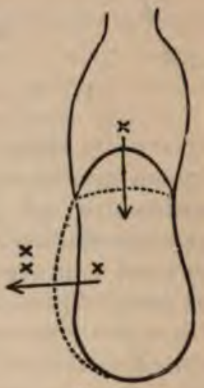

Fig. 16.

come and the more does it take a circular form. In the same way the more an alveolus of the lung is blown up by the efforts of coughing the more does it resemble the inflated bladder. What is true of a single alveolus is true of the chest as a whole. It tends as nearly as possible to become globular, with a circular outline not only in the transverse but in the longitudinal direction. The sternum and vertebræ prevent it from becoming completely globular, notwithstanding all efforts, and it thus assumes the barrel shape so characteristic of emphysema, as being the nearest possible approach to a globe. In going through a hospital ward one sees here and there patients who are constantly sitting up in bed and do not lie down at all; these are for the most part people who have great difficulty of breathing. The reason for this position has no doubt been often given, but I do not recollect coming across it in print and I can not say whether the reason that I now give has been evolved from my own brain or whether I have learned it from others.

When a man is sitting upright the diaphragm moves up and down during respiration (Fig. 16). At each inspiration it descends and displaces the intestines and the abdominal walls outward. During each expiration the diaphragm ascends and the intestines and abdominal wall return back to their former position. In the upright posture the diaphragm moves vertically, but the abdominal walls and intestines move in a horizontal plane and there is no lifting work for the diaphragm to do. The case is quite different when a man is lying on his back, for then the diaphragm moves in a horizontal plane and the abdominal walls and intestines in a vertical one. During inspiration as the diaphragm encroaches on the abdomen for the purpose of enlarging the thorax (Fig. 17) it has actually to raise the intestines and the abdominal walls instead of merely moving them in a horizontal plane. As the diaphragm returns into the thorax during inspiration its progress will be accelerated by the weight of the descending intestines, and thus the recumbent posture may be sometimes useful in cases of bronchitis with emphysema, and so such cases may be seen sometimes lying down although there is considerable interference with the aëration of the blood. In cases of cardiac disease no benefit of this kind is obtained, and therefore we find that a large proportion of those whom we see sitting upright in bed in a hospital ward are suffering from disease of the heart.

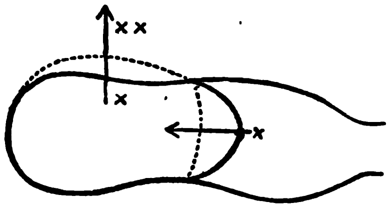

FIG. 17.

When a patient lies upon his side the intestines also move in a horizontal plane, and this is the position usually assumed during healthy sleep, for in it there is no interference with expiration any more than when the patient is sitting upright, while at the same time the rest obtained is much more complete. The side upon which one lies is immaterial to most healthy persons, and they frequently lie first upon one and then on another, turning over perhaps several times in the course of the night; but in cardiac disease or cardiac irritability without organic disease patients frequently are unable to lie upon the left side because the heart beats against the ribs with such force as to cause physical discomfort. At the same time the heart itself appears to be stimulated by the blows which it gives itself against the thoracic walls and to palpitate more violently than before. The patient is therefore obliged to lie upon the right side. A similar result may occur if the liver is enlarged or congested, for then it seems to drag upon the suspensory ligaments when the patient lies upon the left side, and thus he is obliged to turn round that the liver may be supported by the ribs. If a heavy meal has been taken shortly before retiring to rest the person may be unable to lie upon his left side because the stomach drags upon its pyloric end. On the other hand, if the stomach is distended by flatulence, the gases sometimes will not escape while the patient is lying on his right side, and he must either be raised into a sitting posture or be turned on his left side to allow the gas to eructate by the œsophagus and the tension in the stomach to be relieved,* for the œsophagus joins the stomach at such an angle that when the patient is on his right side the gases appear to accumulate and not to find an exit through the œsophagus, but when he is on his left side they pass upward with comparative ease. This, of course, is a matter of very slight moment to patients who are able to move readily, because they adjust their own position at will and soon find out which is the most easy one for them. But when a patient is so weak that he is unable to move himself he is frequently allowed to lie flat on his back and to suffer much from abdominal distention and even from difficulty of breathing, due to the diaphragm being pushed upward, when he might be relieved by simply sitting him up for a few minutes or turning him over on his left side.

In this short paper I have made no reference to many other postures in disease, neither have I attempted to discuss the postures due to trade, nor have I attempted to make the paper complete. I have merely tried to give an illustration of an easy method of recording posture in a tolerably precise and easily understood way, and have attempted to connect external signs with physiological conditions as an illustration of the method of tracking which I mentioned in a former paper in the hope of inducing others to prosecute the same line of work.—*London Lancet.*

Forecasting the future of psychology, Prof. Charles Richet anticipates, with regard to comparative psychology, that we may some day arrive at the reason of madness and crime, with all the important social solutions which that knowledge would carry with it. With regard to transcendental psychology, we possess, he said, numerous gifts often or almost always imperfect, which allow the supposition that human nature has extraordinary resources, and that it contains forces which it does not even suspect. The author hoped the day would come when all these scattered gifts would be realized.

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* I have found this practice useful. The explanation I have given of its utility was, I think, suggested to me several years ago by John Haddon, M. A., M. D.

THE PROBLEMS OF COMPARATIVE PSYCHOLOGY.*

BY JOSEPH JASTROW, PH. D.,
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TO any one thoroughly impressed with the intimate relations of mind and body, it seems natural enough that the gradual development and perfection of the one should carry with it analogous stages in the growth of the other; but even the most profound student must at times give wondering expression to the marvelous extent, the endless variety, and the unexpected precision of the interrelations of the physical and the psychological. An extensive survey of the phenomena to be studied, and a discerning and comprehensive use of the comparative method in studying them, are as necessary and as promising in the mental as they have proved to be in the physical sciences. We must overcome the tendency to study too exclusively our own adult, civilized, conscious selves; to view the landscape by observing its reflection in a mirror, and thus seeing everywhere our own image. With full appreciation of the supreme interest we must always have in our own mental powers, it may be maintained that in proportion to our knowledge of the earlier, simpler, and lowlier manifestations of intelligence, will be our ability to appreciate and utilize the best and worthiest faculties in ourselves.

Comparative Psychology finds its origin and its material in the variety of animal life, in the series of changes of which an individual life consists, and in the evolution of more complex forms of life from one generation to another. The first of these—Animal Psychology—endeavors to arrange in orderly sequence the various forms of mentality from protozoon to man, to discover in what this advance consists, to establish orderly relations between mental powers and the nervous system, and the like. The study of the stages, and especially the earlier stages, of the growth of the human mind—Child Psychology—has only recently been pursued in a scientific spirit, so that systematic records of the essential and important points of child-growth are lamentably rare. But even this limited research has brought to light an interesting body of facts, and holds out the promise of more valuable results as the fruits of more extended investigation. The side of anthropology that deals with the stages of man's mental progress from rudest savagery to the highest civilization; tracing the variety and onward movements of customs, habits of thought,

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*** Abstract of a lecture delivered before the Chicago Institute of Arts, Science, Letters, and Religion.**

and beliefs; showing the effect of environment upon mental constitution, and in endless ways contributing to the natural history of human endeavor—all this abundant material has been ably canvassed, but needs to be rearranged upon a psychological basis to form the science of Anthropological Psychology.

It is so obviously impossible within the present limits to consider the facts and generalizations of these departments of science, that no justification is necessary for confining our attention to some consideration of the relations of these three paths of development to one another, and particularly to the psychological position of man. In so doing excursions into each of the fields will be made, and some glimpses be obtained of the several departments of Comparative Psychology.

To appreciate the comparison of infant with animal traits, one must bear in mind some important characteristics differentiating the young of the human kind from the young of other animals. The series of changes of which an individual life consists indicate that the individual enters life in a condition simpler than that which it eventually attains. These changes diminish in extent as we descend the scale of organisms, until in the lowest organisms the newly born and the adult are almost indistinguishable. Whether we consider the embryonic preparatory stage of life, or whether we regard as the beginning of existence the entrance to the environment of Nature, and speak of the preparatory stage as that which intervenes between birth and maturity, we shall find it measurably true that in proportion to the complexity of mental development to which the individual may eventually attain will this pre-adult period be lengthened. An aspect of this law, of special psychological interest, is the resulting difference in the powers present in the newly born of different species: the lower organism has a larger share of its powers ready at birth, has less to learn, less to be modified by and adapted to its environment than has the higher organism. Many of the marvelous instincts characteristic of the insect tribe seem to be at the service of the new-born individual. "With such creatures as the codfish, the turtle, or the fly-catcher, there is . . . nothing that can be called infancy" (Fiske). The most complete experiments bearing upon this point are those of Mr. Spalding. In the first minutes of life chickens follow "with their eyes the movements of crawling insects, turning their heads with the precision of an old fowl. In from two to fifteen minutes they pecked at some speck or insect, showing not merely an instinctive perception of distance, but an original ability to judge, to measure distance, with something like infallible accuracy." A chicken hooded as it emerged from the shell was unhooded when three days old; six minutes later "it followed with its head and eyes the movements of a fly twelve inches distant; and about ten minutes later "made a vigorous dart at the fly, . . . seized and swallowed it at the first stroke." When placed within sight and call of a hen, "it started off toward the hen, displaying as keen a perception of the qualities of the outer world as it was ever likely to possess in after-life. . . . This, let it be remembered, was the first time it had ever walked by sight." The young of mammals, though not as independent as chicks, show quite a remarkable series of powers ready at birth. A pig in one of Mr. Spalding's experiments, blindfolded at birth, went about freely, though stumbling against things. When the blinder was removed the next day, it "went round and round as if it had had sight and suddenly lost it. In ten minutes it was scarcely distinguishable from one that had had sight all along." And Mr. Fiske tells us that "all mammals and most birds have thus a period of babyhood that is not very long, but is, on the whole, longest with the most intelligent creatures. It is especially long with the higher monkeys, and among the man-like apes it becomes so long as to be strikingly suggestive." Mr. Wallace observed an orang-outang three months old, perfectly helpless, unable to feed or walk without assistance, or to grasp objects well, and of these creatures Mr. Huxley says that they "remain unusually long under their mother's protection," and are probably not adult until ten or fifteen years old.

The extreme divergence between the state in which the individual enters the world and the powers attainable during life appears without question in the human species. A more complete condition of helplessness than appears in the human infant can scarcely be conceived: only such senses and movements as are immediately necessary to nutrition are present; although sensitiveness to light, and after some days to sound also, appear, accurate perception by these senses is impossible for several months. While the newly hatched chick sees a grain of corn and accurately seizes it, the human infant in the presence of a desired object, even after months of practice, performs a host of uncoördinated, useless movements, obtaining the object as much by accident as by design. On the other hand, we should not forget the marked educability of the higher animals. An old bird does and avoids much that is impossible to the young one; the kitten and cat, the pup and dog, show still greater differences. As a single illustration from the vast testimony on this point, Dr. Eimer's observations with a trap for catching sparrows may be cited. At the first setting he caught a dozen sparrows; at the second setting, nine were caught; but all these "were young birds, hatched the same spring, and therefore of little experience. Not a single old sparrow had entered the trap." The following spring "a curious spectacle was observed: apparently several sparrows had the desire and the intention to go into the trap, and these were obviously the young, inexperienced birds which had been hatched since the trap was last set"; but the older birds sounded the cry of warning, and kept the venturesome young sparrows away.

Let us next view the prolongation of human infancy in the light of the law of habit. This law declares that every reaction of an organism to a condition in its environment renders the repetition of that reaction quicker, easier, more certain, more uniform; and the existence of habits implies an environment sufficiently constant to repeatedly present to the organism the same or closely similar conditions. Mere existence in a world so full of regularities, of rhythm and law, of recurrences of the same needs, results in the performance of definite actions in definite ways; and it equally results that the earliest experiences will produce the strongest impressions and will gradually render more difficult the learning of other modes of reaction, even though these others, owing to a change of conditions, would be more useful. Accepting the power of adaptation to an extensive and variable environment as *an* if not *the* index of a high intelligence, it follows that prolongation of the period during which acquisition is possible and easy will greatly further intellectual progress. The supreme significance of education thus appears as an outcome of the long preparatory period of human life; the modifiability of the individual is what makes possible training, education, alike in animals and men, and modifiability involves immaturity. Man attains his high intellectual position by entering the world the most helpless of living kind; but, because less freighted with the ingrained habits of his ancestors, is he freer to develop habits of his own. "It is babyhood," says Mr. Fiske, "that has made man what he is."

Pursuing our thought in another direction, we find that organisms entering life more nearly mature will be more like one another, will present fewer individual differences than animals with extended periods of immaturity; and in turn one generation will be more like the preceding and the progress of the species be proportionately slow. The early independence of the young involves action upon inherited instincts, which naturally are closely the same for all members of the species; there thus results a fundamental similarity, leaving a relatively small margin for individual differences. A further result of a prolonged infancy is the group of emotions it arouses and perpetuates on the part of the parents. Motherly devotion and affection, fatherly interest and supervision extend over a larger and longer period as the species is more and more highly developed, until among the highest races of man it continues in a modified form throughout life, and in this modified form contributes to the development of the sentiments of kinship, family pride, altruism, and many social virtues. We thus have reason to connect education, family government, together with the rich emotional capabilities, the complex intellectual powers that follow in their train, with the apparently insignificant fact that the human infant enters life in a much less mature condition than the young of other species.

We have thus far been occupied in comparing stages of animal with stages of human development; we shall now test the validity of the same train of thought in the comparison of different stages of human progress. It would appear that among less civilized peoples there is a shortening of the pre-adult period, a precocity of development, an earlier abandonment by the parent, an earlier independence of the young. Mr. Spencer tells us that in equatorial Africa the children are described as "absurdly precocious," that among the west Africans the youth are "remarkably sharp when under puberty—that epoch, as among the Hindus, seeming to addle their brains." An interesting result of this difference is the early wane of the powers of receiving new ideas, and the consequent limitations of the mental horizon. The civilized mind at first lags behind the uncivilized, but the latter soon comes nearly to a standstill, and is then immeasurably outstripped by the continued growth of the former. Thus—still drawing upon Mr. Spencer's facts—of the Australians it is said that "after twenty their mental vigor seems to decline, and at the age of forty seems nearly extinct"; of the Sandwich-Islanders, "that in all the early parts of their education they are exceedingly quick, but not in the higher branches; that they have excellent memories, and learn by rote with wonderful rapidity, but will not exercise their thinking faculties"; of New-Zealanders, that "at ten years of age [they] are more intelligent than English boys, but as a rule few New-Zealanders could be taught to equal Englishmen in their highest faculties." Sir Samuel Baker says of the negro in Africa, that in childhood he is in advance in intellectual quickness of the white child of the same age, "but the mind does not expand—it promises fruit, but does not ripen"; and the educators of the negro in this country have encountered similar difficulties—great aptitude at beginnings, but inability to go on to original thinking.

The comparison regarding the uniformity of minds whose period of development is relatively brief will apply to widely differing human races. There can be little doubt that primitive people are more like one another than are individuals belonging to a higher mental type, and in the different classes of a civilized community there is greater individuality among the educated than among the uneducated, and this can hardly be unrelated to the postponement of independence, the longer education, which the former enjoy. This similarity of individuals in relatively low stages of development is accompanied by a lack of mental pliability, a rigidity of custom, thought, and habit, that in turn leads to the perpetuation of meaningless customs, to an unyielding conservatism, an uncertain and fitful advance. And we may add that the development of the parental feelings and virtues seems clearly richer in highly developed races than in undeveloped ones. We may epitomize our thought in Mr. Spencer's words: "The animal kingdom at large yields us reasons for associating an inferior and more rapidly completed mental type with a relatively automatic nature. Lowly organized creatures guided almost entirely by reflex actions, are in but small degrees changeable by individual experiences. . . . Inferior and superior races are contrasted in this respect. Many travelers comment on the unchangeable habits of savages. The semi-civilized nations of the East, past and present, were or are characterized by a greater rigidity of custom than characterizes the more civilized nations of the West. . . . And if we contrast classes or individuals around us, we see that the most developed in mind are the most plastic."

I have dwelt long upon this argument because it illustrates so well the closely analogous developments of these three paths of mental unfoldment, inferences traceable from facts gathered along one of the lines finding corroboration along the others, and all contributing to the significance of the dictum that the child repeats *in parvo* the history of the descent of man, and of the growth of the human race.

Resuming at this point our comparison of animal with infant traits, we have learned to expect mental similarity only in such animals as in their adult condition surpass at least in certain respects the capabilities of the human infant at birth. Within this range we find abundant points of community of various degrees of value and familiarity. The playfulness that is characteristic of children is no less so of kittens, nor is their imitativeness more typical than that from which the word "to ape" h
been derived. Curiosity, inventiveness, dislike of ridicule,
of being fondled, craving for attention, with the resulting
ousy and anger when such attention is refused, are types of
complex emotions common to intelligent animals and chi
Indeed, the terms of familiarity so often found and so
established between children and their pets can not but b
in part at least, upon a deep sympathy and community
tional life. On the intellectual side correspondences ar
frequent and significant, but are difficult to describe an
M. Perez, a discerning student of children, has carefull
the life histories and early trials of two pet kittens
constant occasion to draw analogies between the ki

infants. Both show at parallel stages of development the appearance of the same faculties, often in strikingly similar forms. Just as infants learn to distinguish between men and women, between persons differently dressed, between old and young, kindred and stranger, so an intelligent dog learns to distinguish between visitors and beggars, between strangers and friends of the family, between those who will fondle him and those who will not. A single illustration is all we can stop to recount. A child was accustomed to hear prayers read by the head of the household, who while thus engaged often rested his head on his hand. When asked to say prayers, the child assumed this at first inexplicable attitude and mumbled something under its breath. The real process was incomprehensible, the outward form had been mimicked and some insignificant detail seized upon as the essential. Precisely the same is true of the behavior of the monkey described by Dr. Romanes. This pet animal was given the key of a trunk in which nuts were kept, and "every time he put the key into the lock and failed to open the trunk he passed the key round and round the outside of the lock several times. The explanation of this is that my mother's sight being bad, she often misses the lock when putting in the key, and then feels round and round the lock with the key; the monkey therefore evidently seems to think that this feeling round and round the lock with the key is in some way necessary to the success of unlocking the lock, so that, although he could see perfectly well how to put in the key straight himself, he went through the useless operation first." Not alone can this general parallelism between infant and animal traits be maintained, but to a considerable extent can it be shown that the powers and traits appearing earliest in the child are those already present in the lower groups of animals; and Dr. Romanes has drawn up a table exhibiting the first appearance of various emotions and intellectual powers in the animal scale and in the life history of human individuals, in which he makes the order very largely the same for both.

We may now proceed to illustrate the relation between child psychology and anthropological psychology, to trace points of community between the infancy of the race and the infancy of the individual. At the stage at which, owing largely to the development of language, the analogies between infant and animal traits become weak and scanty, the comparison between the child and the savage increases in extent and importance. Difficult as it is to select typical instances of this varied and suggestive similarity, both in emotional and intellectual traits, yet the attempt must be made. In the emotional sphere we would instance instability of character, impulsiveness, an easy and quick transition series of emotions to their opposites, violent passion upon slight provocation, with an equally intense pleasure in trifles, a great joy in brilliant and startling sense-impressions, a narrow range of susceptibilities, with the self-centering emotions—especially fear, anger, jealousy, vanity—the more prominent. The instability of the child's character hardly needs illustration; it depends largely on the limited range of memory and rational expectation. A child in pain is appeased by a sugar-plum; its anger forgotten in a new picture-book. The entire attention is given to one object; this fills the mental horizon, much as the hypnotized subject attends solely to the suggestion of the operator. Passionateness is a typically childish trait; at two months the characteristic pushing away of distasteful objects, screaming, growing red in the face, appear and continue with increasing vehemence until a wise surrounding gradually substitutes for them a more rational procedure. Of childlike traits in savages there are abundant illustrations. The Snake Indian is termed "a mere child, irritated by and pleased with a trifle." Of the tribes of the Malayan Peninsula it is said that "like children their actions seem to be rarely guided by reflection, and they almost always act impulsively." The tears of the South Sea islanders, "like those of children, were always ready to express any passion that was strongly excited, and like those of children they also appeared to be forgotten as soon as shed." Accompanying this there is "a childish mirthfulness—merriment not sobered by thought of what is coming." Mr. Spencer thus comments upon these facts: "The saying that a savage has the mind of a child with the passions of a man (or, as it would be more correctly put, has adult passions which act in a childish manner) thus possesses a deeper meaning than appears. There is a genetic relationship between the two natures, such that, allowing for differences of kind and degree in their emotions, we may regard the co-ordination of them in the child as fairly representing the co-ordination in the primitive mind."

Similarities in intellectual traits lie close at hand; the study of language offers a number of pertinent illustrations. The prominence of gesture, pantomime, facial and other expressions in the primitive speech has been conclusively established, and i equally typical of the child's language at certain stages of i development. In both, speech partakes less of symbolism a has a natural directness of meaning. When we are told that Bojesmans can not converse at night without a fire, because language is dependent upon explanatory gestures; that the guage of a Ceylon tribe is composed largely of signs, grim and guttural sounds; or that the Tasmanians observe no order or arrangement of words in their sentences, we are reminded of like characteristics in a child's babbling. S ties in linguistic details may also be observed. Primitive languages abound in reduplicative words, as is shown in many words that we have adopted from them, such as *cocoa, anana, agar-agar, pow-wow;* and Sir John Lubbock has found from twenty to eighty times as many such reduplications in savage as in European tongues. Children are constantly using reduplications, some of which we have adopted from their baby talk; such as *papa, mamma,* the German *amme, pupe,* the French *bébé.* The imitative faculty, a marked characteristic of savages and children, appears in language in the many words founded upon direct imitation or sound analogy. The child speaks of the *mu-mu,* the *bow-wow,* the *tick-tack,* the *shu-shu,* the *ting-a-ling;* and the large proportion of onomatopoetic words in savage tongues is well recognized. Difficulty in pronouncing certain sounds, inaccuracy of articulation, a mention of only the prominent words without definite order and connection, a mere skeletonizing of the sentence—these and the like are found both in the infancy of language and in the infant's language.*

The characteristics of language are often indicative of the mental traits of those who use it. The child's word sphere is at first concrete and specific, acquiring but very gradually a use of ideas and words that are generic and abstract. These are equally the limitations of the savage mind; the absence of generic and abstract words in savage tongues has been noted by various travelers. Some Brazilian tribes have "separate names for the different parts of the body, and for all the different animals and plants with which they were acquainted, but were entirely deficient in such terms as 'color,' 'tone,' 'sex,' 'genus,' 'spirit,'" etc. The language of the Veddahs (Ceylon) is said to be so primitive "that the most ordinary objects and actions of life are described by quaint paraphrases." Some of the Indian tongues have words for red oak, white oak, etc., but not for oak or for tree. Other evidence of the mental poverty is easily supplied. "The mind of the savage," says Sir John Lubbock, "like that of the child, is easily fatigued, and will then give random answers to spare himself the trouble of thought." Mr. Galton says of the Damaras that they never generalize, and "a Damara who knew the road perfectly from A to B, and again from B to C, would have no idea of a straight cut from A to C; he has no map of the country in his mind, but an infinity of local details."

The savage and childish conceptions of quantity, number, time, and space show striking similarities of limitation and de-

* The study of the natural language of the deaf-mutes yields important corroborations of many points. This has been ably studied by Mr. Tylor in his essays on Gesture Lan- 'arly History of Mankind; see especially page 54.

fect. There seems to be considerable evidence that very primitive peoples do not count above four or five, all quantity above that being simply an indefinite many. Mr. Galton has given so striking and graphic an account of a Damara's conflict with matters mathematical, that one can not forbear citing it in detail: "In practice, whatever they may possess in their language, they certainly use no numeral greater than three. When they wish to express four, they take to their fingers, which are to them as formidable instruments of calculation as a sliding rule is to an English school-boy. They puzzle very much after five, because no spare hand remains to grasp and secure the fingers that are required for units. Yet they seldom lose oxen; the way in which they discover the loss of one is not by the number of the herd being diminished, but by the absence of a face they know. When bartering is going on each sheep must be paid for separately. Thus, suppose two sticks of tobacco to be the rate of exchange for one sheep, it would sorely puzzle a Damara to take two sheep and give him four sticks. I have done so, and seen a man put two of the sticks apart, and take a sight over them at one of the sheep he was about to sell. Having satisfied himself that one was honestly paid for, and finding to his surprise that exactly two sticks remained in hand to settle the account for the other sheep, he would be afflicted with doubts; the transaction seemed to come out too 'pat' to be correct, and he would refer back to the first couple of sticks; and then his mind got hazy and confused, and wandered from one sheep to the other, and he broke off the transaction until two sticks were put into his hand and one sheep driven away, and then the other two sticks given him, and the second sheep driven away. . . .

"Once while I watched a Damara floundering hopelessly in a calculation on one side of me, I observed Dinah, my spaniel, equally embarrassed on the other. She was overlooking half a dozen of her new-born puppies which had been removed two or three times from her, and her anxiety was excessive as she tried to find out if they were all present, or if any were still missing. She kept puzzling and running her eyes over them backward and forward, but could not satisfy herself. She evidently had a vague notion of counting, but the figure was too large for her brain. Taking the two as they stood, dog and Damara, the comparison reflected no great honor on the man."

Of corresponding difficulties in children it would doubtless be possible to collect considerable evidence. Prof. Preyer, in his painstaking study of his infant son, found that the child would miss one of his set of nine-pins when ten months old, but so late as the twenty-seventh month he failed to teach the child the difference between numbers from one to five; and two months later three matches were not distinguished from four matches, and "too much" and "too little" were confounded in the same way as "five and two." Children's notions of time are equally defective. M. Perez mentions a child describing a year as "many, many, many to-morrows," which expression is doubtless as exact as the underlying idea. The same child could not be taught the difference between "yesterday" and "the day before yesterday." In a statistical research it was found that, of children ready to begin their school life, eight per cent did not comprehend the meaning of *three*, seventeen per cent of *four*, and twenty-eight per cent of *five*.

The similarities between the mental processes of child and savage are far from being exhausted by this sketchy enumeration; it may indeed be maintained that the most interesting and characteristic have not yet been mentioned—those that depend upon similarities of imagination and general mental development. Both savage and child are ignorant of the laws of Nature, and the part that is taken by science and knowledge among the civilized and adult is in them filled by a vivid imagination, substituting faint and fanciful analogies for logic, and flourishing upon a *naïve* credulity. Consider what a large part chance and luck, which have been aptly termed the measure of our ignorance, play in the lives of savages and children. To the savage an appeal to chance takes place upon every occasion, and the issue is regarded as the expression of a powerful force; the same grade of concepts have a most tenacious hold upon children. What boy has not carried an odd stone, or an old penny, or a pet marble, for "luck"? To what boy would not the reasoning of the Indian, who prefers "a hook that has caught a big fish to a handful that have never been tried," not seem natural and valid; although he might not go so far as the Bushmen, "who despise an arrow that has once failed of its mark," and so rather make new ones than collect those that have missed? How many childish superstitions are based upon a tracing of cause and effect with no stronger evidence than that of the people whose chief died after breaking off the anchor of a stranded vessel, and who accordingly bowed to the anchor, trying to appease its revenge! When a boy tosses a second penny after one that is lost in order to find it, perhaps repeating a formula in so doing, or when he takes care not to step on the cracks between paving-stones in going to school for fear of failing in his lessons, he is actuated by a train of thought easily paralleled among almost any primitive people. When the Malays eat tiger, "to acquire the sagacity as well as the cunning of that animal," or the Dyaks refuse to eat deer for fear of becoming faint-hearted, or the Caribs eschew pigs and tortoises for fear of having their eyes grow small, "the idea may seem absurd to us," says Sir John Lubbock, "but not so to children. I have myself heard a little girl say to her brother, 'If you eat so much goose you will be quite silly,' and there are perhaps few children to whom the induction would not seem perfectly legitimate."

Consider furthermore the world of fable and fairies, in which children live and move, in which no laws are adhered to or transgressed, in which nothing is impossible and nothing expected, and we are in quite the same atmosphere as that in which savage myth and belief flourish and multiply. Many such myths are doubtless earnest attempts at explaining natural phenomena, and we can not but be struck with the fact that the childish attention is spontaneously directed to the same kind of problems, and often gives them very similar answers. The same mental tendency invests inanimate objects with mysterious powers and creates the belief in fetiches, in some occult connection between a force, power, or demon, and something that is regarded as its representative. The savage mind requires some concrete object upon which to hang the epithets and work the spells; no matter by what far-fetched analogy the two are regarded as connected, the fetich serves as a substitute of a more abstract notion, too vague for the savage's weak mind to retain. The name, the image, the shadow, the picture, a part of the person or dress thus acquire a peculiar relation to the person or object in question, and we meet with names that are tabooed, sorcery with a man's shadow or lock of hair, the dread of having one's picture taken, and the like. Analogies to these procedures among children could doubtless be traced had we a pertinent collection of their spontaneous sayings and doings. In the absence of such I must refer to the childish habit of talking to animals and obtaining answers from them, to their unquestioning faith in the personifications of fable, to the fact that of forty-eight children questioned by Dr. Stanley Hall "twenty believed sun, moon, and stars to live, fifteen thought a doll and sixteen thought flowers would suffer pain if burned"; or again, to the early and marked development of the dramatic instinct, that transforms everything and everybody into something else, and invests prosaic objects with an endless variety of qualities and histories. This is the function of toys; they form the lay figures upon which the child's imagination can weave and drape its fancies; and the doll, whether as some believe a direct descendant of the old-time fetich or not, is certainly related to it psychologically. The real and the ideal, the world of fact and the world of fiction, are divided in the mind of savage and of child by no definite boundaries, and are constantly confused.

We may linger a moment longer in our comparison of the childhood of the race and of the individual, to notice the possibility of tracing similarities between the spontaneous attempts of children to imitate the social conditions under which their elders live, and the actual history of social and political institutions. Two striking illustrations of this have been recorded. Dr. Stanley Hall has described the evolution of a sand-pile into a farming community, under the promptings of the organizing play instinct of some New England boys. Farms, roads, houses, barns, men, women, cattle, tools, and so on, were fashioned, and in their growth we find mimicked the evolution of human industry, the problems of social life, the distribution of wealth, the invention of money, the fluctuation of prices, the tendencies that make the monopolist and the socialist. And yet it is distinctly play; the wooden farmers of the community being not unlike dolls, though possessing a personality with curiously real relations to the boys themselves. A more valuable illustration, because less of play and more of reality, is shown by the governmental and social regulations of the boys of the McDonough School near Baltimore, the description of which we owe to Mr. John Johnson. These boys roamed over eight hundred acres of land full of objects arousing a boy's desires and curiosity, such as birds' eggs and nests, rabbits, and nuts of all kinds. From an original common ownership in the land a few boys, by extra exertion and improvements, gained privileges over certain portions of it; and step by step as the number of boys increased, and the desirability of various bits of land was more clearly recognized, unwritten laws grew up, judicial procedure was inaugurated, testamentary power granted; money, which took the form of "butter" and school credits, introduced; and the intricacies of speculation, fluctuation of values, attempts at the redistribution of the soil, conservatism and liberalism gradually appeared as problems, and were solved in some satisfactory way. These and other phases of social and political movements had as intense a reality as in actual life, and in them Mr. Johnson finds many and striking analogies to the history of social and political institutions.

One further aspect of our train of thought deserves a moment's consideration, and this is the analogy between primitive mental traits and those appearing in the decay of mind, in arrested mental development, in hypnotism, and in other somewhat unusual and morbid psychic conditions. In the waning of mental powers we observe a remarkable law, by which the latest, least firm acquisitions are first lost, and the older, more deeply impressed, more primitive manifestations are longest retained. We thus possess an additional method of corroborating the various deductions above drawn, and in a sense truer than at first appears we have a "second childhood" the inverse of the first. To give a single instance where a detailed study would alone do justice, many of the stages in the growth of language can be again studied in inverse order in diseases of language. In such disease the syntactical language is lost first, the more primitive gesture language is retained to the last; and Prof. Preyer has shown in full detail the striking similarity between the various defects and impairments of language, and the stages of its acquisition in children. In the arrested development of idiots we may observe a slow and gradual growth of faculties which in their normal rapid growth are so perplexingly interwoven as to make accurate analysis an exceedingly difficult task. Again, we have continued in idiots traits appearing in certain stages of child growth, but later outgrown; as, for example, a tenacious but mechanical memory, a delight in striking sense-impressions, an accurate mimicking of surrounding noises, a love of teasing and torturing animals, and the like. Finally, in hypnotism, in which condition we have a withdrawal of control by higher centers, a reduction to a more primitive grade of mentality, we see analogies to childish traits; the vivid imagination, the complete absorption of the mind of the subject in the one suggested act or object, his ready suggestibility, his keen perception and accurate mimicry, may perhaps indicate the line of thought here pertinent. Any and all such analogies may be easily carried too far, but essential and significant points of community may be traced without falling into this error.

I have thus attempted to lead the way through some of the fields in which modern psychologists have reaped a valuable harvest, and from which they expect a still richer fruitage as the result of a more thorough cultivation. To such of my readers as may feel that they have been hurried over the ground and allowed glimpses when protracted study would alone suffice, I can only offer the excuse of the professional guide, that there was much to show in a limited time. Those who may feel that they have been asked to consider things quite trivial and familiar, must take comfort in Mr. Bagehot's words that "small things are the miniatures of greater," and that my purpose has been accomplished if I have succeeded in freshening "their minds by object-lessons from what they know."

DEPARTMENT M—of Ethnology, Archæology, History, Cartography, etc.—of the Columbian Exhibition has been given one hundred and sixty thousand square feet of space in the gallery of the northern half of the Manufactures and Liberal Arts Building, together with a strip of land a thousand feet long and from one hundred to two hundred feet wide, along the border of the lagoon in the south-eastern part of the grounds. Here the groups of native American peoples will be arranged geographically, and will be living under normal conditions in their native habitations during the six months of the Exposition. The scheme of classification of the department, as given in detail by the National Commission, covers a great diversity of subjects.

THE SYNTHESIS OF LIVING BEINGS.

By M. ARMAND SABATIER.

IF it is true that crude or dead matter and living matter are not separated by any impassable gulf, it seems reasonable to think that the resources of our laboratories, of which the power is increasing every day, will be able at some time to prove themselves capable of producing living matter from mineral. I purpose to discuss the legitimacy of this hope, taking into the account the results that have been already obtained, and appreciating the value of the objections that are opposed to it. It has long been supposed that the very complex substances that are the basis of living beings (plants and animals) could not be reproduced in laboratories by the simple combination of the forces which the chemist employs, and which reside in dead matter. "Vital force only," Gerhardt has said, "operates by synthesis and reconstructs the edifice that has been beaten down by chemical forces"; and Pasteur says, "We have not yet realized the production of a dissymmetrical body by the aid of compounds that are not so." These words of two illustrious chemists have met in modern labors a denial which is becoming every day more emphatic. Chemistry has entered upon the road of the synthesis of organic compounds, and has recently made a remarkable step, and has gone beyond a point which had been considered impassable.

Wöhler made the first synthesis in 1828, and obtained urea through the reaction of ammonia on cyanic acid. By taking simple bodies as the point of departure, we have been able to reproduce the carburets of hydrogen and formic acid; from the carburets we have gone up to the alcohols and to all their derivatives.* Berthelot produced alcohol by bringing together the gaseous body ethylene and sulphuric acid. The product of this reaction, decomposed by water, furnished alcohol. Wurtz obtained the synthesis of alcohol in another way. He subjected aldehyde to the action of nascent hydrogen, and alcohol was produced by the direct fixation of the hydrogen. As my colleague, M. Oeschner de Coninck, has remarked to me, this synthesis is of particular interest from the biological point of view, with which I am especially occupied; for everything tends to prove that this is the way alcohol is produced in plants. We are then in the presence of a case where the forces of the laboratory follow, for a given end, the same course as the forces of living Nature.

A considerable number of alkaloids of vegetable origin have been obtained directly by synthesis. M. Oeschner de Coninck, ap-

* Schutzenberger, Chimie appliquée à la physiologie animale, etc. Paris, 1864.

plying a special process of hydrogenization to the alkaloids of the peridic series, has pointed out a process of synthesis of the volatile vegetable alkaloids. He has obtained an alkaloid presenting the same composition as cicutine, differing from it only in a few physical and chemical properties, but possessing the same toxic action as the alkaloid of the hemlock.

These results, and others, were of a nature to cause hopes to rise; but still the synthesis of the sugars, and of the proteic substances which are the essential basis of protoplasm, seemed to defy the efforts of chemists.

To give an idea of the manner in which these results were regarded only yesterday by the partisans of the special, irreducible character of life, I quote a few lines from a book recently published (1886) by M. Denys Cochin, under the title Evolution et la Vie. After having recognized that modern chemistry entered with Wöhler and Berthelot into the way of synthesis; that it had made the synthesis of urea, formic acid, and ethylic alcohol; that these results had been for a long time regarded as contradictions of the laws of mineral matter and as impossibilities; and that, consequently, science has imitated some of the works of Nature, M. Denys Cochin adds (page 208): "These are arguments of which it would be wrong to exaggerate the weight. It is enough, to show this, to recall roughly the facts on which the discussion bears. Organic matter, vegetable or animal, is formed of very complex substances. The most complex, those which we may regard as the superior products of the synthesis performed by life, are the sugars and the albumens. These superior products are subjected during life to a slow combustion, which is fed by every effort and every expenditure of energy. The complex albumens are split and transformed into simpler albumens; the simplest of all is urea, a product of secretion, the waste of vital combustion; and urea itself splits into water and carbonate of ammonia. Organic matter thus returns to the mineral world. The sugars undergo a series of similar combustions and end by giving carbonic acid and water. . . . Now, the products of which chemistry performs the synthesis are always products of combustion, wastes of living matter, like alcohol, urea, and formic acid. They are never albumens of complex formula, not even sugars, the most perfect products of vital synthesis.

"Is there a line between superior and inferior organic products? Is there a characteristic that permits us to separate between them? Superior organic products are endowed with a curious power. Dissolved in water and traversed by a ray of polarized light, they cause the plane of polarization to turn at a certain angle to the right or the left. There is an unforeseen relation between this power of dissolved bodies and their crystalline form. There exist right crystals and left crystals similar to one another as the right hand is to the left, but which can not be laid over one another; the direction of the deviation of polarized light corresponds with the direction of the crystalline form. It must be supposed that, after the solution of a right or left body, its separated molecules are still dissymmetrical. Of like character are the separate steps of a winding stairway; their form tells whether the stairs turned to the right or the left. Now, all superior organic bodies—the albumens, the sugars, dextrin, and cellulose—are what we call active bodies, endowed with the power of turning the plane of polarized light to the right or the left; and never by any artifice of the laboratory has it been possible to prepare directly a right body or a left body. In spite of the synthesis of alcohol, urea, and formic acid, we still have a right to say organic matter is not fabricated outside of the living being. The work of life can not be counterfeited. We can not artificially provoke the formation of a cell; we can no more reproduce the materials of which it is made. The substances we have been able to reproduce are only the waste of life returning toward inert matter, and already nearly mineral."

The analysis of these few pages can be summarized by saying that the synthesis of all the products of life, without exception, was long regarded as a contradiction to the laws of mineral matter and as an impossibility. Yet chemistry has performed the synthesis of some products of life—urea, formic acid, ethylic alcohol, etc. But the authors of the challenge do not acknowledge themselves beaten; they have simply drawn back and circumscribed the field of their defeat. "Yes," they say, "we acknowledge that chemistry has been able to perform the synthesis of some products of life; but they are inferior products, refuse. It has still been never able to prepare directly the superior products like albumen and the sugars. We can not counterfeit the work of life."

The reader has been able to view and measure the motion of retreat. We can, with a little kindliness, regard it as having been performed in good order. But we can also, with entire impartiality, see in it the first steps of a backward march which will end in a rout. We can indeed say that the rout has already begun. In fact, the reputed impassable has just been partly passed, and syntheses characterized as impossible have been in large part realized.

The synthesis of the most important of the series of sugars is now an accomplished fact. The researches which have permitted the realization of this immense advance in organic chemistry, and which are the work of M. Fischer and his pupils, have led to a discovery of great importance. In the series of sugars we met an optical isomery identical with that of malic and tartaric acids. Sometimes the sugars present a right isomery, a left isomery, and an isomery inactive by compensation, and a splitting into two sugars, one right and the other left. This is exactly what we have witnessed in right and left tartaric acids, the union of which constitutes paratartaric acid, inactive by compensation. It is not useless to insist upon this resemblance, and to remark that the reactions which have permitted us to effect the synthesis of the principal sugars are of a purely chemical character, and that they demonstrate that the chemist can reproduce substances endowed with the rotatory power and aside from all intervention of life. The sugars, reproduced by synthesis, remain proteic or albuminoid substances. Here, again, the prophets of vital force are found wanting.

M. Grimeux in 1885 had prepared synthetically, by the action of oxychloride of phosphorus upon a mixture of leucine and tyrosine, and further treatment with NH_3 (ammonia), an amorphous, colloid substance, offering some of the characteristic reactions of albumen: precipitation on ebullition, the xanthoproteic reaction, the reaction of Millon, and the biuret reaction (soda and sulphate of copper). But M. Schutzenberger has just made a considerable step in the synthesis of those substances. A note in the *Comptes rendus* of the Institute of January 26, 1891, exposes the results of a successful experiment in the synthesis of a proteic substance presenting all the physical and chemical characteristics of the peptones.

An extended series of researches on the products resulting from the decomposition by hydration of proteic substances, albuminoid or other, under the influence of alkalies (baryta), have led M. Schutzenberger to attempt the synthesis of a proteic substance, starting from the simple terms of its decomposition by hydration. After numerous fruitless attempts he succeeded in forming a nitrogenous compound, which by its characteristics should be placed in the class of proteic substances, by combining, with the elimination of water, the ultimate and crystallizable products arising from the decomposition of albumen and fibrin under the influence of baryta. After a series of operations, of which I do not recite the detail, Schutzenberger obtained an amorphous product, soluble in water, precipitable by alcohol into white, cheesy lumps. The body thus obtained exhibited great characteristic similarities with the peptones. Its physical characteristics, its chemical reactions, and its modifications under the influence of heat, were faithfully like those of proteic substances. A great advance has therefore been made toward synthesis of organic substances, and the future promises still more complete results.

The chemist has then been able to realize the construction of most of the complex compounds which appear exclusively reserved for the living organism. These compounds are not merely products of splitting or oxidation, wastes of life, but are also compounds like those which constitute the superior products of life. We should recognize that these products, that this albumen obtained by synthesis, while having the same elementary composition as living albumen and the same physical and chemical characteristics, is nevertheless distinguished from it by a very important point: it does not exhibit the characteristic phenomena of life. It is not capable of performing the part of a leaven, and has not the instability of living albumen. We have for the moment established only one thing: that the chemist is capable of creating, by direct synthesis, the most characteristic compounds and the highest products of life.

Will chemistry ever be able to produce living albumen capable of actively performing the part of a leaven, and endowed with sufficient instability to go through all the modifications that permit the combustions, splittings, and demolitions that lead to disassimilation and excretion? It seems to me that we are permitted to hope for it. But within what limits will this power of the chemist be included? Will he ever be able to make a living being? Will he succeed in making even a simple cell, a grain of starch, a muscular fiber, or any shapely and differentiated element? In order to answer these questions, we must dissipate some confusion and present all the elements of the problem.

To ask the chemist to make directly a differentiated being, or even a muscular fiber, a nervous cell, a grain of starch, is to ask him to do what Nature herself has probably never been able to do, and what it is probably impossible to realize. Can one in good faith exact so much? Is it not enough to ask the chemist to be as powerful as Nature? The question is then reduced to—Will the chemist be able to do what Nature has done? Let us see what Nature has done, looking from the evolutionist's point of view.

If the living form of matter was ever born by virtue of the action of natural forces, the event must have taken place in a medium the conditions of which differed from the existing conditions of our globe; for such formation of natural matter does not seem to be realized among us. Under these special conditions of the medium, living matter must have appeared in the most simple, the most rudimentary condition, for beginnings are always humble and little differentiated. We can conceive nothing of this kind more simple than droplets, more or less minute, of a substance comparable with albumen or protoplasm—that is, a substance fermentable and unstable in sufficient degrees for a current of vital exchanges to be established within it. The droplets lived, increased in volume, and multiplied by division, because the vital exchanges could not be efficacious and properly regulated except on condition that the mass bore a well-determined proportion to the surface. If the mass became too great, the surface would become insufficient, the mass increasing in proportion to the cube of the radius, and the surface in proportion only to the square of the same radius.

The little protoplasmic masses created under special conditions of the medium would continue in that medium as long as it remained the same. But this medium becomes modified, because it ceases to be what it was—a fact clearly established by geology and paleontology—and we may presume that the modifications were made slowly and progressively. The little protoplasmic masses would also modify themselves and adapt themselves to the conditions created around them. The medium being changed, the living being would be changed too; but, the medium changed, the conditions that had permitted the direct formation of living matter, spontaneous or heterogeneous variation, would also have vanished. The new medium would then be such that the little living masses already created would continue to live, adapting themselves to it, but that new living masses could not be directly formed in it.

The first little masses born on the whole surface of the globe, unless the conditions were much more uniform than they are now, became the starting-point of successive generations, which, obeying the law of progress that presides over evolution and subjected to the conditions of the medium, acquired successively differentiations, very slow, but progressive, which determined in the homogeneous mass the appearance of granulations, localizations, limited condensations, partitionings, networks, etc., that made of the homogeneous droplet a more or less complicated organism. Such were the very slow advances, not becoming perceptible till after very long periods and through millions of successive generations. The nucleus of the cell, the muscular fiber, the nervous cell, the grain of starch, the fatty globule, the secretory cell, etc., were not formed by Nature at the first stroke. They are probably the result of work performed during millions of years and through milliards of generations. These milliards of generations of living droplets or living cells have therefore been as many little laboratories, in each of which has been elaborated, perfected, and differentiated the muscular fiber or grain of starch. Each of these little laboratories has brought to this work some share of activity, and each has added something to the differentiation.

Some, for example, have begun by producing more specially contractile particles in the homogeneous protoplasm; others have accumulated these particles in particular regions. This concentration is effected very slowly, very progressively. In other ulterior droplets, these regions have progressively delimited themselves; later on, the motions of contraction have gradually oriented themselves to one direction rather than another; still later, this habitual direction of alternate contractions and elongations has determined the formation of the contractile substance into fibrillæ arranged in the same direction, and has achieved the formation of muscular fibers; and so on.

Nature, therefore, has not accomplished the formation of differentiated elements at the first stroke. It has created living matter, simple and homogeneous; and this has been called, through a considerable series of ages and generations, to elaborate the differentiated elements with which we are acquainted. More than Nature can do must not be demanded of the chemist. Those who ask him to create directly the cell and muscular fiber infinitely exceed the absurdity of the persons who would tell the miner, whose business is limited to extracting the mineral, to make an iron-clad vessel with his ordinary tools and methods. He could supply the mineral, but a metallurgist would be needed, with furnaces, retorts, and reagents, to extract the crude metal from it. After him would have to come, to conceive and draw the plans, the founder, men to manipulate the rollers and the hammers, the turners, the polishers, the fitters, and the builders proper, all of whom would contribute in succession and through a long series of days to the preparation, the perfection, and the starting of the various parts of the great vessel; and all this under the eye and direction of the engineer who has conceived the plan and ordered the execution of the work, and provided the means of carrying it into effect.

In like manner an innumerable series of minute workers and minute laboratories have contributed, in conformity with the plan of the Creator, to the differentiation of muscular fiber, of the starch-grain, and of the nervous cell.

What can be expected of the chemist is thus well defined and outlined: it is to create simple living matter—albumen or protoplasm—as Nature has created it. We are authorized to believe that he can do this by the progress that has been recently and rapidly made in organic syntheses.

We have remarked, it is true, that, although the synthesis of albumen has been effected, living albumen, active like that of protoplasm, endowed with a strong leavening power and an instability adapted to vital changes, has not been produced. It is not impossible, as Pfluger believes, that non-living and active albumen are isomers—that is, bodies having the same elementary composition, and differing only in the arrangement of the atoms in the molecule.

Chemistry has already given proof that it is competent to produce isomeric changes in a considerable number of bodies (as we have seen for hyposulphite of soda); and nothing permits us to certify that, after having produced non-living albumen, it will not ultimately find means to determine in it the isomeric change which will make living albumen of it. It is proper to remark, besides, that life itself produces two isomeric states of albumen: one, the active state in protoplasm; and the other, the passive or inert state in the albumen of the egg, in birds. The latter, which is destined to feed the embryo, may be preserved intact for years, and show itself indifferent to oxygen, which can neither oxidize it nor contribute to its breaking up. It should be remarked, besides, that this albumen, deprived of the leavening power, is a product of secretion of the cells of the oviduct—a fact which comes to the support of the thoughts I have expressed above on the mechanism of excretion.

To create simple living matter the chemist may follow different ways. He may exactly reproduce the conditions of the medium which have favored the appearance of living matter; or, he may find new conditions that will lead to the same result, by producing, for example, the isomeric change of which we have just spoken. The same synthesis may, in fact, be produced in different ways, as has been seen in the case of alcohol. Will the chemist ever realize either of these conditions? Who can say peremptorily, No? The creation of living matter by chemistry is not, therefore, *a priori* absolutely impossible.

But, supposing these conditions realized, will the chemist be able to give rise to parcels of living matter which, like the first created at the origin of life on the globe, can become the starting-point for successive generations and for a new evolution in the present conditions of Nature? It seems to me that the answer to this question must be negative—for the reason that the first created parcels lived and were propagated through a long series of ages, among the same conditions as prevailed at their birth; they have since subsisted, notwithstanding the modifications of the medium, because those modifications, slow and taking long spaces of time, have permitted living matter to modify itself slowly and adapt itself to the new conditions. The question, then, amounts to asking, Will the chemist who shall realize, during a sufficient time and within a limited space, the conditions that formerly presided over the formation of living matter, be able to maintain them during sufficient time or to modify them slowly enough for living matter to have to adapt itself and enter into useful and conservative relations with actual Nature? If we consider the time Nature has required to reach this result of adaptation, we may logically conclude that such experiences are utterly outside of the conditions permitted to human experience. If, then, man shall some day create living matter, he will be able to observe it during a longer or shorter time; he will be able to study it; but it will be an embryo, the development of which can not be completed, on account of the absence of suitable conditions of the medium.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

ECONOMICAL TREES.

By FREDERICK LE ROY SARGENT.

THE well-known power which many plants possess of developing adventitious roots from almost any part, when placed under favoring conditions, is manifested in a somewhat extraordinary manner by several trees recently brought to the notice of botanists.

In the Bulletin of the Torrey Botanical Club for August, 1891, the present writer published an account of a linden growing in Boston, Mass., where it had been subjected to injury from horses gnawing the bark, and in consequence had a considerable portion of the trunk decayed, as shown in the accompanying sketch (Fig. 1). At the edge of the wound the cambium had formed a callus, and from a point in this living tissue there proceeded several vigorous roots which penetrated the decaying wood in all directions, evidently finding a rich soil.

Subsequent issues of the Bulletin have contained descriptions of several other examples of trees exhibiting a similarly economical utilization of the products of their own decay. These include swamp maples, a Norway maple, a willow, and a white mulberry. In an English paper appeared not long ago an account of an oak which had "sustained itself for years by a mass of roots grown into its own trunk!"

In one of the swamp maples observed by L. M. Stabler, at Great Neck, Long Island, the primary injury apparently resulted from a storm which split and twisted the trunk. One of the adventitious roots, "at least two inches in diameter, started as high as ten feet above the base of the trunk, and passed down through the decayed portion to the ground" (Fig. 2).

The Norway maple, described by W. A. Buckhout, had "a large branch split off, showing that the splitting had started several years before, that the margins of the trunk had become well calloused, and from several points roots had extended into the cleft, which naturally became partially filled with dust and decaying bark. The largest root was an inch in diameter, divided considerably near the lower end, and was over two feet long."

Of the small white mulberry growing on the grounds of the Department of Agriculture at Washington, Mr. Sudworth says: "The conditions are essentially the same as those noted in the case of the linden, except that the mulberry is perhaps more seriously injured, a considerable portion of the trunk having been destroyed by decay. The adventitious roots observed spring from the free border of a longitudinal crack where the trunk forks, the edges of the wound having been healed for some time, while the subsequent decomposition of the inner layers of wood formed a quantity of mold, which, lying in contact with the healed borders, seems to have induced the growth of adventitious roots from one side into the decayed mass." *

Fig. 1.—Portion of Trunk of Linden, growing in Boston, Mass. (Sketched by the writer.) From the Bulletin of the Torrey Botanical Club.

Fig. 2.—Portion of Trunk of Norway Maple, growing near State College, Pennsylvania. (Sketched by William A. Buckhout.) From the Bulletin of the Torrey Botanical Club.

To this list may now be added another mulberry (Fig. 3) observed by the writer during the past winter in Thomasville, Ga. Its owner, Dr. T. S. Hopkins, says of it: "I have had an intimate acquaintance with this grand old tree for thirty years. I do not know how old it was when I first knew it. Some fifteen years ago it was uprooted by a storm. I carefully amputated its limbs and re-erected its body. It lived and improved, and to-day furnishes as much shade as it did before its fall and the surgical operation made necessary by it." In point of size, extent of decay,

* In a letter dated July 26, 1892, Prof. B. E. Fernow, Chief of the Forestry Division at Washington, informs me that while in Harrisburg, Pennsylvania, he saw a most interesting and well-developed example of self-rooting capacity in a paper mulberry (*Broussonettia papyrifera*). The tree stands opposite to No. 31 South Front Street in that city.

and the number and thickness of its adventitious roots it would seem to be much the most striking example of an economical tree thus far described. The trunk is now about three feet or more in diameter, and so much decayed as to leave merely a shell of

FIG. 5.—TRUNK OF MULBERRY, GROWING IN THOMASVILLE, GA. (Sketched by the writer.)

no great thickness. The adventitious roots are some of them as thick as a man's arm. They all ramify through the disintegrating heart of the tree, and the longest of them appear to reach the earth. Besides saving from waste the products of decay, these roots must add considerable strength to the weakened trunk. This feature is perhaps all the more significant in view of the mulberry's near kinship with the banyan tree, which makes such wonderful mechanical use of aërial roots.

With regard to the way in which such economizing roots originate, and their physiological significance, it seems clear, as Mr. Sudworth has suggested, that the conditions necessary for their production are essentially the same as those favoring root-production in cuttings and layered branches. That is to say, given a vigorous cambium or similar formative tissue, near a more or less injured region, the presence of moisture for a certain period, and a congenial soil, then adventitious roots may be expected to appear. That in all the cases above cited these conditions were most probably present antecedent to the appearance of the roots seems surely to be a fair inference from all we know regarding them.

When, as in Mr. Buckhout's maple, there is opportunity for dust, etc., to accumulate in a small cleft near the callus, before total separation of the limb, the conditions are practically the same as in those not uncommon cases where seeds are found to sprout in the fork of a tree and grow for a number of years.

Now that the attention of observers has been called to this curious power which trees have of making the best of a bad matter, it will doubtless be found that the phenomenon is of more common occurrence than was at first suspected.

THE LATEST ARITHMETICAL PRODIGY.

By M. ALFRED BINET.

MATHEMATICIANS, doctors, and philosophers have lately enjoyed a rare opportunity to study a new calculating prodigy, a young man twenty-four years old, who performs mentally, with surprising rapidity, operations in arithmetic involving a large number of figures. We purpose, pertinently to his case, to consider the psychological aptitudes which serve as the basis of mental calculation. We shall use in our study the report of the committee of the Academy of Sciences which examined M. Inaudi, and the results of our own personal observations of his powers, by which we are convinced that he can bear comparison, for the extraordinary development of his memory, with all other known calculators. Jacques Inaudi was born at Onorato, in Piedmont, on October 13, 1867, of a family in modest circumstances. He passed his earlier years in tending sheep. At the age of six years he was taken with a passion for figures, and began to combine numbers in his head while at watch over his flock. He did not try to give his calculations a material form by counting on his fingers, or with stones, but the whole operation was mental. He conceived numbers by the names which his elder brother had recited to him. Neither he nor his brother could read then. He learned by ear the numbers to hundreds, and exercised himself in calculating with what he knew. When he had done his best with these numbers he asked to be taught those above a hundred so that he might extend the sphere of his operations. He has no recollection of his brother teaching him the multiplication table. At seven years of age he was capable of performing in his head multiplications of five figures. In a little while he started with his brother to wander through Provence, the brother playing the organ and Jacques exhibiting a marmoset and holding out his hand. To increase his receipts he proposed to the people he met to perform mental calculations for them; at the markets he assisted the peasants in making up their accounts, and performed difficult arithmetical operations in the *cafés*. A manager engaged him to give representations in the cities. He came to Paris for the first time in 1880, and was presented to the Anthropological Society by Broca, who wrote a brief note on the case.

Since 1880, M. Inaudi has made great progress. First, he learned to read and write, and then the sphere of his operations widened. His education, which was slow, is still rudimentary on many points; but he has a receptive intelligence and an inquiring spirit, is pleasant and modest, converses agreeably, with good sense, and sometimes with irony; and is ready at cards and billiards. It would be wrong to regard him as a simple calculating machine.

The operations he performs are additions, subtractions, multiplications, divisions, and extractions of roots. He also resolves by arithmetic problems corresponding with equations of the first degree. These are to him exercises of mental calculation, by which we mean a calculation made in the head, without the employment of figures or writing, or any material means to assist the memory. His general process is as follows: first, when the problem is stated to him aloud, he listens attentively and repeats the data, articulating them clearly, to fix them well in his mind; if he does not comprehend the problem, he has it repeated. It may be communicated to him by writing, but he prefers to receive it by hearing; and if we insist upon his reading it, he pronounces it in a low tone. When he has fully grasped the question, he says, "I begin," and proceeds to whisper very fast, in an indistinct murmur, in which we can catch from time to time a few names of numbers. At such times nothing can move him or distract him; he performs the most complicated operations in the midst of the excitement of public representations. He can even talk while mentally working; he answers questions properly, and even keeps up a regular conversation without disturbance to his arithmetical operations. During his exercises he is sometimes seen to lift his hand to his forehead or to close his fist, or to draw imaginary lines with the forefinger of his right hand in the palm of his left hand. These are little tricks of no importance, that vary from one day to another. Finally, after an interval which is always short, he says, "I am done," gives the solution of the problem, and proves it for his own satisfaction.

The two remarkable features in M. Inaudi's mental calculations are the complexity of the problems he undertakes, and, in a less degree, the rapidity with which he finds the solution. Most of the questions that are put to him involve the use of a considerable number of figures; he can add in his head numbers composed of twelve ciphers each; he multiplies by one another numbers composed of eight or ten figures each; he tells how many seconds there are in an arbitrarily selected number of years, months, days, or hours. These operations, to be well carried on, require the subject to keep in mind the data of the problem and the partial solutions till the moment when the definitive solution is found. For so considerable a task M. Inaudi takes, they say, an extremely short time—so short as to convey the illusion of instantaneousness. It has been published on this subject that "he adds, in a few seconds, seven numbers of eight or ten figures. He completes the subtraction of two numbers of twenty-one figures in a very few minutes, and finds as rapidly the square root or the cube root of a number of from eight to twelve figures, if the number is a perfect square or cube, but needs a little more time if there is a remainder. He likewise finds, with incredible celerity, the sixth or seventh root of a number of several figures. He performs a division or a multiplication in less time than it takes to announce it." M. Inaudi found in thirteen seconds the answer to the question, How many seconds are there in eighteen years, seven months, twenty-one days, and three hours?

But while M. Inaudi calculates rapidly, he is not much more rapid than a professional calculator who is permitted to work out his problems on paper; M. Inaudi's merit is that he performs his operations in his memory.

His processes are not ours, and although he has been able to read and write for four years and is acquainted with the ordinary methods of calculation, he does not use them. M. Charcot caused him to perform at the Salpêtrière two divisions of equal difficulty, one on paper according to our method, and the other in his own way; the second required four times less time than the first.

M. Inaudi, faithful to the processes of his infancy, manages them with surprising dexterity. He has perfected, developed, and enlarged them, but has not changed their nature.

The basis of his calculations is multiplication; even in dividing or extracting the square root, he multiplies. He makes a series of multiplications of approach. In a division, for example, he finds the quotients by groping; seeking and trying a number which, multiplied by the divisor, will produce the dividend.

He follows a course in multiplication which is peculiar to him. If more than one figure is included, he does not perform the process all at once, for he has no more extended multiplication table than ours; but his method consists in decomposing a complex multiplication into a series of simpler ones. If he is to multiply 325 × 638, M. Inaudi calculates thus:

300 × 600 = 180,000	300 × 8 = 2,400
25 × 600 = 15,000	25 × 30 = 750
300 × 30 = 9,000	25 × 8 = 200

In short, he makes six multiplications instead of one. He begins on the left, multiplying, therefore, the figures of the highest value. In other cases he changes the data around. Instead of multiplying by 587, he multiplies by 600 and then by 13, and subtracts the second product from the first. The observation of M. Inaudi brings a new factor to the theory of partial memories. It is usual to employ the word memory in a general sense to express the property, common to all thinking beings, of preserving and reproducing the impressions they have received; but psychological analysis and a large number of facts in mental pathology have shown that memory should not be regarded as a sole faculty, having a distinct seat; in the final analysis, memory is a group of operations. There exist, according to the report of the committee of the Academy, partial, special, local memories, each of which has its special domain, and which are so independent that one of them may be enfeebled, may disappear, or may develop to excess without the others necessarily presenting any corresponding modification. The older psychologists missed this truth. Gall was probably the first to assign its proper memory to each faculty, and founded the theory of partial memories. It is at the present time supported by multiplied facts, a large number of which have been furnished by M. Taine. He has cited, among others, the cases of those painters, designers, and statuaries who, after having carefully regarded a model, can make its portrait from memory. They supply fine examples of the development of visual memory. Then there are cases of musical memory. The subject has been revived of late years in the study of diseases of language. Cases have been cited of patients in whom the single memory of language, very limited and special, is abolished, while the other memories remain intact; there are patients who, without being paralyzed, can no longer write, but continue to speak; others lose the faculty of reading while they keep that of writing, so that they can not read the letter they have just written.

The study of arithmetical prodigies presents the same question under another aspect: no memory is destroyed in them; but one of the memories, that of figures, acquires an abnormal extension that excites enthusiasm and admiration, while the other memories, regarded as a whole, present nothing peculiar. They even sometimes continue below the common grade. Subjects of this class are real specialists who interest themselves during the whole course of their existence in but one thing—numbers. Pertinently to this point, a characteristic anecdote is related of Buxton, a celebrated calculator, who was taken to a performance by Garrick. At the conclusion of the play he was asked what he thought of the piece. He replied that a certain actor had entered and made his exit so many times, and had pronounced so many words, and so on. That was all the recollection he had of the play. The committee of the Academy has taken the measure of the different kinds of memory in M. Inaudi, and has concluded that he has not a greatly developed memory for forms, events, places, or musical airs, and I have found that his memory for colors is very weak. He gives surprising results only in numbers. This inequality in the development of memories assumes a remarkable character when we compare in him two things nearly identical, the memory for figures and that for letters. A series of letters was pronounced in his presence which he was asked to repeat exactly, and the same was done for figures. It would seem at first sight that the articulated sound of a pronounced letter would be as easy to hold in the ear as that of a figure, so that a person capable of repeating, for example, twenty-four figures, as M. Inaudi does without much effort, would have no more difficulty in repeating twenty-four letters. But this was not the case. It was found, not without surprise, that M. Inaudi could not repeat more than seven or eight letters from memory. He hesitated, lost his usual self-possession, and wanted to withdraw from the experiment; and when two lines of French were read to him, he could not repeat them exactly after a single hearing.

The recollection of the figures is a necessity for every mental calculator. It is of service to him, first in retaining the details of the problem, and then in retaining the partial solutions till the complete solution is found. The complexity of the problems which a person can hold in his head gives an idea of his memory. But there is a more direct and simpler means to measure the extent of the memory for figures, and that is to cause him to repeat a series of figures, seeking to find by trial the maximum number that he can repeat without mistake. Such trials are common in psychological laboratories. According to my personal observations, persons can repeat on an average from seven to ten figures without making a mistake, when they are pronounced with a rapidity of two per second. The division of figures into groups, the special vocal intonation, or some kind of rhythm, are artifices which may sometimes increase the number, and make the effort to repeat less painful. These results agree with those of an American psychologist, Mr. Jastrow, who mentions 8.5 as the average number found among pupils in his country.

M. Inaudi has practiced this kind of repetition for a long time. We repeat the number, dividing it into periods of three figures each, and giving the value of each period. For example, to make him repeat the number 395,820,152,873,642,586, we give it out, three hundred and ninety-five quadrillions, eight hundred and twenty trillions, one hundred and fifty-two billions, eight hundred and seventy-three millions, six hundred and forty-two thousand, five hundred and eighty-six. We are careful to dwell on the articulation of the numbers. M. Inaudi repeats, as fast as he comprehends it, each period of three figures; then, when he has taken in the complete number, he says confidently, "I know it," and repeats the whole series with great volubility.

I have witnessed his repetition in this way, without mistake, of a series of twenty-four figures. M. Charcot, in order to compare his capacity with that of Mondeux, another famous calculator, repeated with him the experiment, which had been tried with Mondeux, of telling off a number of twenty-four figures, divided into four periods, so that he might announce at will the six figures included in each of the periods. Mondeux took six minutes to reach the result; M. Inaudi only had to hear the figures given out. Thus a single hearing suffices M. Inaudi to fix in his mind a long series of figures or the statement of a complicated problem; he does not go back to repeat the numbers several times as we are obliged to do. He only asks, when the series of figures is a little long, to have it pronounced slowly. Once fixed in his memory, the number is retained with a precision and sureness which it is hard to conceive. M. Inaudi can not only repeat a number of twenty-four figures in the order in which he heard it, but in an inverse order, beginning with the units; he can repeat half the number in one direction, and the other half in the other direction; and all this without hesitation, without fatigue, and without mistakes.

Ordinary persons can recollect a number of many figures only a few seconds unless they have aids to their memory. M. Inaudi's memory retains for a very long time the numbers that have been given to him. He is in the habit of repeating at the end of a sitting all the numbers on which he has been set to work, in the different questions put to him. This experiment, which I saw made at the Salpêtrière, gives really incredible results. A large number of problems were given to M. Inaudi during the afternoon, the data of all of which were preserved in writing, in order to verify the exactness of the repetition. On this day he repeated two hundred and forty-two problems. It is said that he repeated four hundred at a sitting given in the Sorbonne.

These numbers, however, should not be taken as the measure of M. Inaudi's memory for figures, because he did not learn them one after another, without interruption. They were contained in distinct experiments, in which the calculator burdened his memory each time with only twenty-four figures. He therefore had intervals of rest, however brief; and these rests probably facilitated the assimilation of the whole mass, which was really enormous. Usually, he told us, he did not try to retain groups of more than twenty-four figures. One day, twenty-seven were given out to him. That was the maximum number that was essayed. I proposed to him to recite twenty-six, and he was able to repeat them all exactly by employing his usual processes. The experiment tired him a little. After a short rest, I read fifty-two figures to him. In the middle of the experiment, when he had reached the twenty-sixth figure, I pronouncing them and he repeating them, he stopped. He was troubled, and expressed a fear that he would forget the whole. He then repeated rapidly from memory the figures which had just been pronounced, after which he asked me to continue. I went on then to fifty-two figures. He then tried to repeat them all. He did it, but with some transpositions and confusions, and about ten mistakes. The number fifty-two seems to constitute a limit for him.

We have now to examine a little more closely what is meant by the memory for figures; for there are an immense variety of psychological types, and the same mental operation may be comprehended and performed by two persons under absolutely different forms. There are many ways of fixing figures in the memory and calling them out again; or, in other words, several images of a different kind are employed. According to the investigations of the committee of the Academy, M. Inaudi's processes are the contrary of those which arithmetical prodigies are generally supposed to use.

These persons, according to their own testimony, are accustomed to take visual memory as the basis of their mental operations. They have an inner vision of the numbers that are pronounced, and those numbers, during the whole time of the operation, stand before their imaginations as if they were written on a tablet set before their eyes. This process of visualization was that of Mondeux and Colburn, and of all who have given clear explanations of themselves. With this, nothing is easier than to account for the faculty of mental calculation—that is, of calculating without reading or writing anything. Whenever any one has a clear and sure visual memory, he does not need to have the figures before his eyes to read them and write them out in order to be able to combine them; he can turn away his eyes from the slate, because they are written as if with chalk on the tablet which his memory presents to him. This explanation appears so satisfactory that Bidder, one of the greatest mental calculators of the century, wrote in his autobiography that he could not comprehend the possibility of mental calculation without this faculty of representing the figures to himself as if he was looking at them.

This interpretation has been confirmed by the researches of Mr. Galton. Inquiring of a large number of calculators and mathematicians of every kind and every age, he has learned that most of them have a visual image of the figures during their calculations; the natural series of figures is presented in a straight line, or follows the bendings of a curved line. With some persons the figures appear placed as if in relation to the rounds of a ladder; with others they are inclosed in squares or circles. Mr. Galton calls these images number-forms. The visual image must be very clear for it to be possible to recognize so many details. M. Taine, who has studied the phenomenon of the image with much care, has discovered a resemblance between mental calculators and checker-players who do not have to look at their boards. He explains their faculty by the clearness of their visual images. "It is evident," he says, "that every move, the figure of the whole checker-board, with the order of the different pieces, is presented to them as in an inner mirror; else they would not be able to foresee the probable consequences of the move that has been made upon them and of the one they are about to order." The direct testimony of players confirms this interpretation. "With my eyes turned to the wall," says one of them, "I see at once the whole board and all the pieces as they really stand. . . . I see the pieces exactly as the turner has made them—that is, I see the checker-board in front of my adversary, and not some other checker-board."

In the light of so many facts we are naturally led to believe that all mental calculators work by the considerable development of their visual memory. But the study of M. Inaudi shows that we can not draw a general conclusion from them, and that there are other means than mental vision that seem to have the same
...nd power. M. Inaudi declares that no figure is
...der a visual form. When he endeavors to
...v-four figures that have just been pro-

nounced, or when he combines numbers to solve a problem, he does not see the figures, but hears them. "I hear the numbers," he says distinctly, "and it is my ear that retains them. I hear them sounding in my ear, just as I have pronounced them, in my own voice, and that inner hearing persists through a good part of the day." At another time he told M. Charcot: "Sight is no help to me; I do not see the figures. I will say even that I have more difficulty in recollecting the figures and the numbers when they are communicated to me in writing than when I receive them by speech. I feel cramped in the former case. I do not care about myself writing the figures. Writing does not help me recollect them. I prefer to hear them."

His words are confirmed by his actions. When the numbers are given to him written, he pronounces them aloud, putting himself in substantially the same position as if they had been communicated to him by the hearing; then, when he begins his calculation, he turns his eyes away from the written figures, the sight of which, instead of aiding his memory, is only an embarrassment to him. "How can I depend on seeing the figures," he says, "when it is only four years since I learned to read and write? Yet I calculated mentally before that time."

Our supposition that M. Inaudi relies on auditive images in his calculations is not absolutely correct. A pure auditive image is very rare. Auditive images and sensations of words are associated with the motions of the larynx and the mouth required to pronounce them; and when a person represents to himself a word under the form of a sound, he should at the same time experience special sensations in the organs of phonation, as if the word was about to be pronounced. In other words, so far as concerns language, the auditive type has the closest connections with the motor type; the two are often combined.

This probably takes place with M. Inaudi. We have seen that his lips are not wholly closed when he is at work. They move a little, and an indistinct murmur issues from them, in which we may catch from time to time a few names of figures. The whispering sometimes becomes so intense as to be heard several metres off. I have assured myself, by taking the respiratory curve of the subject, that it bears very clear marks of this phenomenon, even when we do not hear it. His sounding organs are then really active while he is calculating in his head. M. Charcot, wishing to determine the importance of these movements, and see what would happen if they were not executed, asked M. Inaudi to make a calculation with his mouth open. But this device did not wholly prevent the motions of articulation, which were still apparent. I tried to prevent M. Inaudi from articulating sounds in a low tone, and asked him to sing a vowel during his calculation;

if the sound of the vowel kept pure in tone, it was certain he did not articulate the figures. The experiment caused M. Inaudi great embarrassment. He was still able to calculate in his head, but it took him four or five times as long as under the usual conditions, and he succeeded in doing it only by cheating a little—that is, he made some articulations of figures in a low voice, the production of which was at once detected on listening attentively to the sound of the sung vowel.

These experiments showed that articulation constitutes an integral part of M. Inaudi's mental calculations, as well as that every experimental artifice that interferes with articulation makes the calculation longer or modifies its accuracy. In other words, M. Inaudi uses auditive and motor images of articulation concurrently. We have no experimental means of determining which is the predominant factor. M. Inaudi thinks that the sound guides him, and that the motion of articulation intervenes only to re-enforce the auditive image. We might be liable to suppose, in view of the part that is played by the memory in mental calculation, that it is the only faculty developed in arithmetical prodigies; and some authors have fallen into this error. But it will be well to guard against such a supposition, which is contrary to the most certain and best established psychological facts. If we take any elementary act of the mind and analyze it, we shall find that it involves the concurrence of a large number of co-ordinated operations; with much stronger reason must such a concurrence be supposed necessary for acts as complex as mental calculations. We have found in our studies of M. Inaudi that a considerable number of his faculties have attained an extreme development, and they are precisely the ones that concur in operations of mental calculations. Perception, attention, and judgment, to the extent and in the shape in which they are needed in his work, have acquired the same perfection as his memory for figures.

It remains to inquire how these aptitudes for calculation have been formed. When we examine the history of these arithmetical prodigies, we are struck by the three facts of their precocity; the impulsive, in a certain sense all-possessing, character of their passion for calculation; and the generally illiterate, often miserable, medium in which they have grown up. Their stories have many traits in common. They are most frequently children of poor and ignorant parents. They are seized with the passion for calculating in their earliest years—at from five to ten years of age on the average—the age when most children are living in the illusions of plays and stories; they begin to combine numbers in their heads, apparently without any exterior provocation, and without the influence of parents or schoolmasters. As they grow up some of them become mathematicians like Gauss and Ampère, while others continue all their lives what they were in the beginning, simply specialists in figures. We do not know whether this distinction arises in the nature of things, or simply results from the chances of life. Very good minds think there is a relation between the calculating faculty and mathematical talent, and believe that, if these prodigies were intelligently given a special education, they might most of them become remarkable mathematicians. Experiment has not given a definite result on this point. M. Inaudi has determined not to go to the mathematical school, but will preserve and develop his natural gifts. Another question arises as to the influence of heredity in these cases. For a long time physicians have been accustomed, when an abnormal combination of talents appears in a particular person, to find a number of special characteristics in his family. Sometimes these have appeared through several generations, as in certain noted families of musicians and naturalists. Sometimes the peculiarity appears in the shape of eccentricity. No such peculiar family traits have been found associated with M. Inaudi, nor any special antecedents in himself. He has never been ill, and his development has been normal.

The study of M. Inaudi has been fruitful for psychology. On one side it has brought a remarkable confirmation to the theory of partial memories; and on another side it has made us familiar with a new form of mental calculation, the auditive form. It may also have taught us something else. We have found that it is possible for some faculties, like memory, to acquire an extent double and triple that of the normal. The fact permits us to descry in how large a measure the human mind is still capable of improvement.—*Translated for The Popular Science Monthly from the Revue des Deux Mondes.*

The polished stone hatchet, according to Mr. Thomas Wilson's report on anthropology at the Paris Exhibition in 1889, is recognized almost all over Europe as an amulet protective against lightning. It is called in many languages "the stone of lightning" or "thunder-stone." The hatchets are drilled for suspension, or are put over the fireplace or in the stones of it, or are inserted in a crack. The general belief is that they come from the heavens in a flash of lightning; and one peasant declared that he had seen such a stone fall, and, going for it, had found it and extracted it from the hole still hot. Flint arrow-heads are also regarded in the same way. A common amulet, of great power, in Brittany is what is called there the *pierre du croix*, a mineral, staurolite, which crystallizes in the form of a cross. It is regarded as a token from God in favor of the religion of the country, and is given to these his chosen people in recognition of their piety and religious fervor. In Italy the coral is an amulet supposed to guard its owner against the evil eye. These are the principal objects of regard; but there are many others of less importance, which are, however, much relied upon.

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REASONING ANIMr "lower animals," and a

As an instance of this

BY ALLEN PRINGLE. to be well authenti-

THE question as to whether animals reason or he Newfoundland one. For myself I am convinced that they do, as the imbecile logic sometimes than some of the *genus homo*. The ng it out to what we observe as mind in animals is all instinct and no was in ought to have taken its departure with the discovery that the idiot mal had a brain and nervous system quite similar to that of man- and subject to the same general mental and physiological laws. The truth is, man has both reason and instinct, and so has the animal. Instinct acts spontaneously without thought, while reason reflects and adapts means to ends. When we wink with lightning rapidity to protect the eye from something flying into it, or when we start back in fright from a sudden and threatened danger, we act instinctively; the animal does the same. On the other hand, when we act from reflection and adapt means to ends, we exercise reason; the animal does the same thing. In our daily contact with our domesticated animals we find ample proof of this. I mention the horse, the cow, the dog, and the honey-bee, not because they are the only animals that reason, but because most people are specially interested in these domestic animals, and are familiar with their characters and habits. Many other animals exhibit a high degree of intelligence.

A most remarkable case of bovine intelligence which recently came to my knowledge, and for the truth of which I can vouch, has prompted the writing of this paper. A cow and steer—the latter two to three years old—were the only occupants of the barnyard where the occurrence took place. A baiting of hay was put out to them, the cow taking possession. The steer wished to share it; but the cow, like some higher animals, was selfish and was bent on taking the whole of it, and as often as he would manœuvre around from side to side to get a bite she would drive him off at the point of her horn. The steer was so persistent that at last the old cow's patience gave way, and making a determined and vicious charge on him, punished him severely, though he was her own offspring. The steer felt badly hurt, not only in body but evidently in mind as well, and immediately started out of the yard and off down the lane toward the pasture where were the rest of the stock, bell vengeance at every step in a language which was un- bystander and which the mother well under- sting and listened intently to the threaten- When these died away in the distance with evident apprehension. In due bringing with him a companion

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special..., I submit that this is one of the cases which furnish in-
math...overtible proof that animals do reason. No amount of mere
th...stinct could avail that steer in conceiving and carrying out the complex "plan of campaign" which he adopted to take revenge on the selfish and cruel old mother who refused to share her ration with him and punished him besides. The plan he so readily adopted required not only feeling to prompt it, but thought and reason to carry it out. The end to be attained was the punishment of his assailant, which he was not able to inflict himself, and he adopted the means necessary to accomplish the end. This was thought and reason, and not only so, but there was language as well, for what else were the threatening sounds he uttered and which the mother well understood; and how else could he have communicated his grievance and desires to his companion in the field? It will also be noted here that the steer exhibited in this case not only a measure of what is called man's highest faculty—reason—but a good deal of another passion which often rankles in the human breast—viz., *revenge*. It would be no loss to *us* to allow the "lower animal" to monopolize this "animal propensity."

The horse, as we all know, is even more of a reasoning animal than the cow. I knew of a horse who would leave his pasture under cover of darkness, and go some distance off over several fences into a field of grain, where he would help himself, and invariably return before daylight to his own pasture without disturbing a single rail on any of the fences he jumped. Others have had a similar experience. Here is not only reason, but a high degree of shrewd cunning worthy of a James or a Scotland Yard detective! I once had a wise, motherly old brood-mare who had lost an eye. In the case of her first foal after that loss I noticed that she would at first hurt the young colt when it happened to be on her blind side and she would make a move in that direction, sometimes knocking it down and hurting it with her feet. But very soon I perceived that when the colt was out of her sight on her blind side she would not stir till she first looked around for it to ascertain if it was in danger, and when she would not be able to get her head round far enough to see it, she would move slowly and with the utmost caution till she could see it. Here were manifested not only intelligence, but what the phrenologists call cautiousness, locality, and philoprogenitiveness.

We now come to the dog, which perhaps exhibits as high a degree of intelligence as any of the other "lower animals," and a higher order sometimes than the human. As an instance of this we may take the historical case (which seems to be well authenticated) of the human imbecile (not insane) and the Newfoundland dog and child on the bank of the river. As often as the imbecile would put the child in the water the dog would bring it out to save it from drowning; and when at last the child's life was in danger through exhaustion, the dog forcibly restrained the idiot from again putting it into the water. Here was a degree of reason, fidelity, and affection in the so-called "dumb animal" much higher than that in the human specimen before him.

A short time since a gentleman of the highest veracity related to me the following, which he personally witnessed: A child fell into a canal. The father's dog was present and immediately jumped in to save the child. As it came up the second time he caught it and kept it above the water. Finding, however, that he could not properly keep it up without some support, he swam with his charge to a beam which crossed the canal just above the water, and, placing his two fore paws upon the beam, rested there and kept the child's head above water till both were rescued.

Now, in this case, instinct or training might impel the dog to jump in after the child, but it would not enable him to adapt himself to the circumstances (new to him) and utilize the beam as he did. This required perception and reason.

It was the late Henry Ward Beecher, I think, who related and vouched for the following: A large and a small dog happened to start from opposite sides of a stream at the same time to cross it over a narrow board which spanned it. They met in the middle. Both came to a stop, for they could not pass each other on the narrow board. The little dog sat down on the board, held up his head, and began to whine. The big dog stood a moment, apparently cogitating what to do, when suddenly a thought struck him. He spread his fore legs apart to the outer edges of the board, also his hind legs, and then looked at the little dog as much as to say, "Now is your time!" whereupon the little fellow shot through between the big dog's legs and safely reached the other side, wagging his tail with delight and approval of so clever a trick; while the big fellow walked philosophically over to his side, no doubt well satisfied with himself, as he certainly had good reason to be.

Dogs, of course, could be trained to do that as well as many other things, but these had not been so trained. The circumstances were new and quite accidental, and the big dog who solved the difficulty had neither the necessary instinct nor training to aid him, but had to fall back on his own mental resources, and he proved himself quite equal to the occasion.

We now come to the honey-bee—last in the list, and the smallest, but by no means the least. Insignificant in size as she is, the honey-bee can put any or all of these other big animals to flight in very short metre! In her marvelous powers of delicate mechanism she can also distance them all, and even cast us in the shade. Hers is one of the fine arts in animal mechanics. As diminutive as she is, she, too, has a brain and nervous system, with ganglions similar to those of the human brain, and with nervous tissue equal to ours in proportion to weight. We need not, therefore, so much wonder that this industrious little insect thinks and reasons, and lays out her work with mathematical accuracy, exercising that exquisitely fine little brain with such extraordinary results. After watching, admiring, handling, and studying the honey-bee for thirty years no one need tell me that this wonderful little creature is void of reason and intelligence and is guided solely by what is called instinct. She, of course, acts much from instinct, as that word is popularly understood, the same as the higher animal does. But new conditions and exigencies arise in which there has been no experience, and where there is, therefore, no instinct adequate to guide. It is then we see unmistakably the exercise of reason in the bee to adapt herself to the new environment.

But the honey-bee, like human beings with reason, makes mistakes; and, indeed, these very occasional mistakes furnish evidence of my contention, for, if the bee were solely guided by an "unerring instinct," she would make no mistakes. Allow me to note here one or two of her natural blunders. A colony of bees left to themselves will, for instance, swarm themselves to death—that is, they will cast so many swarms in the one season that the parent stock is left so weak that it dies in the winter; and the last two swarms cast (say of four altogether) are also so weak and late as to be unable to gather enough stores for winter, and they, too, perish. This, of course, is a great mistake; for, did they swarm but once or twice, all would be strong and in good condition to face the winter. This mistake they make in a state of nature, in a hollow tree in the woods, as well as in the model hive of modern bee-keeping.

I once had a colony which, in the latter part of winter, being dissatisfied with its queen, began to raise young queens to supersede the old one long before there was any prospect or possibility of having drones to mate with the young queen. This certainly was a mistake, as it meant the depopulation and extinction of the colony; whereas the old queen could have carried them safely through to the proper time to supersede her. I may say here, by way of explanation, that when a colony of bees finds its queen failing in fecundity, from age or other causes, the workers, fore-seeing a gradual depopulation of the hive, set about warding off the impending ill by superseding their mother and queen—that is, by rearing a young queen to take her place. In the case just noted the *object* was all right and the *means* to attain it all right, but, like ourselves sometimes, they were doing their work at the *wrong time.*

A normal colony of bees consists of one queen, some drones—more or less—and from 30,000 to 50,000 workers. The queen is the mother of the whole family—of the workers, the drones, and even her rivals, the young queens, which are to take her place in the hive, and they sometimes dispatch her in superseding her. The workers, as their name implies, do all the work of gathering honey, rearing brood, etc. The drones, like the drones in the human hive, do next to nothing, but do it well, with this difference, that the human drone fails to do well what little he does do.

The conclusion I have reached is this: the horse, the cow, the dog, the honey-bee, and other animals have a certain degree of reason and intelligence as well as instinct, and also have, some of them, strong social and domestic feelings, and are therefore entitled to greater consideration and kinder treatment at the hands of man than they sometimes get. I have also come to the conclusion, viewing the multitude of mistakes and follies of the higher animal, man, that his superior reason and more exalted faculties are not on the whole turned to as good account as the inferior reason and faculties of the so-called "brute beasts."

COLOR IN FLOWERING PLANTS.

By ALICE CARTER.

COLOR is as omnipresent as light. Life, the greatest of artists, uses the most common materials to produce masterpieces which sunset clouds can not surpass. The possibilities of almost infinite color variation are present in every green plant, even in its roots and stems. Appropriate conditions only are needed to bring them out; only power to help in the plant economy can intensify and make them hereditary and permanent. There is little doubt that by careful selection leaves would become as wonderfully variegated as flowers. Indeed, this has been done: some of our cultivated maples—masters of *chiaroscuro*—"are positively rainbow-dyed." Bright-leaved birches, beeches, begonias, and foliage plants are continually improving under man's directive care. These do not appear under natural conditions in our climate, because they are of little or no use. Still, there are tings in our autumn woods. The red of the dogwood, the yellow of the tulip tree, the brilliant purple of the sweet-gum tree might doubtless be enhanced and modified and made to appear at different seasons by intelligent selection and change of conditions; and travelers tell us that in the tropics, where the struggle for existence is most severe, bright-leaved plants are common. Why? What are the uses of color? Since the publication of the works of Sprengel, Müller, Delpino, Hildebrand, and others, its attractive power has been so enthusiastically studied that the thought of its having other meanings has been largely lost sight of.

Flowers are the hope of a plant; their careful protection from injury is of vital importance. They are, as a rule, so short-lived that there must be special adaptation for the speedy fulfillment of their function. On the other hand, the value of crossing is so great that many of them have become partly dependent for its accomplishment upon the aid of other organisms. But the very provision made for the entertainment and attraction of these friends also serves excellently the wants of numerous intruders who would take the treasure without giving any equivalent for its use. Therefore it is that among flowers (and fruits, to which somewhat similar reasoning applies) we find the most marvelous combinations of attractive and protective qualities, and, as with animals, color is an important element in each. The very beauty which is the Elysian field of some happy insect may be the Gehenna of another. The essentials of a heaven are as varied as individual tastes. Hence it is impossible to limit a given color to one function. Use is many-sided, and while the attractive power must still be emphasized, others should not be forgotten. Color, like everything else, is always increasingly developed in proportion to its usefulness, and accordingly most common and most protean among flowers and fruits, although by no means confined to them.

I. Chemical Uses.—It has sometimes merely chemical uses.

The work of (green color) chlorophyl, the study of which is a science in itself, need not be dwelt on here.

According to Pick, red color, too, has an important chemical office, inasmuch as in its presence the food substances manufactured by young, growing shoots (in which it frequently occurs) are transported more rapidly, so making possible the desired quick development of each organ, while those which are made last do not remain in the autumn leaf to be lost with its fall, but are speedily conducted to the winter storehouses.

Photography shows that color changes the properties of light. Stewart suggests that every flower by means of its color may transform the sun's rays in accordance with its own needs.

II. Protective Color.—The knight of the fairy tale who started on his quest with shoes of swiftness, charmed sword, and invisible cloak, may well have been one of Nature's models. Many a time since, the invisible cloak has given the victory to her heroes. In the hand-to-hand battle of life, which is continually waging, many an animal escapes unscathed simply by being so like the objects among which it lives that only the keenest sight can distinguish between them. This is "protective coloring." Walking-sticks resemble twigs; alligators, floating logs; brown bitterns, the rocks among which they stand motionless watching for prey; gay birds-of-paradise are almost invisible among the branches of brilliantly blossomed trees. But the phenomenon is not confined to animals.

A remarkable thing about fruits is the great difference *in color* between the dry and fleshy kinds. It is hard to think of a conspicuous dry fruit in all our flora, yet they are far the most numerous; for, of the eight hundred and eighty-nine genera of flowering plants given in Gray's Manual, eight hundred and nine have dry fruits. But many of the eighty fleshy-fruited genera are brightly colored: ten have white, eight yellow, eight yellowish, thirteen blue, twenty-three (usually shining) black, sixteen purple, twenty-five red species. Only four have no other color than green.

Surely this is a significant contrast. There is no intrinsic reason why a nut-shell should not be as brightly tinted as a peach skin, but in the light of modern theories of distribution the problem is simplified. It is now known that dry fruits are disseminated by purely mechanical means, by the agencies of wind and water, or by the unconscious help of animals to whose hair, feathers, or feet they adhere. But fleshy fruits are largely, often entirely, dependent upon animals which eat the attractive and palatable covering, and in one way or another scatter the uninjured seeds. As there are wind, water, and insect pollinated flowers, so there are wind, water, and animal carried fruits; and the first two classes of both are inconspicuous, the third commonly beautifully adorned. The negative reason, then, for the absence of color among dry fruits is the needlessness of attractive characters; but there is a positive and perhaps as powerful a cause which has operated to the same end. Dry fruits are by no means unpalatable. The staple vegetable foods, sought after alike by the lower animals and by man, are grains, legumes, and nuts. In their great popularity is their great danger; their treasure must be hidden. The seeds of many *Compositæ* greedily eaten by birds, are therefore covered; the distasteful or even poisonous fruits of
freely exposed. The hard shells of nuts, the
ngs of many pods, defeat the attacks of
rmed bodies of Siegfried and Achilles

did not save them. There never yet was armor without vulnerable point. Nature "arms and equips an organism to find its place and living in the world, and at the same time she arms and equips another to destroy it." Squirrels deftly open the hardest hickory nuts; larvæ penetrate the thickest-shelled almonds. Wallace describes how cleverly the black cockatoo of the Aru Islands breaks into the kanary nut, which is so hard that only a heavy hammer will crack it.

Every little helps, and the absence of the straw may save the camel. Therefore, if in addition to their hard coverings these fruits are also colored so as not to be easily seen, they have still another advantage. Mr. Bailey describes the pods of the sensitive pea as "protectively imitative," much resembling the leaves of the same plant when closed after irritation. Wallace thinks that the dry fruits of herbs "have no doubt often been prevented from acquiring bright colors by natural selection, in order to protect their seeds." And it seems logical that the same purpose may be served by the sober colors of the larger dry fruits.

Fuller describes a kind of figwort as a possible instance of a protectively colored *flower*. The blossoms are inconspicuous and purplish; the ripening ovary develops a dark purple tint, and somewhat resembles the fallen corolla; the buds, too, are as deeply colored as the opened blossoms, an unusual thing. Since this species is adapted to pollination by wasps, and avoided by other insects which have a respectful awe of their formidable sting, the miniature flowers and the fruits seem to be well protected by resembling the blossoms—an economical method to say the least, and so effective that the wasps themselves, sometimes deceived, were seen to alight on the buds and ovaries.

III. Warning Color.—In the forests of Nicaragua there is a brilliant red and blue frog, which is scornfully rejected by the birds who usually devour frogs and lizards greedily. All the other batrachians are protectively colored and feed only at night; but these little fellows hop boldly around with no thought of fear. A certain hermit crab is found always in shells which are covered with a (usually) bright-colored sponge or sea-anemone, both of which are avoided by the crab's enemies. In such cases striking color is correlated with obnoxious chemical qualities, and the enemies understand it.

It would be decidedly advantageous to plants which are not otherwise fitted to survive the attacks of herbivorous animals to accumulate substances offensive to them and then to advertise their disagreeable qualities as clearly as possible, either by peculiar form or color or odor; and what we are constantly learning of the sagacity of animals leaves little room for doubt that they would quickly recognize these species and shun them.

Kerner and Stahl have proved that tannin is distasteful to snails, goats, rabbits, sheep, and cattle. It is therefore not strange that natural selection has brought about the accumulation of this disagreeable substance in organs and at stages of growth needing special protection; and, in fact, it is most abundant in young leaves, flowers, and unripe fruits.

Wigand has shown that red color often accompanies tannin, and it is also true that red-leaved plants commonly contain oxalic acid. Pick suggests that the union of elements of the oxalic acid and of the red coloring matter, resulting in the formation of crystals of calcium oxalate, prevents the formation of such an excess of the acid as would prevent the action of the ferments by which starch is made diffusible. Raphides are bundles of calcium oxalate crystals. Stahl says that the single-pointed crystals which exist in certain irises are an effectual protection against snails, and that in the pickerel weed there are, besides these, raphides and cells rich in tannin—perhaps a suggestion that raphides may have arisen as the further development by natural selection of such solitary crystals. For these delicate, sharp rods are a formidable defense, piercing the skin of a would-be destroyer of the tissues containing them like so many needles. (Taste Jack-in-the-pulpit leaves.)

So there is law in it all. Tannin abounds in plant-tissues. Where it is, red color often appears; and where there is red color, oxalic acid is frequently found; where oxalic acid is, raphides may be formed; and, finally, where there is tannin or raphides or both, there are substances generally disliked by herbivora—a long story, which the red color of the exposed parts of many plants doubtless tells briefly but effectively to their enemies.

For example, various members of the orpine family are not eaten by large animals, because their leaf-tips—the most available parts—contain tannin, "*as shown by their dark-red color.*" Otto Kunze says that the Javanese surround their coffee plantations with a living hedge of red-leaved plants, so keeping off the swine, *which abhor this color.* The brightly tinted leaves of young oaks, maples, etc., are seldom eaten; and in the tropics, where there is the severest struggle for existence, gay leaves are most abundant.

The mottled leaves of arum, lady's-thumb, some everlastings, and prince's pine, and probably of adder's tongue and cyclamen, are protected by raphides; those of begonia have sour, and of coleus and wild ginger, bitter sap. Such variegations of leaf-surface, which may be imperceptible to the larger animals, may have much
-aller ones. Species of caterpillars and of beetles
› particular orders or even genera of plants,
'e the cockatoo to the kanary nut, they
the peculiar characters of these plants,

while kept away from others by effective defenses. (Halicta feeds on the deadly nightshade, which is poisonous to most animals.) I have no doubt that the butterflies, whose wonderful instinct leads them to deposit their eggs upon the plants best adapted to nourish their young, are aided in distinguishing between species and often warned off of the wrong ones by such spots and markings; for they well know how to put two and two together.

The coloring matters of plants are closely connected chemically with the aromatic group of substances (Vines). Naturally, then, odor sometimes takes the place and does the work of color. The presence of distasteful oils, resins, etc., is announced by the odor of some plants no less effectively than that of obnoxious tannin, stinging raphides, or bitter alkaloids, by the colors of others. The most brilliant flowers are not the sweetest; both qualities are not ordinarily needed (though they may exist together, as in the hard-fighting plants of the Mediterranean region); 14·6 per cent of the white flowers are odorous, only 3·2 per cent of the red.* And odor, like color, may be at the same time attractive and repellent—a phenomenon probably much more common than we imagine.

Ten of the thirty species mentioned by Kerner as not eaten by herbivorous mammals are either aromatic or strong-scented. Pasture mints and field onions are avoided by cattle. What hungriest mammal would relish a meal of the skunk-cabbage or the spotted arum? Yet flies are attracted to both. If the offensive odor which some beetles and caterpillars emit when handled is a warning, surely that of these plants says more plainly than words, "*Nemo me impune lacessit.*" Herbivora seem even to be repelled by the sweet fragrance of wintergreen, lily of the valley, violets, and of some orchids, which attracts to them their insect friends.

Again, the same animal may be simultaneously attracted and warned by a color. Dr. Ogle found the white and blue varieties of a species of monk's-hood growing in the same district of Switzerland. Almost every opened corolla of the white variety was perforated; none of the blue. The flowers are dependent for pollination upon bees; the perforated white variety therefore produced no seed, and this form was rare; but the blue, entered legitimately and abundantly pollinated, common. So the importance of the warning is evident. The blue corolla invites guests to the feast of honey, but at the same time proclaims that it is for their interest to get it lawfully. The bees understand that unpleasant properties of some kind are associated with the color of this form.

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* Cruger

Protective organs or substances are frequently increased in the vicinity of flowers. Long ago Erasmus Darwin wrote: "The flowers or petals of plants are perhaps, in general, more acrid than their leaves; hence they are much seldomer eaten by insects." "Many caterpillars will rather die than eat the flowers of the plant whose leaves are their special food." * But insects are not the only foes who steer clear of petals. Kerner gives a long list of plants whose leaves are eaten by herbivora, the flowers untouched. In our own land the blossoms of the waysides and fields—May-weed, buttercups, daisies, dandelions, sorrel, wild carrot, etc.—by their very abundance witness to their immunity from the attacks of grazing animals.† The survival of many showy flowers in St. Helena, notwithstanding the introduction of goats, which have destroyed the luxuriant forests, may perhaps be due to the beauty which brands them unpalatable.

The conspicuousness of all of these species is the noteworthy point. They are landmarks, doubtless, to the lower animals as to us. That blossoms are most completely shunned when they are large and showy is almost axiomatic. If bright flowers tasted well, they would be speedily annihilated. The majority of good fodder plants have insignificant flowers.*

There is still another class of enemies which may be prevented from attacking flowers by the disagreeable chemical properties of their conspicuous petals. These are the birds. Mr. Brockhurst writes that in the dry summer of 1880 the sparrows, seeking pollen, destroyed his crocuses, preferring the yellows to the purples and whites. They also attacked the primroses, devouring hundreds of them in one morning. Orioles have been seen to bite through the corollas of the trumpet-creeper and golden currant. Young seeds and soft petal tissues would certainly seem to be dainty bird-fare, and would surely be more often so used were they not chemically protected from such injury. As things are, however, other food seems to be preferred when it can be found. In addition to the need of defense against rain, and of adaptation to the form and size of the chosen visitors, necessity of keeping the pollen, nectar, and ovules from destruction by birds may have helped in the formation of tubular and palated corollas. Flowers need the beauty of Helen to attract lovers, the guile of Penelope to discriminate between the true and the false; to provide for the one, and against the others.

IV. MIMICRY.—Mr. Bates found in South America and Mr. Wallace in the Malay Archipelago several genera of very abundant, brilliant butterflies which birds refused to eat; and, accom-

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* Kerner.

† The disagreeable substances are volatile, disappearing when the flowers are dried

panying these, a few individuals of rare species, themselves defenseless and palatable, differing widely from the type of the genera to which they belong, and so closely resembling the others as to be readily mistaken for them even by experienced collectors. Since its discovery, numerous examples of this so-called "mimicry" have been brought to light in many classes of animals, its conditions being always the same. A rare, helpless species is protected from attack by similarity, in external appearance only, to a common, easily recognizable, well-defended one.

There are strong resemblances between widely separated genera of plants. The submerged parts of water-crowfoots are much like those of water-marigolds. "It is almost impossible to distinguish between" the euphorbias of Africa and the cacti of South America, when not in blossom; mare's-tail looks like an equisetum—one is a flowering, the other a flowerless plant; the false goat's-beard closely resembles the true; dalibarda "in aspect and foliage resembles a stemless violet." Observation may find proof of some advantage gained to the feebler plant by the likeness in the last two cases, inasmuch as the plants occupy the same localities, and in each case one of the species is much more limited in distribution than the other. But none of the others are examples of true mimicry, because the similar plants do not inhabit the same regions, and it is hardly supposable that any benefit accrues from the likeness. Similarity of conditions may have much to do with it in some instances, but a deeper cause, and one of a kind which we can not yet conceive, must be sought in explanation of the extraordinary results sometimes reached.

Nevertheless, there is true mimicry in plants.

The only South African balsam is strikingly like an orchid which grows in the same locality and is visited by the same insects! Surely a clear case of plagiarism.

The "cow-wheat" is parasitic upon the roots of wheat, whose seed its own so exactly resembles that the two can only be distinguished by careful botanical examination. So the husbandman who himself sows tares among the wheat, one day wakes to say, "An enemy hath done this."

Sir John Lubbock thinks that the harmless dead-nettle may be protected from grazing cattle by its great likeness to the stinging nettle—a member of a widely different order.

In 1833 Robert Brown conjectured that the remarkable insect-like forms of the flowers of the genus *Ophrys* (bee orchid, etc.) "are intended to deter, not to attract insects." But Darwin has shown that some of the species are self-sterile, and all of them are constructed as though insects had played an important part in the shaping of the floral organs. The native home of the genus is the Mediterranean region, where all kinds of methods of defense are resorted to. Most insect-like orchids resemble brilliant butterflies, which are as a rule unpalatable, and therefore enjoy comparative immunity from attack. May not the flowers be protected by the resemblance, as the defenseless butterflies discovered by Wallace are? Some such reason as this makes it more easy to comprehend the need of such elaborate development for which adaptation to small flies or bees, as in the case of lady-slippers, is hardly a satisfactory explanation. Nature is too economical to spend so lavishly for the accomplishment of what has been done much more simply in other ways. The desirability of combined attraction and repulsion brings with it the need of many new wiles. If "all things are fair in love and war," much may be expected of a man or flower engaged at the same time in both pursuits.

Another orchid (*Pogonia ophioglossoides*) is very difficult to find because of its great likeness to the much more abundant Indian cucumber which lives in the same places. In company with two botanists and a gardener well versed in the ways of the woods, I have spent hours in finding half a dozen specimens. Mr. Gibson, too, met with the same difficulty, actually treading the orchid under foot, "the imitative whorled foliage of the medeolas having beguiled my discrimination." Surely, though, it is the pogonia which is the imitator. It is the rare form, fulfilling all the conditions of mimicry. The two plants dwell together. The rare one differs from its allies; there is no other pogonia, and, indeed, no other orchid of our flora which has its leaves whorled on the stem. The whole appearance of the plant is decidedly non-orchidean, and, so far as pressed specimens show, the flower continues the imitation, for the greatly elongated sepals and three-parted corolla—all green—have decidedly the semblance of the second whorl of leaves always found on the flowering stems of the medeola.

V. Alluring Color.—Color is sometimes a trap.

There is a singular class of beings, half animal, half plant, in their ways of living—a fascinating, uncanny sisterhood—the insectivorous plants, which display marvelous ingenuity in the entrapping of their victims.

The bladder-wort, which abounds in stagnant ditches or ponds, is a member of this class, which has no apparent attractive powers. Yet Darwin says that one species has wonderfully constructed bladders, curiously like an entomostracan crustacean, and, strangely enough, these are the very animals most frequently killed by them.

Pitcher-plants excited the interest of scientists and travelers over a century ago, but the meaning and mechanism of these "plant-saloons" was only discovered within comparatively recent times. Glandular hairs lead up the margin of the pitcher, and through its mouth to a field of such sugar-plums as grow everywhere in fairyland. Flies, ants, and sometimes moths, follow the baited path to feed on the sweets. But getting out is not so easy as going in. Some, reaching the limit of the sugar grove, slip on the glassy surface which is below it; others, satiated with the honey, try to fly away, but are dashed against the opposing lid of the pitfall, fall back into the tube again, and at last they, too, slip from the middle walls to be drained and more or less completely digested by the fluid secreted from myriads of hairs at its base.

The lure of the allied genus, *Darlingtonia*, is still more perfect. The singular, orange-red, fleshy, two-lobed organ which hangs over the pitcher's mouth much resembles the flower of the same plant, so that visitors which normally pollinate that may be betrayed by the double deceit. This is curiously like Stewart's description of an Asiatic lizard whose body is protectively colored like the sand on which it lives, but at each angle of the mouth a fold is produced into a shape "exactly resembling a little red flower which grows in the sand." Insects approach and are captured.

The elongated, hollow leaf-tips of Nepenthes have the same general purple coloration. The shade of many an insect which has perished in such a drunkard's grave emphasizes the "touch-not, taste-not" law—"he that is careless in his ways shall die."

The sparkling glands of the sun-dew, pinguicula, and Venus's fly-trap are scattered over the flat leaf-blades. A Portuguese genus is called by the villagers "the fly-catcher," and hung up in their cottages as such. A single plant of martynia, about three feet high and as many in diameter, caught seven thousand two hundred small flies. The abundant hairs secrete an exceedingly viscid fluid, whose unpleasant odor comes to the help of color. The disagreeable smell of *Arum crinitum* also draws many small flies to its spathes, from which escape is made difficult by the sticky downward-pointing hairs of their inner surfaces. Some of the visitors, unable to make their way out, die and are apparently digested. Others crawl up the spadix and fly away to deposit pollen on the stigmas at the base of the next spathe which they enter and in which they will probably die in their turn. So, as perhaps in Darlingtonia, one insect serves two important purposes. "Thrift, thrift, Horatio!" The priests themselves furnish forth the meats of the marriage-tables.

The prevailing colors of the attractive parts of all these plants, with the single exception of the bladder-wort, are the same that we shall find again in fly-pollinated flowers. The lurid red, purple, or pink of the pitcher-plants, sun-dew, etc., recall the blossoms of Dutchman's pipe, Bryophyllum, and Cirrhopetalum, and the spathes of the skunk-cabbage; the glittering, dew-like drops of butterwort and the unicorn plant occur again in the false flower-glands of Parnassia and the deceptive, sparkling ovary of Paris; and that disagreeable odor is a common characteristic in both classes strengthens the belief that in both carrion-loving flies (or beetles) are the objective points of the attraction, with this unessential difference that in the one class the plant feeds the flies, in the other the flies feed the plant.

VI. Attractive Color.—Leaving aside the negative evidence derivable from cleistogamy and the existence of only inconspicuous flowers in places where insects and flower-frequenting birds are absent, it remains to prove that attractive qualities actually have reference to the visits of animals, thereby establishing their usefulness—i. e., their eligibility as characters upon which natural selection may work.

Where there are bright flowers there are color-minded animals. All orders of insects are represented to an altitude of 2,300 metres, butterflies, flies, and certain bees even to 4,600 metres. The number and kind of insects are in close relation to the number and kind of flowers and their hours of waking and sleeping. Climate affects the color of all parts of a plant. Cereal grains are said to be brighter in the North. Fruits are invariably so. Many travelers have observed the intensity in the color of Alpine flowers up to certain limits of temperature. But if the brighter color is useless it will not be retained after a few generations, as the inconspicuous character of the flora of insect-poor Greenland shows; if serviceable, it will be not only preserved, but deepened as time goes on. The absolute number of flowering plants decreases with increase of latitude or altitude. As men flock to cities until the average compensation becomes equal to less than what they can obtain in the country, so all insects would stay on the plains or in the tropics until their number, becoming disproportioned to that of the flowers, better rewards can be obtained in less crowded regions. To this interdependence of insects and plants, and to the constancy of the numerical relations between the two, inherited intensity of color must be largely due. If the insects are greatly in excess of the attractive flowers, inconspicuous and conspicuous blossoms would be searched and fertilized alike in the resulting scarcity of food. If the number of flowers is much larger than that of the insects supported by them, the latter, becoming fastidious, frequent only the brightest or more fragrant, neglecting the others, which accordingly remain inconspicuous and self-fertile. When both insects and flowers are scarce, the former will remain only so long as the greater attractiveness of the latter makes it as easy to obtain the same amount of honey as could be obtained in the same time from the flora of richer regions where competition lessens the rewards of labor.

It is, therefore, necessary that the insect-dependent plants of colder places should have special attractions, and they do. Observations prove that one or more of the three qualities—color, nectar, and fragrance—which attract visitors are naturally increased in Alpine and northern plants, and it is not strange that some insects have been persuaded to leave all and follow these into their colder homes.

McLeod in the Pyrenees, Delpino in Spitzbergen and Nova Zembla, Müller in the Alps, and Verhoeff on the island of Norderney, all concluded that, in correlation with a scarcity of certain classes of insects, the flowers are either more conspicuous, or there is a noticeable increase in number of wind or self fertilized forms.

That climate alone can not account for the lack of beautiful flowers in countries where flower-visitors are rare, is the more evident in the comparison of the weedy flora of Tahiti with the rich one of the neighboring Sandwich Islands, or with that of Juan Fernandez, in both of which honey-sucking birds abound.

Again, there is proof of the actual preference of the different groups of insects and birds for particular kinds and colors of flowers.

The richest and gayest flowers of the world are those of temperate Australia, South Africa, the south European Alps, and South America. Honey-suckers abound in the first (are found nowhere else in the world); most of the sun-birds of the world are found in the second; humming-birds are almost exclusively confined to the last; butterflies and bees characterize the third.

Large, bright-colored, scentless flowers seem to be the favorites of birds and butterflies.

Riley says that "white moths are naturally attracted to white flowers." The difference in color between flowers visited by night-flying moths and by butterflies is very instructive, showing that something more than absence of light has led to the general colorlessness of evening blossoms (compare the day and night-flowering species of lily, etc.), many of which are fragrant, keeping "their sweetness to themselves all day," to "let the delicious secret out" under cover of darkness. So fragrance does the work of the honey-guides which are invariably lacking in evening flowers. Since many of these remain open only a short time—one, two, or three nights—it is the more important that they be easily found by the keen sighted and scented friends, to whom fragrance is as sure a guide as color.

But of all insects, the females of the social bees take the leadership in horticulture. They are the most useful and industrious of flower-guests, because they provide not only for their own needs, but also for those of their numerous progeny. Many of them are wise systematists, as Aristotle noted long ago, who wrote, "A bee on any one expedition does not pass from one kind of plant to another, but confines itself to a single species and does not change until it has first returned to the hive." Color must help them much; but since they visit a great variety of flowers, it is seemingly most useful as a means of distinguishing intermixed species, one color, in itself, being perhaps little more attractive than another.

Kerner, Kronfield, Forbes, and Della Torre have seen bumble-bees fly for hours from one flower to another of the same kind, ignoring other species which grew mixed with them. To such persistent and intelligent industry our field and meadow flowers, at least in part, owe their endless variety of shape and color, and as long as bees live there will be fresh modifications for us to wonder at. The "soft sun-brush" directed by the exquisite taste of these little connoisseurs of true art is continually producing new *chefs-d'œuvre.*

Nor is the work of flies to be despised. Some of them are almost as enterprising and have apparently as keen a sense of beauty as many bees and butterflies. Müller speaks of the largest and most handsome of the saxifrages as the "masterpiece of the *Syrphidæ*" (the most highly developed of flies). Fly-flowers have often dark-red color and nectar so scanty that it does not pay the bees to take it—e. g., bryophyllum. In New Zealand flies largely take the place of bees, which are there exceedingly scarce. Some species are exclusively dependent on them. Lurid, snaking spots or markings or disgusting odors often tell the secret of fly-attraction (arum, Dutchman's pipe, skunk-cabbage, smilax).

But some flowers, neither showy nor fragrant, are yet abundantly visited both by bees and flies (bryonia, bur-cucumber, etc.). Kunth found that the greenish petals of some of these plants affect a photographic plate as strongly as those of white, violet, or blue flowers. It is not at all unthinkable that the wonderful eyes of insects may be sensitive to colors invisible to our coarser sense. Kunth adds that the glands of these plants may perhaps contain ethereal oils noticeable to insects though imperceptible to man.

Surely, in the face of all these facts, it can not be denied that there is some relation between the conspicuousness or fragrance of flowers and their pollinization and pollinizers, especially since it is possible in the various insect groups to trace a connection between the two, and since, in the absence of animals of one kind, others have sometimes been delegated to do the work, the botanical character of the region changing correspondingly; as, for instance, in the fly-flora of New Zealand and the bird-flora of Juan Fernandez. Indeed, M. Sevali claims that grasshoppers fertilize the *Leguminosæ* of New Zealand, and Delpino thinks that *Rhodea*, which is self-sterile, depends for the production of seeds upon snails!

In order that the selection of insects may cause change in the characteristics of flowers, two things are necessary on their part. Their visits must be methodic—we have seen that they are so for the most highly specialized groups. They must be frequent. Any one who has followed a "busy bee" for half a day will be ready to witness that they are. A bumble-bee in mid-Sweden was seen to suck honey from the monk's-hood at the rate of from 960 to 1,200 visits an hour; a butterfly visited 194 violets in six minutes and three quarters; 2,155 bees were actually counted on a single head of the "honey plant" between 5 A. M. and 7 P. M., the thirty heads of one plant furnishing supplies for over 64,000 bees in one day. Some one has calculated that 2,500,000 visits are made to the red clover for every pound of honey. The United States, by the census report of 1880, produced 25,743,208 pounds, representing, therefore, 64,358,020,000,000 visits of *hive-bees alone in this country*, and this includes only that used for economic purposes, not at all that kept by the bees themselves. Add to these visits those of the wild bees, bumble-bees, flies, butterflies, birds—which are by no means indiscriminate—and surely here is a force whose selective influence must be enormous, which might easily bring about a comparatively rapid evolution. May not this shed some light on the mystery of the rapid floral development of *Phanerogams* after their initiation in geologic ages? Gardeners and farmers have, in relatively short time, been able to introduce and establish new forms of flowers, fruits, and grains, but the results of the industry of this vast army of workers must have been inconceivably larger.

This brings us to the other side of the question. Something is necessary on the part of the flowers, which must themselves be capable of great variation in color and form in order that selection may have material to choose from. Every one knows that they are so. As the latest production of the vegetable world they are the most plastic, the most easily influenced by alterations of the environment. (Old traits are not easily changed.) Many of them in their individual development pass through a series of changes which sometimes, perhaps, represents the color phylogeny of the species—e. g., several species of honeysuckle are white the first day, become yellow the second, wither the third. A certain hibiscus is white in the morning, rose-color during midday, and red in the evening, repeating these transformations each day as long as the flower lasts. Such changes are supposed to be merely chemical, the oxygen accumulated by night being used up by day.

But the most quick-witted insects would notice them, and we find that some plants have adopted them as dialects of the universal "flower-language." Fritz Müller describes a Brazilian lantana whose flowers last three days, and are yellow the first, red the second, purple the third. A few butterflies stick their tongues into the yellow and red, others visit only the red, none the purple. If the flowers fell the first day, the inflorescences would be less conspicuous; if the butterflies did not appreciate the change, they would lose time in searching for honey from old, functionless nectaries. What may be a purely chemical phenomenon in the hibiscus has become a constant and useful character. (Even more remarkable is the case described by Hildebrand of *Eremurus*, whose flowers open before the reproductive organs are mature. After the corolla is withered, stamens, stigma, and nectaries become fully developed, so the less intelligent insects, decoyed by the bright young flowers and finding there no honey, leave the inflorescence to the friends who love it because "it has opened its heart" to them.)

Tannin, which causes the disagreeable taste of many petals, is peculiarly abundant in cells which exhibit irritability—i. e., it is easily affected by outside agencies. Petals are delicate organs, and whatever irritable substance is in them is therefore the more easily stimulated. Add this to the fact of their youth, and it is natural that flowers should be pre-eminently variable, and altogether possible that certain stages may be seized upon and made hereditary by the selection of the innumerable army of hungry insects.

So, again, there is law all the way through. The operation of entirely natural and conceivable causes leads to the permanent establishment and combination of colors, odors, and forms which may be protective, repulsive, imitative, attractive, or unite several of these functions. And in the "continuous adjustment of internal to external conditions" is the evolution from alga to rose, which shall by no means stop with the rose. The song of the flowers is clear and true:

> "So on our heels a fresh perfection treads;
> A power, more strong in beauty, born of us
> And fated to excel us, as we pass
> In glory that old darkness;
> —For, 'tis the eternal law,
> That first in beauty shall be first in might."

MODERN NERVOUSNESS AND ITS CURE.

By Herr Dr. BILSINGER.

THE signature of our age is a thin-blooded, nervous generation. Only a few decades ago our women were so healthy that they were able to suffer occasional bloodlettings to counteract a supposed excess of blood. Now our girls are pale even in their school age, and the general complaint is that the girls are nervous. Not without reason is the age called a nervous one. While our ancestors, living in natural conditions, hardly knew what nerves were, we complain of excited nerves, even among our children; and adults, especially in the cities, who do not suffer from nervousness are exceptions. There is no doubt that weakness of the nerves, or neurasthenia as the doctors call it, is an acquisition of modern civilization, and at this time, or since attention was called to it by the American George M. Beard, as being as it were a new disease, is playing a formidable part with doctors and laymen.

The term neurasthenia does not so much signify a special affection of the nervous system as it is a fittingly chosen general name for a whole group of disorders the character of which consists in the nervous system failing to act properly, on account of a deficiency of normal nerve-substance. Such a condition, or at least a pronounced tendency to it, is in many cases inherited from parents; and only slightly unfavorable circumstances are required in children thus hereditarily tainted for the development of pronounced neurasthenia. There is, besides the hereditary form, an acquired weakness of the nerves, which may be produced by a considerable variety of causes. The blame for the present condition of our society undoubtedly lies in the haste and pressure of the age, with its battle for existence, driving us into morbidity. The increase and crowded condition of lunatic asylums speaks with admonitory plainness in this matter, and it is time that the right meaning was attached to the momentous phenomenon. Even in the country, where the hygienic conditions are relatively favorable, the evil of nervous weakness is gradually making itself more plain. It is conspicuous in the larger cities, where, with the meeting of great masses of men, the clatter of railroads, and the driving of factories, excitement prevails through day and night, under which the afflicted nerves with great difficulty obtain the rest they need. To this haste and excitement in social life are added the schools with their augmented demands, the trial of examinations, and modern business life; and it is no wonder that only a small fraction of the population escape these attacks on the nervous system.

Our general social conditions, in which the ease that once prevailed is approaching nearer and nearer to extinction, undoubtedly have a great deal to do with the preponderance of nervous diseases.

On the other hand, it can not be too impressively insisted upon that the individual has the means to a certain degree in his own hands of alleviating by a rational mode of life the general harm to which modern man is exposed. But it has to be remarked that the greater number of us, in spite of all the instruction we get, remain in incredibly dense ignorance of matters of personal hygiene. It thus occurs that many allow themselves to be guilty of sins against their own personality by which the health of their nerves is broken to the very marrow. Besides overwork on the one side, there are certain special indulgences, abuse of spirits and other stimulants, too early and excessive tobacco-smoking, and in the majority of cases all together, by which the nervous system is at last disordered and severely injured in its vigor. I was told by an officer that he began to smoke in his twelfth year, and when he marched to France as an ensign he now and then smoked ground coffee when he had no tobacco. It is not to be wondered at that this officer became insane a few weeks after his marriage, and had to be put in an asylum. In other cases there are more or less self-accused disillusions, cares, sorrows, and similar mental conditions, through which the nervous system is weakened and thrown off the track.

Through all these processes waste products are formed in the body, which, acting as self-poisons, cause more or less disturbance in the nervous system. In consequence of the storing up of these self-poisons, patients complain of sleeplessness, nervous pains appearing here and there in diversified alternations, and of being easily fatigued after brief mental or bodily efforts. They are often cross, overcome by trifles, and very frequently complain of nervous disturbances. Nervous dyspepsia is therefore in many cases associated with neurasthenia.

Sadly numerous as such cases of neurasthenia appear at this time, our knowledge has advanced so far that we can, with good heart, give promise of comfort and courage to nervously afflicted persons. For, even in apparently critical cases, a surprisingly favorable result may be reached by the exercise of a little patience combined with a proper and intelligently directed general hygiene. I sincerely advise nervous patients to avoid, as much as possible, all drug remedies. Especially would I warn them against habitual use of benumbing narcotics, however seductively they may operate at first. In my opinion, all these means ultimately do more harm than good.

Of immensely greater value than drugs to nervous patients are the natural factors of healing—air, light, water, quiet, exercise, etc.

The first thing required is, of course, to remove the fundamental causes of the disease. As much rest as possible should be given from without as well as from within; a true religious condition, which a sure faith gives, is therefore of inestimable value to patients. It is self-evident that they must try to be, as much as possible, in the open air, and mountain air is particularly advantageous to them.

Extravagant as they may venture to be in the enjoyment of fresh air, they should be more careful against excessive applications of water. They should always remember that man is not a water animal but an air animal. If in anything, a close adaptation of the treatment by the physician to the individual is particularly necessary in respect to the treatment of nervous patients with water. By the abuse of water in nervous diseases that most sovereign of all remedies has, after a short period of popularity, come into discredit. It is certain that a too indiscriminate application of water is a double poison to nervous patients. It is, on the other side, incontestable that water applications in the right measure, and in a manner adapted to the character of the affection, are excellent. Equally advantageous for them are going barefooted when properly prescribed, and the air-bath. In connection with the water and air cures certain respiratory and muscular exercises are advantages, and may, in certain advanced stages of the disease, be applied passively by massage and similar operations. Among other things, gardening and other occupations in the open air are of great benefit. Unhappily, in the large cities, where the majority of the patients live, there are only a few so fortunately situated as to be able to enjoy such employment to any considerable extent. Those who are able to go clear into the country, and work in the fields and woods in the sweat of their brows, will perhaps, if they are prudent and other conditions are favorable, effect a happy cure of their nervous disorders.

Those who have no garden to till will have to depend on gymnastics as a substitute. Among the simplest and most convenient exercises of this class are those with an instrument called the arm and chest strengthener, of a German manufacturer. The apparatus is handy, cheap, durable, and adapted to a variety of exercises. Further, the resistance of the weights can be easily measured and regulated for each patient, while the operation is in other respects the same. With this little apparatus we can safely produce expansion of the chest, regulation of the activity of the heart, and strengthening of the muscles. With it the metabolism and blood formation are materially assisted in a natural way. The little home apparatus is therefore not only of great advantage to nervous patients, but it can also be used profitably as a prophylaxis against tuberculosis; it fortifies the chest and strengthens the whole constitution. Care should be taken to perform the exercise in a well-aired room, and not to carry it to excess.

A suitable diet, specially adapted to each case, is of great importance in all nervous disease. The best general diet is usually one that is a little stimulating and blood-forming, with frequent changes. The usual courses of meat and wine should be considerably diminished, else the nerves will not be able to get the rest they need. Besides albuminous food, the necessary quantity of nutritious salts should be provided in supplies of fruit, green vegetables, and suitable milk and grain dishes. Very much to be recommended in nervous disorders are a well-prepared dish of oatmeal, a strong soup, or other dish of the kind. Such light food will not indeed be relished by many because of its being too contrary to their former habits. In such cases some savory addition to the cereal food may be a desirable expedient.

The old German acorn coffee is of special value in diseases of the nerves. Unmixed it is not very palatable to civilized men, but preparations may be made of it which will be found very useful in cases of nervous dyspepsia.

A suitable mental treatment should go hand in hand with hygienic and dietetic measures if the most favorable results are to be secured. Patience is a particularly valuable medicine to the neurasthenic; for it is evident that a disordered nervous system can be brought into equilibrium only with time and with the requisite endurance. In other respects the patient must try to contribute force to his cure through self-control, through strengthening of his will, and through bringing his mind up to a proper tone. The word of the poet comes into force that "time is man's angel." For the cure of even serious cases may be hoped for by following the hints we have given above; a corresponding right application of Nature's healing factors may bring about speedy cures even in apparently hopeless cases.

For the modern world, as a whole, the essential thing to be done is to return to ways of life more harmonious with Nature and less vexing to body and soul. The way to do this is clearly pointed out in the teachings of modern hygiene. May society enter upon this way betimes, for its own good and the salvation of the future!—*Translated for The Popular Science Monthly from Ueber Land und Meer.*

"Theories," said Prof. William Rutherford, at the British Association, "are but the leaves of the tree of science—they bud and expand, and in time they fade and fall. [illegible] the tree to breathe and live."

THE FIRST GERMAN PAPER-MAKER.

By EDUARD GROSSE.

"IN the name of Christ, amen. Anno Domini 1390, I, Ulman Stromer, started at making paper on St. John's day at the Solstice, and began to set up a wheel in the *Gleissmühle*, and Clos Obsser was the first who came to work."

So said Ulman Stromer, undoubtedly the first German paper-maker, in his notes which are still preserved. Five hundred years have passed since then, and the art of paper-making can look back on as long a period of earnest effort and profitable work. When Ulman Stromer so long ago established paper-making in Germany he had no foresight of the important position paper was destined to assume in the civilization of man. In book-printing, and outside of it, it is the most efficient agent in the advancement of the race, and has become a supreme necessity. It is the foundation of the book and newspaper arts, the indispensable aid of science and instruction, as well as of commercial and social intercourse. In short, it so governs our whole age that hardly anything could be thought of without paper in its present shape.

It was different in Ulman Stromer's time. Paper was then a rare material, little used, and only to be found in the offices of the learned, of scribes, and of officers. The supply of Germany and of all northern Europe was brought from Italy and Spain, most of it from the factories of Fabriano in Italy, where paper-mills existed in the twelfth century, while a lively paper industry flourished in Spain, with its principal seat at San Felipe in Valencia, as early as 1150. The paper-making art was introduced into both of these lands by the Arabs, who learned it in Samarcand and spread it through Europe. It was introduced into Samarcand in 751 by Chinese prisoners from their country, where it had been carried on from extremely ancient times. It is believed that the Chinese were making paper at the beginning of the Christian era, while the civilized lands of the West had still no other writing material than the Egyptian papyrus, which was not equal to the Chinese paper in quality and serviceableness, and parchment prepared from skins, the high price of which prohibited its general and free use.

The mercantile houses of Germany had trade relations with Italy at an early date. German merchants made trading journeys there, and sent their sons to Italian universities, or to Venice and other marts to learn business. We must therefore suppose that the paper-maker's art was not wholly unknown to the Germans, and that individual dealers had had opportunities to visit paper-mills on their journeys to Italy, even though they may not have had a real knowledge of the art. In any case it is not impossible that enterprising men of business had even before Ulman Stromer conceived the plan of establishing paper-mills with the help of Italian workmen; for the expense of transporting paper across the Alps must have made it very high, and there was abundant prospect of making the enterprise profitable in the fact that there were no paper-mills north of the Alps except in southern France. We are, in fact, inclined to believe that a few paper-mills existed in Germany at the end of the thirteenth and the beginning of the fourteenth centuries. Thus, the paper on which

FIG. 1.—ULMAN STROMER'S PAPER-MILL. (From Schedel's *Buch der Chroniken* of 1493.)

the copy of a document of 1315 is written is a specimen of the German Holbein's paper, for it bears as a water-mark an ox's head, which, according to Gutermann, was the arms of the Holbein family, whose paper-mill was standing at Ravensburg, according to some in 1270, according to others in 1324. But the fact that the Fabrianos also worked a similar water-mark into their paper bears on the other side. It has not been possible to prove that the Holbein paper-mills were in operation before the year 1407, when the first authentic mention is made of a paper factory at Ravensburg, and of the paper-makers Cunrat, Peter, and Stengli. There were also paper-mills about 1347 at Au, near Munich, and in 1356 at Leesdorf in Lower Austria; but documentary evidence to establish the fact is as defective as it is of the early existence of the Ravensburg mills.

But it is incontestably established that the Nuremberg Ratsherr Ulman Stromer built a paper-mill in 1390, which was the first demonstrably in Germany. Through his carefully kept notes many particulars of Ulman Stromer's life and business transactions are known to us. They furnish information concerning the introduction of paper-making, and further permit a deep insight into the conditions of trade and industry at that time. A happy chance has also permitted the picture of Stromer's paper-mill to come down to posterity, and we contemplate with pleasure the rude drawing that represents the high-gabled buildings of this German factory of five hundred years ago. The view (Fig. 1) is reproduced as exactly as possible from Hartmann Schedel's *Buch der Chroniken* of 1493, which was printed by Anton Koburger and illustrated by Michael Wohlgemut and Wilhelm Pleydenwurf with about two thousand woodcuts.


Fig. 2.—Interior of an Old German Paper-mill. (After Jost Amman, 1568.)

Ulman Stromer, born on the 26th of January, 1329, was descended from a distinguished Nuremberg family, whose ancestor, Conrad von Reichenbach, having married into the family of the Waldstromers, resided thenceforth in Nuremberg, and called himself Stromeyr, abbreviated into Stromer. He became a man of extensive business and considerable wealth, and the owner of houses in the city and of a landed estate, and eventually one of the most prominent men in Nuremberg. With a brief interruption he sat in the city council, and was for a long time one of the three chief magistrates. In this capacity he often represented the city in important transactions, and served as its plenipotentiary in foreign affairs, as, for example, in the conclusion of the accession of Nuremberg to the Swabian Confederacy. Ulman Stromer often made long journeys in the interest of his business. Like other great dealers of Nuremberg, Augsburg, and the Tyrol, he [illegible] probably an intermediary of trade between the southern and northern countries. In his journeys to Italy he became acquainted with the paper-mills, and observing the prosperity of the Fabrianos, Cividales, and Battaglias, recognized the immense importance of the trade. It was a short step to decide to establish a paper-mill at home. There being no paper-makers in Germany, he secured the brothers Marco and Francisco di Marchia and their boy Bartolomeo in Italy and brought them to Nuremberg. He built his mill in the so-called *Gleissmühle*, which was situated not far from Nuremberg, near the present Hallerniese. Whether he built a new mill or only adapted an old grist-mill or oil-mill, of which we know nothing, he had to prepare new machinery for paper-making, including stamps, presses, and tubs, and sorting and drying rooms. Notwithstanding these apparatus were of the simplest character, their construction required considerable time, for work was done more slowly in those days than now. When, therefore, Stromer reports that he began paper-making on St. John's day, we must suppose either that months or years had been spent before that in hard work, or that he did not begin the actual making of paper, but only the building of his mill, on that St. John's day. The latter seems, in fact, to have been the case, for Stromer says that it was then that he set the wheel—that is, the water-wheel by which the stamping machine was propelled.

The view of the interior of an old German paper-mill in the year 1568 (Fig. 2) is taken from a woodcut by Jost Amman. In the left background are seen through the window the paddles and upper part of two water-wheels, which, moved by the stream without, drive the works within, especially the large roller that lies against the wall. This, it may be seen, is furnished with projecting beaters which are designed to hit upon the knee-bent stamps visible in front, and work them up and down. The heavy stamps lie with their hammer-shaped ends in a rectangular trough, in which the rags are placed after having been cut up and macerated. These stamps, with their heavy blows on the rags, beat them till the cloth and its threads are resolved into a fine lint, which, bleached, washed, and mixed with an adhesive substance, are carried, a semi-fluid mass, into the draw-tubs. The paper-maker draws the pulp from them with a rectangular metallic sieve, and, while the water is dripping out through the meshes in the bottom, he shakes the fibrous mass that is left till it lies smoothly on the wire-work, felted into an even, homogeneous leaf. This is the still moist paper, which now laid between felts is placed in the powerful press that is seen behind the workman, and freed from water and made smooth. When this is done, the sheet is taken out of the press, carried in piles by apprentices to the drying-ground, there hung on lines, from which it is taken when dried and is then smoothed again. Such in brief outline was the method of the old paper-makers, which has now, of course, been greatly modified and substantially supplanted by the invention of paper-making machinery. Stromer's first assistant, Clos Obsser, was probably not a skilled paper-maker, but a carpenter, who came to fix the water-wheel, while the real paper-making could not be begun till this was done and the stamps were in working order. This was apparently in August, 1390, for on the 7th of that month Stromer swore his assistant Clos Obsser to fidelity and to keep the secret of the art of paper-making, as he did regularly afterward with all his workmen when they began.

The pledge of assistants to secrecy was an old custom which was observed in different trades. It was particularly usual then when working methods were still little known and assistants initiated into the secrets might, by means of their knowledge, injure their employer by inducing an unwelcome competition. Such a danger lay before the Stromer mill. There were as yet no paper-makers in Germany. The process was known only in the southern countries, and Stromer, as a substantial business man, desired to prevent his workmen revealing the secrets of the art or setting up competitions. He therefore made himself secure by an oath from his men and by written contracts. He administered an oath of this kind in the presence of his son Jörg to Clos Obsser on the 7th of August; and a few days later to another workman named Jörg Tirman, recording the fact in a note: "Anno Domini 1390, on the day after St. Lawrence's day (11th of August) Jörg Tirman gave me his pledge, and swore with upraised fingers an oath to hold his trust, to be true to me and my heirs, to further our advantage and keep harm from us, truly without any comrades. He is for ten years to engage in no work in paper-making except for me or my heirs, to whom I leave the paper-mill; and when the prescribed ten years have passed, he may make paper for himself but not for anybody else. For this he has a permit from my own hand." Stromer imposed a similar oath on the Italians Marco and Francisco di Marchia and their boy Bartolomeo, and added the provision that they should not give either advice or help in the introduction of Italian paper-making in any countries on the hither side of the mountains of Lombardy. A copy of the oath was made, attested by five witnesses, and given to each of the parties. He doubtless made a good business out of his paper, for he could sell it at great profit, while the rags and other raw materials, not being yet currently merchantable articles, could be bought very cheaply. He did not lack for customers, but was, on the contrary, not able to supply the demand of Germany or even of central Germany; for it appears, from various account-books, that much paper was still brought in from Italy, and that even the Council of Nuremberg was obliged to obtain a part of its supply there. Therefore Stromer planned an enlargement of his mill, and decided to add to the two wheels driving eighteen stamps a third. In this enterprise he had an opportunity to become acquainted with the worse side of the character of his Italian paper-makers. It did not escape them that Stromer's paper-mill was profitable, and they observed its rapid rise with much dissatisfaction. They tried to get the mill into their own hands under favorable conditions and to enjoy the profits. They sought to reach their object by artful means, throwing every obstacle in the way of his business, and making it unpleasant for him. They neglected their work, did not make the best use of the stamps, and made less paper than they might have made. Under the pretext that they could not do the work alone, they asked him to send for a few more of their countrymen; and when he declined to employ more Italians, they summarily refused to permit the third wheel. When they thought they had tired their employer out, they broached their own plan. They proposed that Stromer should lease them the mill for an annual rent of two hundred gulden. When this was not accepted, they offered him a certain quantity of their own made paper as a rent. This proposition was also declined; the disappointed Italians carried their false play to the extreme, and gave their employer all the trouble they could.

He at last lost patience. He seized the Italians, put them in the tower "behind the drying-kiln," and locked them up, as he says, "in a little room." They were not pleased with their quarters in this "little room," and, giving up their spite, they sent on the fourth day of their imprisonment for the three citizens, Hans Groland, Stromer's brother-in-law, Fritz Amman, and Ulrich Stremler, to negotiate for them with Stromer. He was disposed to conciliation, and it was agreed that both sides should pledge themselves to observe honorably all that should be ordered by the referees. The Italians were liberated, and all went to the Augustine Convent, where the agreement was ratified anew. The Italians had to swear a new oath that they would in future be absolutely true to their former oath, and they would not try to harm by word or deed any one who had been accessory to their imprisonment; that they would have no contention with the master, Ulman Stromer, his family, and servants, otherwise than in the courts of Nuremberg; and that they would interpose no obstacles in the way of their employer and his heirs, and that they would perform what he ordered, whether it were to have one, two, or three wheels in the *Gleissmühle*, or to set them up in another place. After Stromer had thus brought the Italians to terms, he seems to have had no further trouble with his people. The business went on quietly with a steady increase. New workmen were employed every year; and in 1398 seventeen men were employed there, with three women to sort rags, and a bookkeeper. These were all sworn in as solemnly as the first workmen. Among the later hands were three carpenters, each of whom received fifteen pennies a day. A comparison of these wages with the price at which paper was then sold—about forty groschen a ream for writing-paper in 1426—suggests that Stromer's profits were exceedingly large. There was no competition so long as he lived, and his mill continued to be the only one in Germany, a fact which may be ascribed to his careful proceedings in hiring workmen. The year of his death, 1407, was also the year of the beginning of the second authenticated paper-mill, at Ravensburg, which is then first mentioned in the records of the city. A paper-mill went into operation the next year at Strasburg, and others at Liegnitz in 1420, Basle in 1440, Bautzen in 1443, and Augsburg in 1468; after which, the art of printing having been introduced, the demand that arose for paper caused factories to increase very rapidly. There are now in operation in Germany about nine hundred and twenty-five paper-mills, which produce more than 400,000,000 kilogrammes of paper a year.—*Translated for The Popular Science Monthly from Daheim.*

ARE BUSINESS PROFITS TOO LARGE?

By J. B. MANN.

THERE are four essentials to any successful business—viz., capital, labor, skill, and opportunity. The first three of these must be paid, and our question relates to the proportion of compensation to be awarded.

We must start by considering the circumstances of the case. If we take an ordinary country village, we will find several boys with the capacity to labor, but without capital and skill to conduct a large business, and from necessity they become laborers. Then we find two or three perhaps with business ability, but no capital, and if they can not borrow capital—and most of them can not at first—they become laborers also. Occasionally one is found like W. H. Vanderbilt, having both capital and skill, and he steps to the front and does business enough, or more than enough, for several villages. His wealth increases rapidly, and his power to accumulate gains all the time.

Now the laborer looks at Vanderbilt as a capitalist chiefly, and knowing that labor is just as essential to business as capital, naturally asks why it should not be as well rewarded. The answer always must be that it should, but this does not answer the main question as to the proper proportion of profits to be divided. Three things being essential, and each able to command pay, the portion of pay must be governed by circumstances. In the case of our village boys, one only can start in business, and nine start as laborers, so that there are in the beginning nine competitors for the rewards of labor, and but one for the rewards of both capital and skill in management. On the law of competition, which can not be evaded in the long run, this seems to put labor at a great disadvantage, but it is a disadvantage imposed by Nature, and so need not be discussed. The actual fact is, that there are three things equally essential and to be paid for the conduct of business. If we had thirty dollars to divide as the result of an enterprise, and should say that, as all three of the things were essential, each of them must have a third of the emolument, we would shoot wide of the mark. In that case, one individual would get twenty dollars, and nine would get only one dollar and eleven cents apiece. That would be absurd. But the poor man, looking to the owner of a hundred millions, imagines that the division has been something very much like it.

The poor man, however, is mistaken. There is no business of recognized legitimacy that pays labor only a third. There is no business that gives to capital and skill combined even ten dollars out of thirty. Labor gets more than two thirds of the income of most undertakings, and of many gets the whole, while the entire capital not only obtains nothing, but is itself lost in the venture, and its owner relegated to the ranks of labor. No man, employing ten hands at wages of three dollars per day each, expects to make five dollars per day; but that sum would only give him three dollars for his time—the same as his men get—and two dollars for his skill and the use of his capital. This is a case where the employer is possessed of ability to manage the ten men as laborers only, and for such a man five dollars per day for the necessary study, anxiety, and responsibility, can not be deemed out of proportion.

When the man of fifty looks at his boy associates and their careers, probably he will find that only one in ten has reached a handsome competence by his own exertions, and that one because he was energetic, faithful, competent, and thorough systematically from the start. If for a time he served under another, he was careful to do a little more than was expected of him, and did it well. This created confidence and desire on the part of his employer to see him prosper, and a disposition to assist him. In course of time his employer lends him capital, or makes him a partner in the business, and then his fortune is assured. Why did not the other ten boys do the same? Obviously because there was but one chance in ten of that kind, and the one got it, so the others had to be content to serve in less profitable callings.

The regiment has but one colonel, the company but one captain, the State but one Governor; and any great business has limitations to the number of bosses it can find use for. There must be operatives as well as managers, and generally capacity finds its way to the front, and incapacity goes to the rear, as a matter of course, or according to the law of gravitation.

When one finds an opening, and leaves the operative class for the managing class, the value of his service shows for itself in some way that commands recognition. Thus, in the early days of agriculture, farmers send their produce to market by a man who makes a business of marketing for others. He can handle the product of ten farms, say, and hence twenty farmers give a living to two middle-men. After a time a man turns up that is smart enough to sell the product of twenty farms, and obtain better prices for the producers, by taking off a little from the commissions, and soon he gets all the business, and his two rivals are obliged to retire from the field. When they are out, the profits which were divided between two are taken by one, less the small discount that he made to the farmers to secure their custom. Now, doing the work of two, he saves the time and the expenses on the road of one, and so, while they just made a living, he rapidly accumulates, and makes money faster than the farmers who raise the produce which he only sells. In a few years he is the richest man in town, and the farmers, looking only at the result, are dissatisfied, and though he has done the selling for them for less than they could possibly have done it themselves, and also for less than any other man had ever done it for that community, they complain of him as an extortioner, or robber of the poor men who have done all the hard work. To state it mildly, he is a non-producer who has eaten up the farmers of the town.

And what has happened to the farmers has happened to all others. The competent manufacturer has come in, and by doing a much larger business has retired several incompetents to the ranks; the competent trader has done the same, the banker has done it, the expressman has done it, and all others have where there was a chance. From what has been said, it is apparent that the cost of living to the middle-men is not the prime factor in measuring the pay for their services. In the first case named, the farmers were satisfied with paying the larger commissions so long as the men earned only a living, they taking the living as the proper measure, and then they wanted to apply the same measure to the better man, and leave out of the account his better service and management, and lower commissions. They were more content with two dawdlers and inefficients, than with one brisk, energetic, and go-ahead fellow, who served them in better fashion.

It is found, after a term of years, that the one efficient man has saved a handsome property, and has money to lend to others to increase business, and that somehow his portion of taxes and public burdens is very large, and a material help to town expenses, while it is certain that the two men he displaced do not lend any money or pay any taxes of consequence, and probably never would had they retained the business which he took from them. The inefficients would have allowed matters to run along in a careless fashion, and they would have consumed their commissions in living expenses, so that nothing would have been added to the general stock; but the new and vigorous man having come in, the community, instead of having two poor persons who can pay no taxes for highways and schools, has a capitalist who does pay, and who also has money to lend to men who need. The common people in these days decry the richest man in town, and think him a detriment, a sort of incubus or dead weight which the people are compelled to carry, whose money has been made out of them by craft, and they imagine that had the laws of right and justice prevailed, their burden would not have existed. They do not for a moment dream that his capital would never have existed had the old dawdlers kept on to the end.

Nevertheless, they do believe in capacity, and they vote for the competent man for Governor, and town clerk, and assessor, and when they want a farm-hand or market-man they employ the best for the money, and only grumble after the service has been performed. They know that the best help is the cheapest all the time, save at the moment when they look at the aggregate reward in the lump. They know that a good hand is more profitable than two half hands, because the board of one can be saved. Now, the men who manufacture or engage in trade are the servants of the people as certainly as the Governor of the State or the county clerk. They combine materials and exchange goods for others simply because the others find it for their advantage to have them do it. I do not buy at the store because the merchant compels me, but because it is not profitable for me to keep store myself. By getting the manufacturer to take my wool and turn it into cloth I get more cloth. I create the manufacturer by asking him to help me to get the most cloth. In early times the shoemaker went from house to house with his lasts, leather, and patterns tied up in a sack and slung over his shoulder, and made and mended in the family kitchens. That kind of shoemaker long ago disappeared, and is no longer here to be laughed at. He was succeeded by one who stayed at home and worked in his own kitchen. The other went out of business because he came in. He drove the other out, and out to stay; he will never return; he demonstrated to people that the old cobbler was not the best resource for foot-gear, and the moment this was made plain the old system went under; he saved time in packing and unpacking, in traveling to and fro, in waiting, and in many ways made it more convenient all round, so that it was cheaper for customers and better for the workman to have the new system.

Later on the kitchen workman had to abdicate in favor of a man with a shop, a grindstone, shelves, better light and heat, and numerous appliances impossible in a farmer's kitchen. When this man had held the fort a while, the regular manufacturer, with a large building for cutting, sorting, storing, and caring for goods, put in an appearance, and the man with the small shop and comfortable loafing quarters stepped out in the same way and for the same reason that his predecessors had. The new-comer could do better service for less money; the manufacturer came because the world knew what it wanted and sought him. The world wanted some one capable of stopping the enormous wastefulness of the old system. The newest man has made the old cobbler and his ways appear ridiculous, and the operative of today lives better than the well-to-do farmer of 1786. If the old way is the better, there is nothing in the way of returning to it, only the one fact that people can not afford to. Let him that thinks the old plan the better start out with his bundle of lasts and kit and try to earn a living in the good old way.

Attempts at co-operation thus far have generally shown a strong if not fatal tendency to failure because of the difficulty of commanding the requisite skill and faithfulness in management. Co-operators are not willing to pay the price for service which their business needs in order to succeed. They always stand on the theory that the men who conduct great enterprises get too much for doing the business and the operatives too little. In course of time, and usually not very long time, their scheme goes down. This is because in the nature of things no hired person on a salary of fixed amount will all the time keep his wits alive and study into the small hours of the night devising ways and means to make money for other people. They propose in their constitution to take from capital and skill a portion of the profit that has usually been accorded to them and give it to labor; but after thousands of experiments during forty or more years of good business in this country there is hardly a single case of such undoubted success as to warrant the assertion that demonstration of feasibility has been attained. The combined skill of all the co-operators in half a century has produced no concern of magnitude. The almost uniform failures seem to prove that great management must have great compensation, and in endeavoring to get the skill without the pay the co-operators' dream has come to naught.

Now, this is equivalent to saying that the world finds its business can be done at less cost than by co-operation. The latter fails because it is undersold and unable to compete with such skill as gets the better pay.

Had Commodore Vanderbilt been content with the salary of a steamboat captain he would never have developed into a great business man and railroad manager. The prospect of great emolument brought into exercise great powers, so that he cheapened transportation in an astonishing degree and yet made money to an astonishing amount. The people who saved four or five dollars in a round trip between Boston and New York, and the people who got their barrel of flour twenty-five cents less because he ran a railway to Chicago, enjoyed the sensation at the time, but, when they saw his fortune, could not refrain from tears to think of the merciless robbery they suffered at his hands. It is the old story of the farmers and the market-men told at the beginning of this paper. The thing happened and succeeded, not because Vanderbilt was a robber, but by virtue of his giving better terms to people who had to travel and had to eat bread. His inducements were such that he got the business. Suppose he and some others of the same kind of enterprise had not come upon the stage, what would have been the result? Evidently the old ways of business would have continued. We should still be going to Buffalo on canal-boats and creeping along the streets of our cities in dilapidated omnibuses, still be doing our journeying in stage-coaches over dusty roads and tedious hills at a great sacrifice of time, money, comfort, and strength. The enterprise of the money-makers has profited everybody else by exciting production and accumulation. The money-makers have taken pay not out of labor, but out of the increased production and savings which their efforts have secured. Individuals have sometimes suffered. The omnibuses were killed when the horse-car came, and A. T. Stewart did the business of a hundred small shopmen; but the people at large saved time in getting where they were compelled to go in one case, and got what they wanted at less cost in the other. The street railroad makes ten times the money that the stages did, and the people save money and time. The people can do better by buying of Stewart, and therefore they buy. They enriched him to the tune of thirty millions, clean cash. This is a great fact; but it does not show great robbery. It may show the very opposite. The very class of persons who find fault with

Stewart for crushing out so many small dealers are the same parties that say the great curse of society is the number of middle-men it has to carry. If there were anything in this, then Stewart certainly operated in the right direction by getting rid of a portion of the incumbrance; and he got rid of it in the right way, for he allured the customers to his shop by giving better bargains. Something was saved to buyers when they patronized him. Each buyer carried away a little bonus when he left Stewart's store. Something better than a chromo was obtained. It was a cent a yard on cashmeres, perhaps, an eighth of a cent on calico, a shaving on tapes, and a trifle on a paper of pins—just enough to get so much of the trade of the small fellows that they must retire.

Of course it follows that, if he still made too much profit, then he ought to have sold cheaper yet, so as to have driven out another lot of traders. But when we say "ought" in such a case, we must have some rule of a practical nature by which to determine the matter. This we do not have. We know that this merchant sold goods at so little profit that he ruined hundreds of competitors, and compelled their retirement from the field. Shall we say that they ought to have sold any lower? How can we ask him to sell at a profit on which the average trader breaks and starves? Shall we say that he did so much business that he was able to do it for less? But that does not meet the point. That is only saying he should have done less, and not that he should have done it cheaper. Society had no claim on him in this regard, and would have made nothing had it tried to enforce any. Had society asked him to sell less, all the goods not sold by him must have been sold by others, and at as high or higher rates. So society would not have been relieved of its burden of parting with so much of its product as was represented in the commissions or profits taken by Stewart.

But there is another view of it that brings us to the same conclusion. Stewart was in business for about forty years, and for many years sold twenty millions of goods per year. Had he sold but fifteen millions per year at a profit of five per cent, and invested the profit with his usual sagacity, he would have been worth more than thirty millions at the end of his forty years. That he left but thirty millions proves that his profit was not over five per cent on the average. The margin for labor to gain from is, therefore, in the neighborhood of five per cent, because Stewart has proved that the ordinary man can not part with more than that and continue in business. In other words, business stops when the margin goes down much below that rate.

There are some lines of business in which the profit is at times more than five per cent, but in the long run the average can not amount to more than that. Competition increases from year to year, and profits tend downward all the time; consequently, it takes more talent and energy to make fortunes now than it did a few years ago. It is not so easy for a laborer to become a boss as it formerly was; and as the chances for rising to bosshood grow less, the hatred of bosses increases. This is a symptom of discontent, and an evidence of the unreasonableness of the philosophy which is at the bottom of the schemes for relief. Capital must be paid, skill must be paid, and, if they are each paid but two per cent of the accruing profits, one per cent only remains for labor to get as its share, and this to the laborer whose wages are one dollar a day would amount to but three dollars a year. That is something, to be sure, but as a means of elevating the laboring classes is of no account.

THE SCIENTIFIC SOCIETIES OF ITALY.

By Dr. W. C. CAHALL.

TO Italy, more than to any other country, belongs the Renaissance. The soil was particularly favorable. Upon the fall of the Byzantine Empire its rich treasures of Greek manuscripts found their way from Constantinople to western Europe. The fleets of Venice brought the greater part of them to Italy, where they found liberal purchasers. The Greek scholars, finding their vocation destroyed in Constantinople by the Turks, flocked to Italy to teach and translate. The awakening mind of Italy viewed with eager delight this new world in literature. The eternal freshness and beauty of Homer and Plato, and the marvelous knowledge of Nature displayed by Hippocrates and Aristotle, when read in these full transcriptions of their writings, came with the force of a revelation to those accustomed to garbled extracts, loaded down with scholastic commentaries and absurd elucidations. The study of the classics became a passion of the few, and then the fashion of the many. In every city and large town of Italy academies were formed for the critical study of the manuscripts.

George Eliot, in her historical romance Romola, furnishes us with a very interesting account of the proceedings of the Platonic Academy of Florence, then under the patronage of the Medici. Not only pure literature and philosophy but scientific inquiry gained an impetus from these societies. Under the direction of such men as Alberti, Da Vinci, Toscanelli, and Da Porta, Nature came to be questioned in the proper scientific spirit.

Hitherto the scholastics would have had Nature to conform with man and not man conform with Nature. To these teachers thoughts only were real, and all attempts to gain the secrets of Nature were considered useless and contemptible. And, strange as it may seem, the authority appealed to in support of these views was Aristotle himself—not the Aristotle as he was known in Greece and as he has come to be known later, but the Aristotle as he appeared under a double Arabian and Latin disguise. His commentators had no hesitation in ascribing to him just the contrary to what he had advanced. He was to be made orthodox at any price.

All knowledge of Nature that was accidentally unearthed was made to bear a theological import. Even the philosopher's stone was made a theological agent. It was supposed to be able to free man from sin. The search for the stone was commended, since God had promised it to all good Christians, and that passage from Revelation, "To the conqueror I will give a white stone," was quoted in support of this view. Even zoölogy was obstructed with miracles and legends, as witness the wide-spread popularity for centuries throughout Europe of that curious book the Physiologus, or the Beastiary. Without a doubt this book contains a greater number of errors to the page than any other treatise on natural history ever published. It had its origin in the early Christian centuries, when the tendency was to interpret the Bible in an allegorical method, especially resorted to in the earlier commentaries on the account of creation in Genesis.

Among the most astonishing of the statements of this remarkable authority on natural history are the following: "The lion (footprints rubbed out with the tail; sleeps with eyes open, cubs receive life only three days after birth by their father's breath); the sun-lizard (restores its sight by looking at the sun); the pelican (recalls its young to life by its own blood); the eagle (renews its youth by sunlight and bathing in a fountain); the phœnix (revives from fire); the viper (born at the cost of both its parents' death); the serpent (sheds its skin; puts aside its venom before drinking; is afraid of man in a state of nudity; hides its head and abandons the rest of the body); the hedgehog (pricks grapes upon its quills); the panther (spotted skin; enmity to the dragon; sleeps for three days after meals; allures its prey by sweet odor); the sea-tortoise (mistaken by sailors for an island); the hyena (a hermaphrodite); the otter (enters the crocodile's mouth to kill it); the salamader (quenches fire); the tree called peridexion (protects pigeons from the serpent by its shadow); the fire-flints (of two sexes; combine to produce fire)."

It was not because there was nothing better than this book that it gained such a popularity, for there were the works of Pliny and those of Aristotle, though abridged and perverted from their original meaning by commentators. It was because the mind of the middle ages was childish, and, like a child, desired not so much what was accurate as what appealed to the imagination and to the love of the marvelous.

But in the fifteenth and sixteenth centuries there was an awakening in Italy, and when these correct copies of the works of Aristotle, which Cuvier pronounced "fresh after so many copies and young after two thousand years," and those of other classic writers became accessible, they found eager students.

From his study of the ancient authors Columbus received knowledge of cosmography and geography, which materially assisted him to his discovery of the New World. Anatomy found diligent students; Italian anatomists attained European reputation; it was at the school of Fabricius de Aquapendente at Padua that Harvey acquired that knowledge which afterward made his name immortal. Even the pencil of Titian was not above illuminating the pages of the great anatomical work of Vesalius. Titian was not alone among the artists of this period who became enamored with the new sciences. The greatest of these was Leonardi da Vinci, the most universal genius, perhaps, who ever lived. His Last Supper is one of the chief masterpieces of the world; he distinguished himself in sculpture, architecture, poetry, and music; he performed clever feats in engineering; anatomy, botany, geology, mathematics, astronomy, chemistry, and geography all received valuable contributions from his investigations. He anticipated many of those wonderful discoveries in physical sciences which fell to the succeeding generation to fully develop.

No better illustration of Da Vinci's acuteness of reasoning could be obtained, perhaps, than by quoting his observations on the origin of fossils. It must be remembered that geology did not become a science or the origin of fossils fully settled until two and a half centuries after this remark was made. He strenuously asserts the contents of the rocks to be real shells, and maintains the reality of the changes of the domain of land and sea, which these spoils of the ocean supply.

"You will tell me," he says, "that Nature and the influence of the stars have formed these shelly forms in the mountains; then show me a place in the mountains where the stars at the present day make shelly forms of different ages, and of different species in the same place. And how, with that, will you explain the gravel which is hardened in stages at different heights in the mountains?" Had Leonardo labored assiduously in art alone, there never would have been the need of Michelangelo and Raphael; had he confined himself strictly to one science, Galileo and Torricelli would have found their occupation gone. That which proved Leonardo's personal loss was Italy's gain, for his fertile mind started trains of thought which lesser men could prosecute but could not have originated.

The Academy of Milan, instituted in 1485 for the study of the arts and sciences, of which he was director, had a far-reaching effect upon the youth of Italy of that day.

Later on Bruno and Da Porta arose to carry on a similar work for southern Italy. Bruno early espoused the Copernican system, and by the brilliant and fearless manner of his teaching did much to popularize this condemned doctrine.

Bruno was a philosopher rather than an experimenter, and his influence upon the science of the times was not so much what he himself contributed as what he inspired others to do after him. Yet in his work, *Del Infinito Universo e Mundi*, he makes an advance upon the Copernican system in declaring his belief in innumerable worlds besides that on which we live, and also that each star is a sun, about which revolve planets like our earth. In no country at this date was science being approached from so many sides or by such an array of minds as in Italy during the sixteenth century. With such a beginning the Renaissance ought to have done for Italy in science what it did for her in art, music, and architecture—made her the master and teacher of all Europe. But there was a repressive power in Italy, which chilled and stunted every shooting tendril which science put forth, and only when transplanted in France and England attained those fair proportions natural to its growth.

Art and architecture could be appropriated to the service of the Church, and flourished under the favor of the authorities; but the sciences as they grew became iconoclastic, and threatened the existence of some of the most cherished doctrines of the Church. It was decreed in Rome that all such dangerous questionings should cease, or else, as the shrewd politicians there foresaw, the authority of the Church over men's minds and thoughts would be soon overturned.

Adverse indeed were the times for the organization of a scientific society; yet the generous and enthusiastic Frederico Cesi undertook this very thing, in establishing the Accademia dei Lincei, within three years of Bruno's execution, and in Rome at that.

The story of this unfortunate young nobleman's unselfish yet misjudged labors is one of the most pathetic in the history of science. The Accademia dei Lincei antedates the Royal Society by sixty years, and the French Academy of Sciences by even more; yet, though at times its torch burned fitfully, this venerable body still exists and fills a place of honor and influence in its country similar to that occupied by the Royal Society and the

French Institute in theirs. Considering the adverse spirit surrounding it throughout the two centuries and a half of its existence, one can not but wonder that it ever survived or ever was revived.

Frederico Cesi, son of the Duke of Acqua Sparta, was but eighteen years of age when he founded the Academy in 1603, having been born in 1585, nor had either of his three associates passed the age of twenty-three. Young as was Frederico, he already enjoyed the acquaintance, personally or by correspondence, of the foremost scientists and philosophers of his time. His first associate in his undertaking was Francesco Stelluti, who appears to have been prompted by an ardor for study and a nobility of character similar to that of Frederico. The third of this little band was Heck, Eckius, or Reckius, as he was variously called, a Hollander and a Catholic, who found the Calvinistic inhabitants uncongenial, left the Low Countries and settled in the town of Scandriglia, in Sabina, where he practiced medicine. His fame as a profound student in all the branches of philosophy reached the ears of Cesi, who invited him to Rome as an *attaché* to his family. A fourth member was added in the person of Anastasio de Filiis, a relative of the Cesi family, residing with them, and who was devoted to mechanics.

In order to give method to their studies these young men organized an Academy upon the 17th of August, 1603, which date was to be annually remembered by a day of festivity, and gave it the title of *dei Lincei* or *the Lynx*, from the well-known acuteness of vision of this animal, and with the motto, "*Sagacitas ista.*" The plans were drawn upon an ambitious scale. With the orders of the Church and the Masonic fraternity in their mind, they conceived of the organization of a world-wide society, embracing at the same time investigations of a scientific character with a broad philosophical brotherhood connected by affiliated lodges.

The meetings were to be private, and the members were required to be "philosophers eager for real knowledge, who will give themselves to the study of Nature, and especially to mathematics."

They met three times a week and had five lectures at each meeting, each one performing his own duty. Heck was reader in Platonic and Transcendental Philosophy. In one of his theses he proposed a medicine of his own to "keep the soul alert" and to prevent it from growing sluggish by reason of the heaviness of the body. Unfortunately, he could not have taken his own medicine, if it possessed the virtues claimed, neither does he inform us of what his medicine consisted. So we can never know whether Brown-Séquard's mixture had a prior discoverer or not. Each worked industriously, and besides their literary labors they had, within two months of their foundation, constructed a great planisphere upon which they drew both the ancient and modern systems of astronomy.

But evil days came. Investigations, questionings, or any sort of freedom of thought was never looked upon with favor by the ecclesiastical authorities of Rome. Columbus had appeared before the great Council of Salamanca to have his claims of the sphericity of the earth and the existence of an attainable antipodes pronounced by the dignitaries "contrary to Scripture and absurd in philosophy"; but he, with a persistence inconsistent with a good Catholic, at last sailed across the waters and discovered what his judges declared did not exist.

Copernicus had written and submitted to Pope Paul III a system of astronomy which was also pronounced contrary to Scripture and erroneous in philosophy, and the books were condemned and publicly burned.

Bruno had just been silenced by fire for upholding this Copernican system and other heresies; Porta was soon to appear before Pope Paul III for trial and to be warned against resorting to the black arts, because of his scientific attainments; and Galileo was to undergo more shameful treatment for "thinking different to what the Dominicans allowed." So, when Cesi and his friends began their investigations of Nature, studies which had hitherto brought nothing but disturbance, unrest, and revolt at the authorized doctrines, it is not surprising that efforts were made to stop them.

The young men were asked if they had not the works of Aristotle and of Thomas Aquinas, both accepted authorities by the Church for centuries; and if so, why not be content with them, for surely they did not imagine they were greater than these masters in science? But these tactics did not avail. Then appeal was made to Cesi's parents. The old duke was a man of domineering disposition and violent passions, and was unscrupulous of means in gaining his end.

He was told his son's morals were being undermined by his associates, and sought to alienate him from them, but without success.

Attempts were made to reach him through his mother, by arousing her fears as to his morals; but she, with a mother's instinct, could not be poisoned against him.

The duke threatened dissolution of the Academy by force. On Christmas-day young Cesi called his friends together, and, in order to remove all suspicions against immorality, recast their constitution and laws, by which it was ordered that all future meetings should be opened by reading one of the Psalms of David and by prayer. According to the custom of the times, the Academy was put under the patronage of one of the saints—St. John, the "apostle of hidden visions," being chosen, to whose church they repaired in order to gain his assistance in their troubles. But all this only increased the duke's resentment, and young Cesi saved himself from his father's wrath by flight, while Stelluti and De Filiis were sent home under guard.

Though separated, they found means of correspondence. Eckius did not escape so easily. It appears that while in Holland he was compelled to take a man's life in order to save his own, but so clearly in the right that he was not even put upon trial.

The duke, with dark treachery, through pretended friendship, secured from Eckius the names of all the witnesses and his personal enemies, then hurried them to Rome to appear against him before the ecclesiastical authorities. His rooms were ransacked for any damaging evidence against him; and his instruments and manuscripts destroyed.

After lying concealed until almost starved he surrendered, when he was turned over to a troop of soldiers to be returned to Holland.

But, though footsore and weary from the forced marches, the scientific spirit was still alert and uppermost. His observations of natural history, written during this unhappy journey, he sent, together with the drawings illustrating them, to Rome, where they, with other valuable manuscripts of the Academy, were kept treasured in the Albani Library until the French invasion.

The year 1609 was a memorable one in the annals of the Academy, as it was of science in general, as the date of the invention of the telescope. When, in the spring of this year, a rumor of the accidental discovery at Middelburg of the magnifying power of certain lenses, which suggested to the alert mind of Galileo the telescope, reached Italy, Della Porta, in a letter dated August 28th, from Naples to Cesi, gives a drawing of a telescope with a reference for its principles to his work on Optics, published in 1589. Since Porta did not see the telescope until Galileo brought his to Rome in 1611, the Neapolitan, by his own great knowledge of optics, conceived of the correct principle on which it must be built, and thus far forestalls Galileo; but—and the but is here all-important—Porta simply made a sketch, while Galileo *built* the instrument. The records of the Academy of this date determine that the words "telescope" and "microscope" were first used by Frederico Cesi. "In 1609 the Government of Venice made a considerable present to Signor Galileo, of Florence, Professor of Mathematics at Padua, and increased his annual stipend by one hundred crowns, because, with diligent study, he found out a rule and measure by which it is possible to see places thirty miles distant as if they were near, and, on the other hand, near objects to appear much larger than they are before our eyes."

In 1610 Porta became a member of the Academy. The first academy for scientific investigation to be established in modern times was the Accademia Secretorum Naturæ, which he founded at Naples in 1560. Porta was the President and leading spirit of this Academy until it was interdicted by the Pope, and Porta compelled to go to Rome to defend himself against the charge of magic and black arts. Porta became Vice-President of the Lincei, and some of his greatest works were published under its auspices, among which were *Magiæ Naturalis ; De Humana Physiognomonia*, from which Lavater is said to have borrowed so extensively ; *Phytognomonica*, a treatise on the physiology and virtue of plants ; *De Refractione, optices parte*, in which he speaks of binocular vision ; on *Pneumatica*, and various other works. In the *Magiæ Naturalis* he describes the camera obscura, which he had discovered, and mentions the many optical experiments he had made with it. He considered the eye a camera obscura, and thus approximated the true idea of vision. Here we find the passage, written several years before, in which he speaks of a combination of lenses by which "we may contrive to recognize our friends at a distance of several miles, and those of weak sight may read the most minute letters from a distance. It is an invention of great utility, and grounded on optical principles, nor is it to be understood by the vulgar, and yet be clear to the sharp-sighted." Who knows what Porta would not have done, with these facts in his possession, had he not been deterred by the charge of resorting to black arts, already resting upon him! Why should he, he may have reasoned, put to practical test that which, in his then present position, would almost certainly lead him to the stake. Galileo was a bolder man, and enjoyed the patronage of the powerful Medici, yet even he paid the penalty of his boldness.

When Galileo brought his little telescope to Rome in 1611, and set it up in the Vatican gardens, very naturally his most enthusiastic supporters were the Lynceans. Early in the year he became a member of the Academy. His signature runs as follows: "Ego Galileus Galilæus Vincentii filius Florentinna ætatis meæ anno LII, Sal. 1611 die 23 April: Romæ manu propria scripsi." The whole of this, the first visit of Galileo to Rome, was one continued ovation, being received with the most marked distinction by the ecclesiastics and scientists alike. The experience of one looking through a telescope for the first time, at the moon, for instance, must have been novel indeed.

Those of us who remember the sensations they experienced when witnessing for the first time the workings of the telephone or phonograph can make only an imperfect comparison; for we, unlike Italy in 1611, live in a day when mechanical wonders are becoming commonplace. The whole relation of the Academy with Galileo is full of interest. The Transactions of the Academy give accounts of the members studying the heavens through Galileo's telescope. Cesi makes haste to write to his friend Stelluti in April, 1611, of what he had observed. The moon he finds to be "mountainous, cavernous, sinuous, abounding in water," and the heavens are "either in a state of flux and not different from our own air, or else are such as the Pythagoreans held them to be." What a contrast to these days of revelation was Galileo's second reception in Rome four years later! In his work on the solar spots he was led to espouse the Copernican system. This was a heresy already tabooed. All the old warm friendships and smiling faces became suddenly cold. Galileo still hoped to placate the authorities, and demanded a test by experiment to prove the correctness of his hypothesis; but this was the last thing his enemies would have allowed.

They remembered his challenge to the Aristotelians to test their and his views on the laws of falling bodies from the leaning tower of Pisa, and its result.

The only pleasant feature about this whole unhappy affair is the almost unanimous support and sympathy given by the members of the Lincei. And this meant not a little sacrifice on the part of the Academy, considering the condition of affairs at this time.

Throughout the long controversy with the Church, Galileo received nothing but encouragement and assistance from the Academy.

Some of his greatest works were printed at the expense of the Academy; and when one of its own members became Galileo's accuser, the Academy censured and practically expelled him from the body. Not the least among the splendid achievements of the Academy was the publication of the observations of Hernandez upon the natural history of New Spain (Mexico).

This celebrated naturalist was sent by Philip II to New Spain. The result of several years' faithful labor was embodied in a voluminous work, with numerous illustrations, describing the natural objects of the country with such fidelity and thoroughness that, in spite of the researches of more recent naturalists, it still enjoys the highest reputation. The expense attending the collection of material, drawings, and specimens for this great work is said to have amounted to sixty thousand ducats. Yet for fifty years this manuscript was neglected, no serious effort having been made to publish it. Then the indefatigable Cesi discovered it, had three of his colleagues of the Academy—Terentio, Fabro, and Colonna—to edit and annotate it, when the work was published at the expense of the Academy, several years later. It is curious to find prefaced to this edition a brief, dated 1627, of Pope Urban VIII, in praise of the Academy.

Cesi dedicated his work on his microscopic studies of the bee to the same Pope.

When we remember that this was the Pope under whom Galileo was condemned, we learn to what extent the casuistry of the day carried men, when it allowed the Pope to praise science yet condemn the results of science, and to lead the Linceans, as indeed Galileo himself, to insist that the Copernican system was not necessarily true in fact, but true *ex hypothesi*.

So long as Cesi could remain at the head of the Academy it continued to flourish, but began to suffer and decline after he was obliged to remove from Rome to his estates, about a hundred miles from the capital.

The old duke, by his reckless and extravagant mode of life, had so involved the estates that they became unremunerative. So, with characteristic selfishness, after reserving for himself an annuity, he turned over the estates to his son, who assumed all debts.

Cesi bravely struggled to meet these extra responsibilities and cares, and bore with uncomplaining patience the increased petulance and tyranny of his father, but his slender frame was unequal to the task, and in a few weeks after his father's death he was laid beside him in the grave, having died on the 2d of August, 1630, in his forty-fifth year.

A charming, learned, noble-minded man, he died too soon for science, a victim of filial duty. What Cesi had done for others he failed to have done for himself, for the result of his own labors, *Theatrum Naturæ*, was never published, but remains in manuscript, in the Albani Library at Rome, to this day. Cesi was one of the earliest to make accurate observations on fossil woods, and to discover the system of propagation of ferns.

The Academy struggled on for twenty years after Cesi's death, and finally lapsed, to be revived again in 1784, since which time it has forced itself into the fore-front of the scientific bodies of Europe.

The unfortunate circumstance attending the lapse of the Accademia dei Lincei was the lack of unity of the states of Italy, each state or republic having its own academy, thus precluding a strong central representative body, such as the Royal Society of London, the Institute of France, the Academy of Sciences at Berlin, and the Academy of Sciences at St. Petersburg, stood in relation to their own kingdom. The Accademia del Cimento at Florence, and the Academies at Bologna, Turin, Milan, Naples, all flourished at different times under the presidency of some great leader in science, as Viviani, the great geometer, and Torricelli, the inventor of the barometor, at Florence, the Morgagni at Bologna, and Da Vinci at Milan.

If all these could have been consolidated into one central corporation, their Transactions would have compared favorably with those of any other similar society. Another source of the unfruitfulness of Italian scientific societies was the emigration of some of their most eminent members to foreign cities, induced by the wider fields and richer rewards which such cities as Paris and St. Petersburg offered in contrast to those of one of their narrow republics.

But more than all this, more than all else combined, was the deadening influence of ecclesiastical disapprobation. In this atmosphere no freedom of thought or independence of research was possible.

To what purpose were life and energies to be devoted to the discovery of some great law of Nature, to find the results, if displeasing to the ecclesiastical authorities, interdicted from publication, and the person, instead of decorations, subjected to imprisonment, or worse? But the present and future are more hopeful. The atmosphere is clearer and healthier, although it required the thunder and lightning of Garibaldi and Victor Emanuel to effect it.

The old Italy has passed away.

There is now a *Giovine Italia,* and there is every indication of a new impetus to scientific research.

When we recall such names as Columbus, Cardan, Leonardo da Vinci, Bruno, Galileo, Porta, Cesi, Fabricius, Torricelli, Viviani, Telesio, Campanella, Vanini, Bovelli, Cassini, Bellini, Morgagni, Malpighi, Galvani, and Volta, it is but to be reminded of many of the most glorious achievements of science, though some of the authors were obliged to go to other countries to obtain them, while of those who remained in Italy some were rewarded with the stake. If so much was done under such adverse circumstances, one can not but wonder what would have been the result had science received the same encouragement in Italy that fostered art and music, and which science received in London, Paris, Berlin, and St. Petersburg.

The present position of anthropology, says Dr. Alexander Macalister, of the Anthropological Section of the British Association, is critical and peculiar; for while on the one hand the facilities for research are daily growing greater in some directions, the material is diminishing in quantity and accessibility—treasures both of the structure and the works of man are accumulating in our museums, but, at the same time, some of the most interesting tribes have vanished, and others are rapidly disappearing or being absorbed in other races.

SKETCH OF HENRY WALTER BATES.

HENRY WALTER BATES is best known to science as the propounder of the doctrine of protective resemblance or mimicry; and to science and the reading public as the author of the book, A Naturalist on the Amazons, which has been accorded by competent critics a place as a scientific book of travels alongside of Darwin's Voyage of a Naturalist, Wallace's Malay Archipelago, and the volume of Hooker.

Mr. Bates was born in Leicester, England, February 8, 1825, and died in London, February 16, 1892. He was the son of a manufacturer of his native town, known as "Honest Harry Bates," and was intended for a business career. After receiving the usual instruction of tradesmen's sons at a boarding school in Billesdon, he was apprenticed to Alderman Gregory, hosiery manufacturer, Leicester, in whose shop his working hours were from 7 A. M. to 8 P. M. With all the laborious character of his duties, it was during the apprenticeship, his brother says, that he laid the foundation of all that he afterward was. He became a member of the Mechanics' Institute of Leicester, which had a good library and numerous evening classes with competent masters; entered the Greek, Latin, French, drawing, and composition classes; "and worked with an energy and perseverance that brought him to the front in all." This he did by studying late into the night and in the early hours of the morning. He was a diligent reader, setting special value upon Gibbon's great history, joined a glee club, learned to play the guitar, and became known as a good barytone singer.

While attending the classes in the Mechanics' Institute he became acquainted with a number of gentlemen who had tastes for natural history. He was specially inclined to entomology, and cultivated first the *Lepidoptera* and afterward the *Coleoptera*. Holidays came rarely to the boy, but they were eagerly utilized for collecting excursions, beginning the year's work usually with Good Friday. Young Bates habitually wrote descriptive accounts of his expeditions, and was accustomed to sketch and write out descriptions of all the principal insects captured.

After the death of Alderman Gregory, his master, several years before the expiration of his apprenticeship, Bates managed the business on a small scale for the deceased proprietor's son. He had formed an extensive collection of British beetles and was in correspondence with the chief coleopterists of the time. Probably his first contribution to entomological literature was a Note on Coleopterous Insects frequenting Damp Places, which was published in the first number of The Zoölogist, in 1843. A situation was procured for him in the offices of Messrs. Alsopp, Burton-on-Trent, where he remained, in an uncongenial atmosphere, till arrangements were made for his starting with Mr. Alfred Russel Wallace on their scientific expedition to the Amazons.

He first became acquainted with Mr. Wallace in 1844, when Wallace was a master in the English Collegiate School, and began a correspondence with him. Three years later, or in 1847, Mr. Wallace suggested a joint expedition to the Amazons for the purpose of exploring the natural history of its banks, and of gathering facts, as he said, "toward solving the origin of species." The two friends, after spending some time in studying South American plants and animals in the principal collections in London, embarked in a small trading vessel April 26, 1848, and arrived at Pará May 28th. They set to work forthwith, sending home from time to time duplicates of their collections to defray expenses. Though zoölogy was the primary object of their expedition, they also acquired much geographical and ethnographical information. Pará continued to be the headquarters of the two, and of Bates after the separation, from which their excursions were made and to which they returned, and after the departure of Wallace, till November 6, 1851, when Bates started on his voyage of seven years and a half to the Tapajos and the upper Amazons. One of their excursions was down the Tocantins River and to the town of Cametá, and furnished much information on the subject of the complicated river geography. In September, 1849, Bates started on his first voyage up the Amazons in a small sailing vessel (for steamers were not established until the year 1853) and reached Santarem, which he subsequently made his headquarters for a period of three years, but on this journey he pushed on to Obydos, about fifty miles farther. Here a trader was found who was proceeding in a *cubesta* laden with merchandise to the Rio Negro, which was arranged to stop frequently on the way, and Bates, securing a passage, once more increased his knowledge of the Amazons. The destinãtion of the boat was Manaos, or the Barra of the Rio Negro, a spot rendered memorable by the visit of Spix and Martius in 1820. After a short stay Bates proceeded to Ega, the first town of any importance on the Solimoens River, which he reached on the 26th of March, 1850. Here he spent nearly two months before returning to Pará, and thus finished what may be considered as his preliminary survey of the vast collecting ground to be almost called his own. In November, 1851, he again arrived at Santarem, on a second journey, where, after a residence of six months, he commenced arrangements for an excursion up the little-known Tapajos River, which in magnitude stands sixth among the tributaries of the Amazons. A stay was made at the small settlement of Aveyros, and from this spot an expedition was made up the Cupari, a branch river which enters the Tapajos about eight miles above it. At this time Bates was thrown in contact with the Mundurucus Indians, and was able to acquire much valuable ethnological information. It was also during this second journey that the long stay was made at Ega, and the many excursions in its neighborhood resulted in so much general knowledge, both zoölogical and geographical. Bates returned again to Pará on the 17th of March, 1859, after an interval of seven and a half years in the interior. During this long sojourn in the tropics Mr. Bates obtained more than 14,700 species of animals, of which 14,000 were insects, and of these 8,000 were new to science.

After they had been two years together in South America, Mr. Wallace separated from Bates, to visit the Rio Negro and the upper waters of the Orinoco, whence he subsequently went to the Malay Archipelago.

Mr. Bates sent contributions to The Zoölogist from time to time during the whole of the eleven years which he spent in the Amazonian regions. One of his letters gives a curious picture of him as equipped for a day's expedition, in colored shirt, trousers, boots, and old hat; his double-barreled gun over his shoulder, loaded with two kinds of shot; his net in his right hand, while "on my left side is suspended a leathern bag with two pouches, one for my insect-box, the other for powder and two sorts of shot; on my right side hangs my 'game-bag,' an ornamental affair, with red leather trappings and things to hang lizards, snakes, frogs, or large birds; one small pocket in this bag contains my caps, another papers for wrapping up the delicate birds; others for wads, cotton, box of powdered plaister, and a box with damped cork for the micro-lepidoptera; to my shirt is pinned my pin-cushion, with six sizes of pins."

The summary of the adventures and results of his voyage is given in the Naturalist on the Amazons, "one of the most delightful books of travel ever perused, full of varied information charmingly arrayed," which, prepared after the persistent urgency of Darwin, was published in 1863. This was Mr. Bates's only book.

His most memorable contribution to biological science was a paper published in the Transactions of the Linnæan Society, entitled Contributions to an Insect Fauna of the Amazon Valley, in which the phenomenon of mimicry was unfolded and explained as a means of protecting animals—by giving them guises tending to ward off pursuit by enemies, or by so likening them to surrounding objects that they escape notice. Darwin spoke of the book as one of the most remarkable that he ever read, and "as clearly stating and solving a wonderful problem," and found in it a strong support of his theory of natural selection.

In a paper on the classification of the *Rhopalocera*, or butterflies, Mr. Bates proposed a new system of arrangement by which the progressive modification in structure, or the evolution from a simple to a more specialized type, could be shown. Its merit is attested by the fact of its almost universal adoption in later works on evolution and natural history.

Mr. Bates's long sojourn in the region of the Amazons, fruitful as it was in scientific results, was detrimental to his constitution, and he returned "a wreck of his former self." His "frame remained enduring, but the elasticity had been taken out of it." But "we may rest assured," says the Proceedings of the Royal Geographical Society, "that nothing but physical prostration actually brought about the long-deferred return to England, and this abandonment of the anticipated visit westward, 'to gather the yet unseen treasures of the marvelous countries lying between Tabatinga and the slopes of the Andes.'"

In 1864 Mr. Bates was appointed Assistant Secretary of the Royal Geographical Society, a position in which, says The Athenæum, for the last twenty-seven years he exercised an influence "none the less effectual that he always carefully avoided any action that might make it or himself conspicuous over the progress in our country [England] of geographical science. He had the satisfaction, while other sciences have more or less specialized themselves, of seeing Geography throwing aside the restrictions that bound her to mere records of discovery and surveying, and taking her true place as a link between the other natural sciences, viewing them all from her own separate standpoint, and bringing out the points of connection between them, from a special and novel aspect." He edited the Transactions of the society from the beginning. In this office, according to Mr. Clements R. Markham, "he was unwearied and most successful in obtaining information bearing on geographical work from every quarter and in all parts of the world. He supplied invaluable hints and suggestions to the authors of papers, and he smoothed over difficulties with never-failing tact. His own rich stores of information were invaluable to all who needed help in their work, and over and over again they enabled him to supply a missing clew in some difficult inquiry, or to elucidate and piece together isolated facts, and show their bearings on each other. In all their intercourse with him, his colleagues, as well as the general body of geographers and travelers, have always been as much impressed by his ability and knowledge, and by the soundness of his judgment, as by that simple and kind-hearted way of giving advice which endeared the late assistant secretary to all who came in contact with him."

Among the notices of Mr. Bates's personal characteristics contributed by his old friends to the Transactions, Sir Joseph D. Hooker tells of the time when he first saw him, at Mr. Darwin's, at Down, shortly after his return from the Amazons. "We there spent several days together, and I can remember none more enjoyable. There was such a fascination in his manner and character, and such a boyish, hearty enjoyment of his return to his native country, and all that it contained, from Shakespeare to Punch, and from Darwin to the merest bug-hunter (so long as the work was honest). Darwin's appreciation of him was whole-hearted and all-round, and Bates's first visit to Down was marked with a white stone in his host's memory, as in mine, and often recurred to by us." "Perhaps, to know him at his best," says Mr. Edward Clodd, "and pierce the thick husk of his modesty, was when, the evening employment of beetle-sticking over, and the frugal supper eaten, the pipe was lit and talk started, sometimes on some topic of the day, but, more often, on some subject suggested by his wide and varied reading." Says a writer in The Academy, whose initials indicate that he is also Mr. Clodd: "His leisure hours, diversified by chat with one or two intimates and by omnivorous reading, were mainly devoted to the classification of certain families of the *Coleoptera*, his collection of which, although partly in course of dispersal, is unique. . . . The results of this labor of love and of years are entombed in technical memoirs, and notably in the scarcely more accessible *Biologia Centrali Americana*." Hooker was impressed with his "power of mind," and with that, says this writer, "was conjoined the simplicity and teachableness of a child."

Mr. Bates received many honors, but he never spoke of them, and no one knows how many or what they were. He was made a Fellow of the Linnæan Society in 1871, and of the Royal Society in 1881, and he was twice President of the Entomological Society.

According to Dr. J. J. M. de Groot, of the University of Leyden, whose paper is illustrated by specimens from his collection, the wedding garments of a Chinese woman are symbolical of the happiness, official dignity, and long life which she desires for the numerous children expected to bless the union. These hopes are represented by the dragon, the bat, the stag, the tortoise, and the crane or stork. The head-gear is very elaborate, and is attached by a silver hair-pin with a head of precious stones. These gorgeous garments are frequently used as grave-clothing for the mother, by the piety of the sons, who believe that to place things of good omen in the tombs of ancestors is to secure for themselves and their offspring the blessings of which they are emblems.

Asteroid No. 323, the first that was discovered by the aid of photography (by M. Wolf, of Heidelberg, November 28, 1891), has been named Brucia, after Miss C. W. Bruce, of this country, who has appropriated a considerable part of her fortune to the aid of astronomical research.

CORRESPONDENCE.

THE ABANDONMENT OF PENIKESE.

Editor Popular Science Monthly:

SIR: On my return after a protracted absence, my attention was called to an article by President D. S. Jordan on Penikese in the April number of The Popular Science Monthly. Mr. Jordan is mistaken * as to the causes which brought about the close of the Anderson School at Penikese. If he had taken the trouble to look up the history of the relations of the second director of the school with Mr. Anderson's representatives, he would have found a very simple solution of the matter.

The fund given to Prof. Agassiz by Mr. Anderson was spent in the equipment of the school and in paying for its running expenses during the first year. At the end of the first year it became apparent to all concerned that Penikese was not a locality suited for a marine laboratory. This had been anticipated by some of Prof. Agassiz's friends, who urged him not to accept the gift of the island of Penikese as a permanent home for a summer school.

The second year was carried on by the trustees in the hope of obtaining from Mr. Anderson the permission to remove the school to Wood's Hole, and with the further understanding with Mr. Anderson's representative that Mr. Anderson would be responsible for the expenses of the school during its second term. Neither of these expectations were realized, and one of the trustees was compelled to meet the expenditures, which amounted to a large sum, and are still a charge upon the school. The attendance during the second year was larger than during the first year, and the applications for the third year were beyond the capacity of the school to meet. The second director did not feel inclined to carry on the school at a locality which he had condemned as unfit for the work, and which was handicapped by its isolated position, involving, in addition to the expenses of a favorable locality, extraordinary expenditures in the way of transportation amounting to more than the ordinary expenses of the school. Nor did the second director feel called upon to meet this wasteful expenditure for the sake of carrying on an enterprise which ought not to have been located where it was, and could not be carried on successfully as long as it remained in its original site.

Having thus failed to obtain Mr. Anderson's consent to the removal of the buildings to Wood's Hole, and finding, in response to an appeal from the trustees, that no educational institution in the country cared sufficiently for the scheme to co-operate with them, the trustees represented the case to the Legislature of Massachusetts, and were authorized to convey all right and title to the island, and to the buildings erected upon it for the use of the school, back to Mr. Anderson.

ALEXANDER AGASSIZ.

CAMBRIDGE, MASS., *September* 4, 1892.

* The yacht given to the school was presented by Mr. C. W. Galloupe, and not by Mr. Anderson, as is stated in the article quoted above. Mr. Galloupe generously allowed its sale, to meet a part of the debts of the school.

HOLE OR HOLL?

Editor Popular Science Monthly:

SIR: A letter from Mr. Joseph Story Fay, addressed to "Prof. Edward F. Fernald, Centre College, Pa.," was received by Prof. H. T. Fernald, State College, Centre County, Pa., and by him was sent to me—for whom its remarkably accurate writer intended it. In his letter Mr. Fay takes exception to the allusion to "Wood's Holl," in my article on Changes in Chemical and Geographical Words in the September Monthly, as "the meaningless corruption of Wood's Hole effected by finical summer visitors." As to who effected the change, my authority was the United States Board on Geographic Names, which says in its first report (1891), "The name, which was originally Wood's Hole, was changed several years ago by the summer residents of the place to Wood's Holl." But Mr. Fay says there were no summer visitors there when the change was made, and, as he has lived in the town over forty years, doubtless he knows.

Mr. Fay also incloses a pamphlet giving the theory on which the change was based, but I regret to say that it consists mainly of "may be's" and "why not's." On this point the Century Dictionary has the following, under *hole:*

"In 1875 the name *Wood's Hole* was changed to *Wood's Holl*, in conformity with the (unfounded) supposition that *hole* in such local names is a corruption of a Norse word *holl*, meaning 'hill,' introduced by the Norsemen in the tenth century, and preserved from that remote period by the American Indians."

This quotation follows the above: "This [flag] was to be raised at a good anchoring-place called Five-Fathom *Hole*."—*Ellis, Voyage to Hudson's Bay* (1748), p. 149.

The village of Woods Holl takes its name from the adjacent strait. Any one who remembers the "swimming-hole" of his boyhood will see no need of explaining the word hole as applied to a body of water by means of the Norwegian word for the neighboring hill.

Very truly yours,

FREDERIK A. FERNALD.

NEW YORK, *September* 20, 1892.

EDITOR'S TABLE.

EVOLUTION IN POLITICS.

IN an address on The Impending Political Epoch, delivered last fall before the Ohio Society of New York, the Hon. John M. Ashley pointed out some features in the structure and workings of the Government of the United States which recent developments have shown to be full of peril to the integrity and security of our institutions. They may be described in a group by the phrase, "Unequal distribution of political power." The habit of regarding the Constitution of the United States as a perfect instrument, testifying to extraordinary wisdom and foresight on the part of its framers, ceased many years ago. The trials of the war and reconstruction disclosed many weak and some mischievous features in it, the existence of which was confessed, while they were hardly remedied, in the amendments. The course of events has disclosed other features which may also, in a more or less distant future, prove equally mischievous with those which we have tried to remedy. The most obvious of these is the roundabout system of electing a President by Electoral Colleges chosen by the voters of the several States. The framers of the Constitution are supposed to have intended to provide for the election as President of the man whom the body of electors, carefully chosen for their wisdom and experience as well as for their integrity, should decide to be most fit for the office. The plan has had no such effect, but has simply stood as an obstacle to the free exercise of their choice by the people. There is more positive mischief concealed in it, for, while the electors now respect the choice of the people, so far as it is shown in the nominating conventions, the case might arise in which they should combine to substitute for the ostensible candidate some man who had never been thought of, and who would be rejected by the people at once if he were proposed to them. Another danger is seen by Mr. Ashley in the provision that leaves the determination of the manner of choosing the electors to the Legislatures of the States, and thereby to the caprice of the party which may happen to be temporarily in the majority in the Legislature. A minority securing control for a single year may thus disfranchise or greatly weaken the influence of the majority of the voters of the State at the ensuing Presidential election—as the Republicans charge that the Democrats have attempted to do in Michigan, and as has been recently demonstrated by the action of the Republicans in Connecticut. The events that gave rise to the Electoral Commission in 1876 tell us of a danger growing out of the electoral college plan that we have already had to meet.

Possibilities of great mischief working in the electoral colleges and in the Senate are concealed in the powers possessed under the Constitution by States whose population is small and not likely to grow. Each State is entitled to two senators, and, according to the Constitution, it can not be deprived without its consent of its equal representation in the Senate. Under this provision, Nevada, whose population is not one third that of a normal congressional district, and is declining, is the peer in senatorial power of New York or any of the larger States; and there are now seventeen States in the Union whose combined population is that of the State of New York; but they have thirty-four senators to New York's two. Six new States, whose combined population is not more than enough to make one commouwealth, three of which will probably never have a population sufficient to entitle them to more than one representative, were admitted into the Union by the last Congress—for partisan reasons.

It is provided in the Constitution that if the electoral colleges fail to choose a President, the election shall be made by the House of Representatives, when each State, large or small, shall be entitled to cast one vote. Mr. Ashley shows in a table that under the present apportionment the House of Representatives being composed of three hundred and fifty-six members, twenty-three small States, being just a majority of the forty-four, having altogether only seventy-two members, could decide the election—that is, the case might arise in which "less than one sixth of the members of the House, representing less than one sixth of the population of the nation, can elect the President." Further, of these seventy-two members, fifty-five could cast the votes of the twenty-three States, making the discrepancy still worse. It is not practically likely that the small States will ever combine their votes in this way, but the possibility exists.

A more imminently threatening danger to our institutions, extra-constitutional, but hardly the less binding for that, exists in the nominating convention system, which "has grown to be a monster political despotism, and in both parties is to day the absolute master of the people." Under it the people are in effect, in a large proportion of cases, deprived of all voice in the management of public affairs. It works in with several features of the law in the manner of conducting elections so as to leave helpless the voter who would be independent, and to promote the schemes of designing, dishonest men. For the latter purpose it is a most admirable instrument.

All these defects in our system of government call for some means of remedy, and the subject should be one of anxious thought to all the friends of popular institutions. Mr. Ashley's object in calling attention to them was to bring out the remedy he has devised, which he presents in the form of a series of constitutional amendments. It is not within our province to discuss the merits of his plan. We point out the need, and remark that it has engaged the serious attention of at least one earnest thinker.

Constitutions can not be made to order to last for all time. Governments, like all other things, are a growth, an evolution, are affected by the changes in the conditions of the medium, and need to be conformed to them. Conditions inevitably arise from time to time that can not be foreseen, and must be met as they appear. Our Constitution was for a long time considered nearly perfect, because it well met the conditions for which it was made. That modifications and new provisions should be found to be needed in time is not the fault of the instrument or of its makers, but a consequence of the inexorable law of evolution. While hasty and trivial tinkering are to be deprecated, the existence of that law should be recognized, and there should be no hesitation in adapting the Constitution to its workings.

PREVENTION OF CHOLERA EPIDEMICS.

If we were asked to name what in our opinion is the most important service of science to modern civilization, we should say that it consists in the means that have been given to man to prevent the spread of epidemic disease. It is not so very long ago that large cities the world over were quite unable to exclude such a disease as cholera, and when once it had gained a foothold they were wholly at its mercy until change of season or some other unexplained cause changed the conditions favorable to its spread. Attention was for centuries concentrated on methods of treatment, and down to fifty years ago so little was known of the causes which produced the disease, or of the means of hindering its distribution, that the doctors themselves not rarely became the innocent carriers of its poison. With its cause a mystery, and resistless apparently in its advance, it is no wonder that the frightful mortality attending it struck terror to the hearts of the people among whom it appeared. But, thanks to experience and the scientific investigation of many observers, all this has gradually been changed. It has been abundantly shown both here and in England that, with suitable sanitary precautions, such as are within the reach of every enlightened community, not only cholera but other diseases which tend to become epidemic can, if taken in time, be arrested in their progress and ultimately stamped out altogether by the prompt and energetic application of ordinary hygienic rules. This is now so well understood that epidemics of any kind, particularly in centers of population under municipal control, are justly regarded as evidence of official neglect or mismanagement.

In the case of cholera the work of the sanitary authorities is really very simple. It has long been attempted to exclude the disease from cities and towns by means of quarantine, the prohibition of immigration, and of the importation of certain classes of merchandise. These measures, however, seriously conflicting as they do with the self-interest of individuals and corporations, have always proved more or less ineffective, until it has become very plain that they can not be relied upon to keep out the scourge. In England this is now generally admitted in practice, as the authorities interfere far less with commerce than formerly, but give strict attention to the immigrant and the cargo after they are landed.

The real concern of the sanitarian, then, is with the conditions of living among the masses of the people in the district under his charge, and, if past experience is any guide, his chief duty will be to promote, and, if need be, enforce the virtue of *cleanliness*, interpreting that word in its widest meaning. Filth is a necessity to the very existence of cholera. It has been the one uniform condition present in all the epidemics of which we have any record, and is the usual vehicle for the transmission of the disease. On the other hand, purity and wholesomeness are its deadly enemies, and in proportion as these are secured will the danger of epidemics decrease. Medical authorities are generally agreed that cholera is propagated by a specific poison. It matters not whether we call this a virus, a germ, or a bacillus, the important point to observe is that whatever its nature it must gain a lodgment in the system before the disease can develop. So far as known this poison or germ is only produced by the disease. It is thrown off from the bodies of the sick in the discharges from the digestive tract, and, if not destroyed at once, is ready for its career of destruction. Through defective drains or other channels it may pass into a well or stream which furnishes the drinking-water to many families. This is one of the most common ways for the poison to gain an entrance into the bodies of the healthy. Dirty food and the use of articles soiled with choleraic discharges may also convey it, but most authorities assert that it is never carried through the medium of the air—that is, the disease is contagious, but, unlike scarlet fever and measles, is not infectious. Physicians and nurses work among it with impunity, even in its most virulent form, so long as rigid cleanliness of person and clothing is observed.

The only recorded death from the disease among the attendants in Russian hospitals during the present outbreak is that of a nurse who heedlessly swallowed the remains of a cholera patient's dinner. Drinking-water, however, is by far the most frequent vehicle of the disease, being chiefly responsible for all our most fatal epidemics. During the last London epidemic, in 1866, when the mortality rose to 904 in a single week, Dr. Farr found that the outbreak was confined mainly to the area supplied with water by the East London Water Company. This was drawn from the river Lea, which on investigation proved to be polluted. The supply was stopped, and the deaths decreased from week to week until the disease disappeared from the district. Other London districts that had suffered terribly in preceding epidemics escaped almost entirely in this one, due likewise to the improved drainage and water-supply that had been provided by the authorities during the interval.

Cases of similar import, coming to light during the present epidemic in Europe, are numerous, and equally striking.

These facts point unmistakably to the means required for limiting the spread of the disease. The strict isolation of the sick, the immediate destruction of all discharges and of any articles tainted by them, careful watchfulness concerning the purity of the water-supply of the city or district, and the use of boiled water where possible taint is suspected, with equal vigilance regarding the quality and purity of the food —in a word, the nearest practicable approach to absolute cleanliness of the person, of what he eats, drinks, and wears, and of the home and its surroundings—is the surest guarantee of safety from attack and a certain protection against the occurrence of epidemics.

To secure these important conditions in the households of the masses in our large cities something more is needed than the mere force of sanitary authority. The people themselves should be made to realize that their individual co-operation is indispensable. This may reasonably be expected when they come to understand the causes which give rise to epidemics, and the protective measures that are within their reach. The result will be hastened by adapting our public-school education a little more closely to the needs of modern life, and teaching a generation of boys and girls the simple principles of household hygiene. Dwellers in cities will then demand sanitary provisions that have now to be forced upon them, and the days of scares and mobs in the face of threatened epidemics will be over.

LITERARY NOTICES.

The Principles of Ethics. By Herbert Spencer. Vol. I. New York: D. Appleton & Co. Pp. 572. Price, $2.

One of the two volumes which form the crowning portion of Mr. Spencer's Synthetic Philosophy is now completed. It contains The Data of Ethics, previously published alone, also The Inductions of Ethics, and The Ethics of Individual Life. In the new parts of the volume Mr. Spencer first sets forth, with his usual wealth of illustration, the astonishingly various and contradictory conceptions of right and wrong which exist among different peoples. Here the unpardonable sin is disrespect of deified ancestors, there it is neglecting to kill a sufficient number of enemies; elsewhere it is *smoking!* The number of cases in which a man is thought by his fellows to be in duty bound to injure others leads Mr. Spencer to distinguish the ethics of enmity from the ethics of amity. In the stage of society in which intertribal and international wars are frequent the former actually predominates over the latter, and it is only since industrialism has largely repressed militancy that the ethics of amity has gained the ascendant. Under the three heads Aggression (by which he denotes the infliction of bodily harm), Robbery, and Revenge, Mr. Spencer specifies acts that have been required by the ethics of enmity. Thus, "far from being regarded as a crime, child-murder has been, throughout the world in early times and in various parts of the world still is, regarded as not even an offense: occasionally, indeed, as a duty." Then there are the killing of adults at funerals, especially at the obsequies of chiefs, the sacrifices of human victims to gods, and "the religious homicides which, in comparatively modern times, have been committed, alike by Catholics and Protestants, to appease the supposed wrath of their God against misbelievers." Reducing conquered enemies to slavery is the chief of the bloodless injuries that have been sanctioned by the ethics of enmity. A closely allied form of robbery is the stealing of women, which has prevailed in all early stages of social progress. "Often where the men are killed the women are preserved to become mothers. It was so with the Caribs in their cannibal days; and it was so with the Hebrews, as shown in Numbers xxxi, 17, 18." The stealing of property has been regarded as ethical among many tribes. Coming to the subject of retaliation for injuries, Mr. Spencer finds that "among human beings in early stages, there arises not only the practice of revenge but a belief that revenge is imperative—that revenge is a duty." The persistence of dueling and the vendetta to the present day shows that this belief is not yet extinct. Yet, as societies have come into more settled social states, a spirit of forgiveness has appeared and made some growth. "The soul of goodness in things evil" must be recognized in the case of the crude idea of justice embodied in the custom of taking revenge. Even in the practice of this custom occasionally there grow up usages requiring some maintenance of equality, such as awakening sleeping foes or otherwise relieving them from a disadvantage before attacking them.

Considering in succession the virtues Justice, Generosity, Humanity, Veracity, Obedience, Industry, Temperance, and Chastity, Mr. Spencer finds abundant evidence that "the ethical sentiments prevailing in different societies, and in the same society under different conditions, are sometimes diametrically opposed," and he deems this fact enough to show that the human mind has no originally implanted conscience. "It has become clear to me," he says, "that if, among ourselves, the current belief is that a man who robs and does not repent will be eternally damned, while an accepted proverb among the Bilochs is that 'God will not favor a man who does not steal and rob,' it is impossible to hold that men have in common an innate perception of right and wrong."

A positive induction which follows from the same evidence is then set forth by Mr. Spencer in these words:

> But now, while we are shown that the moral sense doctrine in its original form is not true, we are also shown that it adumbrates a truth, and a much higher truth. For the facts cited, chapter after chapter, unite in proving that the sentiments and ideas current in each society become adjusted to the kinds of activity predominating in it. A life of constant external enmity generates a code in which aggression, conquest, revenge are inculcated, while peaceful occupations are reprobated. Conversely, a life of settled internal amity generates a code inculcating the virtues conducing to harmonious co-operation—justice, honesty, veracity, regard for others' claims. And the implication is that if the life of internal amity continues unbroken from generation to generation, there must result not only the appropriate code, but the appropriate emotional nature—a moral sense adapted to the moral requirements. Men so conditioned will acquire to the degree needful for complete guidance, that innate conscience which the intuitive moralists erroneously supposed to be possessed by mankind at large. There needs but a continuance of absolute peace externally, and a rigorous insistence on non-aggression internally, to insure the molding of men into a form naturally characterized by all the virtues.

To those who regard ethics as comprehending only the behavior of a man toward his fellows, the third part of this volume will seem superfluous, dealing as it does with actions which concern directly the actor alone, and only in remote ways affect others. But in Mr. Spencer's view, if life is a *desideratum*, then all conduct which conduces to a complete form of it is to be morally approved. On this basis he shows in successive chapters that ethics requires the individual to preserve a due balance between activity and rest, to take sufficient nourishment, to use stimulants very sparingly, to cultivate the faculties with which he is endowed, and to indulge somewhat in amusements. Finally, he discusses two subjects—marriage and parenthood—that may be called intermediate between individual and social life.

To complete the second volume of this work there still remain to be written the parts on Negative Beneficence and Positive Beneficence, and the writing of these parts Mr. Spencer "hopes to complete before ability ends." He is, he says, "especially anxious to do this because, in the absence of them, the divisions at present published will leave, on nearly all minds, a very erroneous impression respecting the general tone of evolutionary ethics. In its full scope, the moral system to be set forth unites sternness with kindness; but thus far attention has been drawn almost wholly to the sternness. Extreme misapprehensions and gross misstatements have hence resulted."

Thomas Carlyle's Moral and Religious Development: A Study. By Ewald Flügel. From the German by Jessica Gilbert Tyler. New York: M. L. Holbrook & Co. Pp. 140. Price, $1.

This is a clear and graceful rendering into English of Dr. Flügel's study of Carlyle. If we are not able to follow Mr. Froude in his estimation of the sage of Chelsea as indisputably the greatest man, excepting Goethe, that has appeared in Europe for centuries, we can easily subscribe to the German philosopher's opinion that he is "a moral force of great significance." Worship and work were the watchwords of Carlyle. History, science, philosophy, poetry, and art were worthless to him when divorced from ethical significance. Records and events were barren unless the historian sought in them the meaning of human life. The translator has omitted Part I, the appendix, and notes, which appear in the original; these pertain chiefly to the life of Carlyle, and are given fully elsewhere by his biographers. In the portrait attached, the philosopher looks forth dejectedly at a flippant generation.

Primitive Man in Ohio. By Warren K. Moorehead. New York: G. P. Putnam's Sons. Pp. 246.

Mr. Moorehead, one of the most active and efficient of the explorers of the Ohio mounds, who has already given in his Fort Ancient the fruit of a most thorough and exhaustive investigation, believes that exaggerated notions prevail of the civilization of the mound-builders. These exaggerated ideas are fed by the works of superficial lookers at the mounds, who in their writings do not lose sight of sensational effect, and by writers who try to uphold theories previously formed. It is the purpose of this book to do away with certain of these illusions. The author is, in fact, a little impatient that they should exist, for he says: "Why there should be so much speculation and uncertainty concerning the aborigines is inexplicable to us. No question of equal importance could have been more easily determined had the early writers given as much care and patience to mound exploration as are given at the present time." The book presents the results of four seasons of exploration, during which one hundred and seven mounds, graves, and cemeteries were opened. In every excavation careful field-notes were made on the spot, and each night the result of the day's work was fully written out. Earthworks are not included in the descriptions. The author has been assisted by Mr. Gerard Fowke, who contributed the chapter on Flint Ridge; Dr. H. T. Cresson; Mr. Jack Bennett for illustrations, sectional drawings, and ground plans, and for observations on osteological collections and palæolithic man; and Mr. W. H. Davis for a chapter on the Muskingum Valley. The descriptions relate to mounds in Licking County (Newark), the Muskingum Valley, the Madisonville Cemetery, the east fork of the Little Miami River, Fort Ancient, Clinton County, and Chillicothe and Ross County. From the results reached in the explorations, the author draws the conclusions that the tribes did not occupy the northern part of the State for any considerable length of time, but were settled chiefly in the large river valleys; that both the brachycephalic and the dolichocephalic races intermingled largely in all the valleys save the Muskingum; and that nothing more than the upper status of savagery was attained by any race or tribe living in the present State of Ohio. "If we go by field testimony alone, we can assign primitive man high attainments in but few things, and these indicate neither civilization nor an approach to it. First, he excelled in building fortifications and in the interment of his dead; second, he made surprisingly long journeys for mica, copper, lead, shells, and other foreign substances, to be used as tools and ornaments; third, he was an adept in the chase and in war; fourth, he chipped flint and made carvings on bone, stone, and slate exceedingly well, when we consider the primitive tools he employed; fifth, a few of the more skillful men of his tribe made fairly good representations of animals, birds, and human figures in stone. . . . On the other hand, he failed to grasp the idea of communication by written characters, the use of metal (except in the cold state), the cutting of stone, or the making of brick for building purposes, and the construction of permanent homes. Ideas of transportation, other than upon his own back or in frail canoes, or the use of coal, which was so abundant about him, and which he frequently made into pendants and ornaments, and a thousand other things which civilized beings enjoy, were utterly beyond his comprehension."

The Evolution of Christianity. By Lyman Abbott, D. D. Boston: Houghton, Mifflin & Co. Pp. 258. Price, $1.25.

Dr. Abbott's recent book, is more like a collection of sermons than a treatise. It has the fullness of illustration and the free indulgence in repetitions characteristic of discourses delivered to an audience that has nothing to do for the time being but listen. The gist of the book is an acceptance of the idea that the Christian religion, like all other institutions and organizations, is a growth. This idea is elaborated in successive chapters with respect to the Bible, theology, the church, Christian society, and the soul. Dr. Abbott accounts for the contradictions and imperfections which he admits exist in the Bible on the ground that the writers of the later books perceived the will of God more clearly than the men who wrote the earlier ones. He says: "The later books present higher ideals of character and conduct, clearer and nobler conceptions of God, more catholic and more positive interpretations of his redeeming work in the world, than the earlier books. The revelation is a progressive revelation. The forms, whether of religious thought, of public worship, or of church order and organization, in the Bible, are not the same; those of the later ages have grown out of those of the former ages, and are superior to them. In brief, the Bible is the history of the development of the life of God in the life of a peculiar people; and it traces the development of that life from lower to higher, and from simpler to more complex forms." The logical outcome of this doctrine is that the theologians of the present day are better able to set forth the true religion than even the writers of the Gospels and Epistles. Dr. Abbott and those who agree with him apparently retain but few things, such as the anthropomorphous nature of the First Cause, the belief in miracles, etc., that divide them from scientific moralists, and the above doctrine seems to release their successors from any obligation to retain these if they should see fit to abandon them.

The Free-trade Struggle in England. By M. M. Trumbull. Second edition, revised and enlarged. Chicago: The Open Court Publishing Company, 1892. Pp. 288. Price, cloth, 75 cents; paper, 25 cents.

This is indeed in every respect a book for the hour. It treats at length on what is at the present the liveliest issue in the United States, from whatever point of view it may be regarded. As a historical summary of a memorable and pivotal period in English politics it is of deep political interest. Most appropriately it is dedicated to the distinguished champion of free trade, the Hon. John Bright, M. P., "the eloquent friend and defender of the American Republic, the enlightened advocate of peace and free trade among nations," and it contains a *fac-simile* autograph letter from Mr. Bright, written in 1882, in which he says, "The American tariff is so incapable of defense that discussion of the strange burden that lays upon your people can only end in some great change and great reform."

In a second letter, addressed to the author later in that year, Mr. Bright says: "I do not expect your people will copy from us; they will learn from what is passing around them how much they suffer from your present barbarous tariff. There are persons among us who are not anxious for a reform of your tariff. They say you can not have an export trade, and can not compete with us in foreign markets." In the preface to this second edition, Mr. Trumbull shows the necessary character of this particular study as a guide in our present political conditions. Citing from Mr. Whitelaw Reid's letter of acceptance, "The fact that our form of government is entirely unique among nations of the world makes it utterly absurd to institute comparisons between our own economic systems and those of other governments," our author states quite emphatically that this is "a very serious error." He does not believe any government is "unique" enough to violate the laws of moral science with impunity; that no government will ever be so "unique" as to *justly* tax one man for the benefit of another, or forbid its citizens to buy their goods in the cheapest markets. It is because he finds every argument used by the advocates of the American system in 1884, borrowed from the speeches of the parliamentary orators in 1844, that he concludes the principles of both systems are the same, and hence they must be beneficial or injurious to one country as well as to the other. To keep the volume abreast of the debate in this country, it has been revised, and enough additional facts and arguments interwoven throughout the historical portions sufficient to make it a good campaign document. The historical portion of the book is rather well condensed from the more elaborate histories of free trade published in the Cobden Club Series and pamphlets, and it appears, upon the whole, fair and impartial. The book seems especially opportune whichever partisan reads, because logically the historical *résumé* comes before the actual discussion of free trade *versus* protection. Otherwise, how could we intelligently understand what was done, why it was done, and the circumstances which lead through so fierce a contest up to the final accomplishment? There is an excellent index, so necessary to a book of this character.

An Introduction to General Logic. By E. E. Constance Jones. London and New York: Longmans, Green & Co. Pp. 283. Price, $1.50.

The author's purpose in preparing this work has been to provide a First Logic Book which, besides being useful in teaching beginners, may furnish a brief, connected sketch of the science, and he hopes that what he has to say may help to remove certain difficulties familiar to all teachers of logic, which have forcibly pressed themselves upon his attention in his own teaching. He here sets forth, as simply and systematically as possible, views indicated in a small book of Notes on Difficult Points in Logic which he had previously written, in which he discussed fully the cases in which he diverged from traditional doctrines, and his reasons for the divergence. He regards his scheme as following naturally from the view taken of the twofold character of terms, which, as names of things, have both application and signification. On this datum, together with the recognition that things have a plurality of characteristics and a consequent plurality of names, depends the possibility of significant assertion and the whole doctrine of inference. The principle of excluded middle suggests and supports a recognition of the relatedness of things to one another; and a consideration of Bacon's doctrine of form suggests a modification of Mill's view of induction. The relation of induction to deduction appears to be so close that it is more convenient to regard all logic as one than to make a radical and fundamental division between deductive or formal and inductive or material logic. Upon the twofold character of terms, again, depends the recognition of the law of identity as a law of identity in diversity. The author believes that his views about relative propositions, quantification, disjunctives, the force and interdependence of the principles of logic, the systematization of fallacies, and, partly, the elaboration of immediate inferences, are to some extent new.

Darwin and after Darwin. By George John Romanes. Vol. I. The Darwinian Theory. Chicago: The Open Court Publishing Company. Pp. 476. Price, $2.

In the volume now before us Mr. Romanes gives a statement of the evidence which supports Darwin's biological doctrine, leaving to a second volume the discussion of post-Darwinian questions. Taking first classification, he shows that all organic Nature readily falls into an arrangement of group subordinate to group, which is just what would have been expected on the supposition that the relationships of the various species indicate lines of descent. In the field of morphology he points out the fact that where any organ gives evidence of having been modified in a certain direction, other parts of the same organism have evidently been modified to the same extent. Here also comes in the argument from vestigial structures. Some of these vestiges can be noted only during the infancy of the species, such as the form and functions of the limbs of young children. One of the illustrations in this chapter is from a photograph taken by Dr. Louis Robinson in his recent investigations on the grasping power of infants. The arguments from embryology, paleontology, and geographical distribution follow in successive chapters. A distinct division of the volume is devoted to selection, in which the theory of natural selection is stated, and criticisms upon it are answered, and the theory of sexual selection is discussed. There is an appendix dealing with some technical points in the arguments from paleontology, and several supplementary notes. The text is illustrated with 125 excellent engravings.

Practical Ethics. By William De Witt Hyde, D.D. New York: Henry Holt & Co. Pp. 208. Price, 89 cents.

This is one of a number of text-books that have been called forth by the recent sudden increase of interest in the teaching of ethics. Its arrangement is based on a list of objects, such as food and drink, dress, exercise, property, time, fellow-men, the poor, society, and God, and it is designed to show the proper relation of the individual to each of these objects. In each case the author sets forth the duty with regard to the relation, the virtue which secures the performance of this duty, the reward which is the natural consequence of the particular virtue, the temptation most likely to lead one away from this virtue, the vice of defective and that of excessive activity in the relation in question, and the penalty of the more common vice. The author makes religion the consummation rather than the foundation of ethics. The style of the book adapts it more especially to college students.

Ethnology in Folk Lore. By George Laurence Gomme. New York: D. Appleton & Company. Pp. 203. Price, $1.

The study of folk lore is in the elementary stage which consists in the gathering of facts belonging to any part of its field and wherever they may be found. Mr. Gomme in the book before us has taken a step toward raising it above this stage into one in which its facts shall be grouped so as to show their hidden significance, and to point out lines of still more fruitful research. He has chosen ethnology for his special theme and marshals the available facts of folk lore so as to throw light upon the history of races. Thus, he maintains that practices and beliefs which are preserved among European peasantry, and are in marked contrast with the prevailing civilization, "are to be identified with the rude culture of ancient Europe, which has been swept over by waves of higher culture from foreign sources." The fact that such practices are most conspicuous among the descendants of a conquered race, where such exist side by side with the descendants of their conquerors, gives support to this idea. An interesting example of this is found in the village festival of southern India, in which the Pariahs—the casteless remnant of a conquered race—appear as the chief functionaries, although the dominant race takes part in it.

In a chapter on The Ethnic Genealogy of Folk Lore, evidence is presented which indicates that many beliefs and practices relating to the dead are derived from a primitive custom of eating dead kindred—a custom that still persists among some tribes of savages. There is much that now seems hopelessly obscure concerning the origin, early movements, and mingling of races, but the thorough and systematic study of folk lore, in such lines as those that Mr. Gomme has traced, promises to throw light into many dark places.

The Wife and Mother. By Albert Westland, M.D. Philadelphia: P. Blakiston, Son & Co. Pp. 282. Price, $2.

The author states in his preface that "this work is addressed to women who are desirous of fulfilling properly their duties as wives and mothers, and is designed to assist them in exercising an intelligent supervision over their own and their children's health." It is a notably full and thorough treatise, dealing with all the incidents of pregnancy and confinement, describing the proper care of the infant, and telling how the common diseases of children may be recognized. The accidents of miscarriage and premature confinement are described, and the extra precautions which they necessitate are specified. In the part devoted to the child, one chapter tells the average size and weight of the child at birth, the usual rate of growth, at what age the teeth appear, the power of walking is developed, and the ability to talk is gained. The style of the book is simple and concise; it is not marred by useless words or mystifying technicalities. The author takes especial care to tell what may be expected to occur during the period of gestation and after the birth of the child, giving the range of variation that is noticed in different persons. With this information the mother need have no alarm when unaccustomed sensations are felt, or if she or her child do not do exactly the same as her friend and her friend's child have done. The book does not attempt to take the place of a physician, but tells, under the various divisions of its subject, what symptoms require that a physician should be called.

Paganism surviving in Christianity. By Abram Herbert Lewis, D. D. New York: G. P. Putnam's Sons. Pp. 309.

The efforts of partisans, the author of this book says, to manipulate early history in the interest of special views and narrow conceptions have been a fruitful source of error. Equally dangerous has been the assumption that the Christianity of the third, fourth, and fifth centuries was identical with that of the New Testament, or was a fair representative of it. The constant development of new facts shows that at the point where the average student takes up the history of Western Christianity it was already fundamentally corrupted by pagan theories and practices. Its unfolding from that time to the present must be studied in the light of this fact and the rise, development, present status, and future history of Roman Catholicism and Protestantism can not be justly considered independently of it. The fundamental principles and the underlying philosophy of these divisions of Christendom originated in the paganizing of early Christianity. This fact makes the re-study of the beginnings of Christianity of supreme importance. The book presents a suggestive rather than an exhaustive treatment of these influences, and of their effect on historic Christianity, in the four points of the influence of pagan thought upon the Bible and its interpretation; upon the organized Church, through the pagan water-worship cult; upon the practices and spiritual life of the Church, "by substituting pagan holidayism for Christian Sabbathism"; and upon the spiritual life and subsequent character of the Church, by the union of church and state, and the subjugation of Christianity to the civil power, according to the pagan models. Under the first of these headings came the corruptions derived from gnosticism and various allegorical interpretations of scriptural doctrines and symbols; under the second the corruptions of Christian baptism, giving rise, among other things, to the doctrine of baptismal regeneration and the use of holy water; under the third, the origin of the substitution of Sunday for the old Sabbath, and the rise, purpose, and tendency of Sunday legislation—to which the author is opposed, on principle and as a Seventh-day Baptist; and under the fourth the whole course of secular interference with the Church. "Other forms of pagan residuum in Christianity" include a low standard of religious life; the metamorphosis of an ancient phallic emblem into the Christian cross; various beliefs connected with baptism; lights in worship; the eastward position; certain features peculiar to the Roman Catholic Church; and the observance of certain Christianized pagan holidays. Regarding the fundamental principles of Protestantism, as involved in present issues, the author concludes that Protestants must accept the Bible in fact as well as in theory, reinterpreting it in the light of "higher criticism" and deeper spiritual life, or be overthrown; that baptism must cease to be the football of denominational polemics and be raised to a question of obedience to the example of Christ; that Protestants must return to true Sabbathism, "which is as undenominational as faith"; and that all union of Christianity with the state must yield before the normal development of true Protestantism.

Elements of Physics. By C. E. Fessenden, Principal, Collegiate Institute, Peterboro, Ontario. London and New York: Macmillan & Co., 1892, Pp. 229. Price, 80 cents.

This is the latest of the excellent series of text-books in science published by Messrs. Macmillan & Co. It is especially worthy of the attention of educators, on account of its simplicity and the natural method of instruction, scientific accuracy of statement, clean text, type, and admirable illustrations. The four simple divisions are: Matter and its Properties, pp. 1–53; Kinematics, pp. 53–64; Dynamics, pp. 64–179; Heat, pp. 179–229.

One is inclined to envy a generation of beginners in science to whom each step is so clearly explained, and where the illustrations really assist the student. The longest chapter, very properly, is devoted to the important subject of dynamics, of which the illustrations are profuse and varied. At the end of each chapter there are well-planned questions designed to test the originality and thought of the beginner, and throughout the book many problems, carefully selected, add to its value.

Six Books of the Æneid of Vergil. By William R. Harper, Ph. D., President of the University of Chicago, and Frank J. Miller, Ph. D., Instructor in Latin in the University of Chicago. American Book Company: New York, Cincinnati, Chicago. Pp. 461. Price, $1.25.

This is a school edition of the great Mantuan bard, prepared with judicious zeal and with the intention of exciting in the youthful student of Latin poetry a genuine love for the most eminent poet of ancient Rome. The bibliography is a unique but complete feature, and exceedingly well arranged. The extracts from ancient and modern poets are quite extensive for so small a text-book. There are eleven full-page photographic illustrations, all from such historic pictures as The Death of Laocoön, Ceres, The Cumæan Sibyl, etc., with Raphael's portrait of Vergil, and a map of the scene of the hero's wanderings on land and sea. The Topics for Investigation, the Testimonies to Vergil's Worth as a Poet, and the Inductive Studies, copied and condensed from the best classical commentators, form a particularly interesting feature of the book.

A copious Vergilian vocabulary, word-list, and concise foot-notes, giving instances of paraphrases of Vergilian lines in modern poets, add to the vivid character of the book and render attractive the lines of the poet, who is ever young because ever studied and always admired. Among the many editions of Vergil, we know of none in size, illustrations, type, scholarship, scope and quality of the work done, more suitable to be put into the hands of the young American student. Those of us who remember the old texts, scant notes (none plain), and who recall the beauties to be discovered without help or hint, and who were expected to discourse on grammatical puzzles like German scholiasts, can well understand why the present generation ought to read more Latin poetry in less time, understand it better, and enjoy it more than the students of thirty years ago. Even Tennyson's stately tribute on the nineteenth centenary of Vergil's death finds here an appropriate place:

> "Light among the vanished ages; star that gildest yet this phantom shore;
>
> . . . . .
>
> I salute thee, Mantovano, I that loved thee since my day began,
> Wielder of the stateliest measure ever molded by the lips of man."

The High-school Algebra. American Book Company. Pp. 360. Price, $1.

This is a revised and enlarged edition of Prof. Milne's Inductive Algebra, already well known as a clear and widely used work. The present edition is prepared to meet the want of the improved method of teaching, and to keep pace with the advanced work demanded for high schools and advanced standing in colleges. Besides the chapters on Radical Quantities, Radical Equations, and Quadratic Equations, there are a general review and special chapters on Imaginary Quantities, Indeterminate Equations, Inequalities, Logarithms, the Binomial Theorem, Undetermined Coefficients, and the Theory and Transformation of Equations, which many of our modern algebras for schools seem to have lost sight of or completely ignore.

Pauperism: A Picture, and the Endowment of Old Age. An Argument by Charles Booth. London and New York: Macmillan & Co., 1892.

In studying some records, kept for thirteen years, of poverty at Stepney in 1889, Mr. Booth came across written records of parochial relief, and from them he draws these pictures of pauperism as seen in certain portions of London, notably at Stepney and St. Pancras, and incidentally discusses one phase of English pauperism, viz., Old Age and its Remedies. The book is one of social science study, filled with statistics, personal data, and an account of the causes usually assigned for pauperism—crime, drink, extravagance, sickness, lack of employment, miserable surroundings, vice and criminality, laziness, early marriages and large families, death of parents, old age.

Stripped of a mass of unnecessary statistics, the pith of the book occupies eight pages. Chapter VII, in which the particular phase of old age pauperism, according to Mr. Booth, is not desirably treated in England

The indoor relief lacks humanity and the outdoor relief encourages improvidence. Mr. Booth therefore suggests a universal compulsory system of state aid supported by taxation—a sort of pension, beginning, at the age of sixty-five, at five shillings per week for the central class of English workingmen, which he computes at one fourth of the whole number. The vagueness of this demand is tacitly admitted by our author when he grants that such questions might be asked as, Have the people at large made any such demand? Have they any grievance on this subject which calls for redress? Would they be willing to be taxed to provide pensions for the old? We all know how thoroughly the social science associations of England have discussed all phases of the pauper question in the United Kingdom, and of the plans of relief past and present proposed. The name is legion. Rich and poor are now taxed to this end, indirectly if not directly; and it were extremely doubtful, if Mr. Booth's plans were not less direct than his well-known zeal and warmth of heart and interest in the cause of humanity, whether it would avail more for the subject he has at heart than this well-written, well-intentioned, but rather imperfect book.

Distinction and the Criticism of Beliefs. By Alfred Sidgwick. London and New York: Longmans, Green & Co. Pp. 279.

The object of this book is chiefly to seek the means of giving more accurate and adequate expression to our thoughts. In the discussion of many questions we come to points where we are at loss concerning the exact significance of the terms we use, or to find words clearly to mark our thought. This is because many important and necessary terms involve ambiguity, leaving, at the best, doubt as to the precise sense in which they are to be taken. One of the first things to ask is, what we shall mean by ambiguity. An ambiguous word may be roughly defined as a word with two or more meanings; it is not, however, the bare fact that a word has two or more meanings that makes it ambiguous in any effectual sense, but the fact that its two or more meanings are in practice confused. The author in his argument attempts, first, to discover the part that is actually played by ambiguity (or rough distinction) in confusing our judgment. In the process of getting to understand exactly the error that rough distinction creates, it becomes necessary to discuss the excuses that may sometimes be made for vagueness. At every level of our thought we are soon brought up against the difficulties that arise out of the attempt to define our words—or to draw sharp distinctions where the things distinguished shade off into one another—difficulties familiar to every one. Hence the author's purpose includes an attempt to find a more philosophical method of dealing with rough distinctions, in place of the happy-go-lucky tact that every one uses, more or less, by the light of Nature; and in connection with this a considerable number of questions arise, and suggest lines of further inquiry. Another interwoven subject is the everlasting struggle that language carries on against difficulties of expression. A third incidental subject is the way in which language acts as a drag upon the progress of knowledge, doing this through "a certain over-conservative tendency in our thought" that keeps us more under the slavery of words than we need be.

Cathcart's Literary Reader, compiled by *George R. Cathcart*, and first published eighteen years ago, now appears in a revised edition (American Book Company, $1.15). It combines the function of an advanced reading-book with that of a manual of English literature. Besides the selections from writers of the Elizabethan period, the Commonwealth and the Restoration, the eighteenth century, and the nineteenth century, the book contains introductory remarks on each epoch, biographical and critical information concerning the authors represented, explanatory foot-notes, and a large number of portraits. While poetry, oratory, and fiction make up the body of the selections, history and modern science are not ignored.

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POPULAR MISCELLANY.

Leather-splitting and Shoe-pegging Machines.—We have received from Mr. Charles H. Parker, of Billerica, Mass., an interesting statement of the claims of Mr. Samuel Parker, of that place, born in 1772, died in 1841, to be regarded as the inventor of the leather-splitting machine. Mr. Parker was the son of a tanner, and displayed considerable genius, which he applied in secret and in the face of many obstacles to the construction of his machine. To test its usefulness he experimented upon it with some leather from his father's tan-yard, and found to his great delight that it did the work it was invented for. A patent was granted to him for the invention, July 9, 1808. The original machine was burned with the tan-yard buildings about forty years ago. Mr. Rich, author of the article in the Monthly on leather-making, says that the historical statements concerning Mr. Parker's invention are correct, and that he probably did as much as any of the early workers in realizing the invention, and is to be credited as a pioneer. The case appears to be one of that numerous class in which many inventors contribute to the perfection of a machine, each furnishing his quota of suggestions for its better working, while the one who produces a machine recognized as practical and puts it on the market gets the credit and profit of the whole.—Mr. J. J. Greenough, of Fort McPherson, Atlanta, Ga., writes us to dispute the claim of A. C. Gallahue to be the inventor of the pegging machine. It appears from Mr. Greenough's letter that he was first to file an application for a patent on such a machine, in 1852, and Mr. Gallahue afterward filed an application which interfered with it. This application was amended in order to avoid the interference, and patents were granted on both; but that Greenough's is the parent of the modern machine, while Gallahue's "did not contain a single feature" of it, except the pegging-awl and driver; while "there is not an essential feature in the present shoe-pegging machine which is not found" in the Greenough claims. The details of the dispute, as Mr. Greenough gives them, are intricate, and we can do no more than fairly state the substance of his claim.

The American Association, 1893.—The next meeting of the American Association (1893) will be held in Madison, Wis. The following are the officers-elect: President, William Harkness, Washington; vice-presidents, A, Mathematics and Astronomy, C. L. Doolittle, South Bethlehem, Pa.; B, Physics, E. L. Nichols, Ithaca, N. Y.; C, Chemistry, Edward Hart, Easton, Pa.; D, Mechanical Science and Engineering, S. W. Robinson, Columbus, O.; E, Geology and Geography, Charles D. Walcott, Washington; F, Zoölogy, Henry F. Osborn, New York; G, Botany, Charles E. Bessey, Lincoln, Neb.; H, Anthropology, J. Owen Dorsey, Tacoma, Md.; I, Economic Science and Statistics, William H. Brewer, New Haven, Conn.; permanent secretary, F. W. Putnam, Cambridge (office, Salem), Mass.; general secretary, T. H. Norton, Cincinnati, O.; secretary of the council, H. L. Fairchild, Rochester, N. Y. Secretaries of the sections: A, Mathematics and Astronomy, Andrew W. Phillips, New Haven, Conn.; B, Physics, W. Le Conte Stephens, Troy, N. Y.; C, Chemistry, J. U. Nef, Chicago, Ill.; D, Mechanical Science and Engineering, D. S. Jacobus, Hoboken, N. Y.; E, Geology and Geography, Robert T. Hill, Austin, Tex.; F, Zoölogy, L. O. Howard, Washington; G, Botany, F. V. Coville, Washington; H, Anthropology, Warren K. Moorehead, Xenia, O.; I, Economic Science and Statistics, Nellie T. Kedzie, Manhattan, Kan.; treasurer, William Lilly, Mauch Chunk, Pa.

Prehistoric Copper Implements.—In a paper at the American Association, on Singular Copper Implements from the Hopewell Group, Ross County, Ohio, Prof. F. A. Putnam emphatically denied the statements that these copper implements were fashioned by white men and given to the Indians in trade. "It must be," said he, "that these implements were made by the native Americans. In all cases where implements and ornaments are found in these mounds, there are found also on the altars nuggets of copper. So it is with the silver implements and those made of meteoric iron. Now, is it likely that the trader would furnish the Indian with nuggets of the natural material? There is conclusive proof that the original settlers of the Ohio Valley worked the metal into these implements and ornaments. Again, these mounds, many of them, have trees growing on them that are between four hundred and five hundred years old. This carries back beyond the time of trading." Prof. Putnam explained that round holes could be cut in the sheet copper which had been hammered out by the Indian, by simply placing the sheet of copper on the trunk of a tree and pounding into it one end of an oak limb squared. He was unable to describe the probable mode adopted by the Indians in cutting edges shaped like the teeth of a saw, but thought it was done by the use of an instrument made of meteoric iron.

Sir Archibald Geikie on the Age of the Globe.—The address of Sir Archibald Geikie, as President of the British Association in Edinburgh, included a historical review of the Huttonian and Wernerian theories of the origin and processes of geological changes, and closed with an examination of the present state of opinion and evidences concerning the age of the globe. While the speaker regarded the demands of the earlier geologists for unlimited time for the formation of the earth's strata as extravagant, he was equally of the opinion that the limitations which the physicists seek to impose on the duration of the processes need to be revised. The rate of degradation of the land under atmospheric influences is capable of measurement, and from this it is concluded that the geological deposits, if they were all made at the most rapid rate witnessed, would require seventy-three millions of years; if at the slowest rate, six hundred and eighty millions of years, for their accumulation. But it may be argued that all kinds of terrestrial energy are growing feeble, that the most active denudation now in progress is less vigorous than that of bygone ages, and hence that the stratified part of the earth's crust may have been put together in a much briefer space of time than modern events might lead us to suppose. But no confirmation of this argument can be gathered from the rocks. We can see no proof nor any evidence that suggests that on the whole the rate of waste and sedimentation was more rapid during Mesozoic and Palæozoic times than it is to-day. A yet further and impressive body of evidence is furnished by the successive races of plants and animals which have lived upon the earth and have left their remains sealed up within its rocky crust. We have no data as to the rate of this evolution, but only the negative evidence that it has made no visible progress since man began to observe and record. And when we look beyond the narrower range of human history at the remains preserved in even the most recent geological strata, we encounter the most impressive proofs of the persistence of specific forms. After careful reflection on the subject, the speaker affirmed that the geological record furnishes a mass of evidence which no arguments drawn from other departments of Nature can explain away, and which can not be satifactorily interpreted save with an allowance of time much beyond the narrow limits which recent physical speculation would concede.

Chaga (Mount Kilimanjaro) and its Inhabitants.—Chaga, or the temperate region of Mount Kilimanjaro, according to Dr. W. L. Abbott, extends a distance of about sixty miles, and is inhabited by a population of sixty thousand. At no point does the cultivation extend lower than three thousand feet, and nowhere above five thousand four hundred feet. This narrow zone is from two to four or five miles wide. It is divided into some thirty states, each governed by a more or less independent sultan, and separated from its neighbors by a strip of wilderness or a deep gorge. The largest state, Mechame, contains probably ten thousand people, while some of the lesser states have only a hundred or two subjects. The state of Useri is governed by Malimia, an energetic sultan who is rather shy of strangers, having a fear of being bewitched. The Sultan of Marang, Miliari, is a great friend of the Europeans. Fumba, the chief of Kilimma, is remarkable for his hugging habits, which make him an extremely unpleasant host. In Moshi, the Sultan Mandara has had more intercourse with strangers than any other chief, and has accumulated European curiosities of every imaginable description—toy steam-engines, clocks, guns of many patterns, stereoscopes, sewing machines, cavalry helmets, books, uniforms. Cena, the Sultan of Kibosho, is the most powerful chief on the mountain, and seems to hold his own, with all the other states allied against him. He is very friendly toward Europeans, and is liberal in his presents of cattle, etc., to those favored visitors. He has constructed a large series of underground passages or galleries beneath his *boma* or stockades. The huts are arranged in a circle, and a sloping shaft leads down from the floor of each hut. From this main gallery another runs off to open out upon a hill-side several hundred yards distant. By means of this arrangement his wives and cattle would be able to escape in case of a surprise or sudden attack. Two hundred warriors keep nightly guard around his house. Many women of Mandara's harem would be beauties in any country, in spite of their dark skins.

Prof. Le Conte on the Origin of Niagara Falls.—Explaining his views of the origin of Niagara Falls at the excursion of the American Association to that place, Prof. Joseph Le Conte said that, as the ice-sheet was pushed slowly backward after the conclusion of the Glacial period, the first of the lakes to be uncovered was Lake Erie. "After that the ice was pushed back from the other lakes. When Lake Ontario was uncovered, the ice was still upon the St. Lawrence River, and the lake had no outlet in that direction as it has at present. It was for this reason that the waters of the lake rose to such a height, and formed the Iroquois beach which extends along the lake to Rochester in what is known as the Ridge Road. It is my opinion that at this period Lake Ontario was drained off through the Mohawk Valley by the Mohawk River, and thence by the Hudson River to the sea. About that time the Niagara River began to cut its way year after year, century after century, millennium after millennium. As the waters of Lake Ontario began to subside, the height of the Falls increased. The upper stratum of rock is Niagara limestone, a hard rock, but beneath it is a stratum of Niagara shale. It is the slow undermining of this shale that causes the Niagara limestone rock to break off from year to year and the Falls to recede. How long it has taken the Falls to go back from Lewiston I do not know. They are going now at the rate of three or four feet a year. At that rate some ten or twelve thousand years would have done the work. The lowest estimates are from seven to eight thousand years. I for my part am inclined to favor the higher estimate. Well, they are still going backward. What will be the final result? They may go back to the lake; but the Niagara limestone is growing thicker and thicker, and may finally extend to the bottom of the fall. In that case the rock would not break off, but would wear away and form a rapids. In any case, if the Falls should recede to Lake Erie, at the present rate it would take at least twenty thousand years, and, of course, we can not be very strongly personally interested."

Cause of Seasickness and Remedies for It.—The inducing cause of seasickness, according to the studies of Dr. Herbert Damvers, is a mechanical irritation of the walls of the stomach due to contact of parts not usually in apposition with one another. The effect of this is to produce reflex stimulation of the vomiting center in the medulla and directly a subacute gastritis; diminished blood-supply to the head and neck (as seen in the extraordinary pallor of the face); and a disturbance of cerebral circulation, resulting in a general nerve starvation, which is evidenced by headache of neuralgic intensity. The author would for clinical purposes group all cases into three divisions, according as head symptoms or gastric symptoms largely predominate, or head and gastric symptoms are combined in nearly equal degrees (mixed cases). The author treats cases of the first group with enemas, followed by nerve sedatives, and then with measures to raise depressed spirits. In cases of the second group he administers warm water as an emetic, followed by prescriptions for allaying gastric irritability. For the mixed cases soda and compound tincture of cardamoms or nitromuriatic acid during the day, with a pill of calomel, colocynth, and hyoscyamus at bedtime, have been found efficient. These methods of treatment apply solely to large ocean steamers, on which the passengers remain a week or more. In the case of short trips on small vessels, in which the motions are different, the author is sure that we have no drug or combination of drugs that will act as a panacea.

Biological Teaching in American Colleges.—Reviewing the present condition of biological teaching in the colleges of the United States, Prof. John A. Campbell remarks that we have now advanced to a stage where we can no longer expect much biological research to be done by private persons, and must look largely to the colleges for work of a purely scientific character. Many problems are peculiar to the country, arising out of the character of its flora and fauna; while, on the other hand, certain kinds of work find in this country more favorable conditions than prevail elsewhere. Much is still to be done in purely descriptive work. There are many regions to be explored before we will know the entire flora and fauna of the United States, and our knowledge of the life histories, especially of the lower vegetable forms, is in a peculiarly unsatisfactory condition. Co-operation among investigators is especially necessary if the best results to the individual are to be reached; while specialization of research is equally imperative for the best interests of science. At present, in this country, these two points are not equally guarded, for we do not find sufficient efforts made to resist the narrowing tendency of specialization. Prof. C. O. Whitman has pointed out the necessity for organization among investigators, and as a result of his efforts there is a much more wide-spread appreciation of this necessity than ever before. There have been advanced lecture courses and courses and co-operative studies in current literature at Johns Hopkins University ever since its foundation. In but few other institutions do the catalogues contain any accounts of such work. But the present indications are hopeful. The necessity for the work is coming to be generally felt, and the means to do it will assuredly follow. The colleges seem to be doing too little to advance the sum of knowledge in the direction of biology. Few of them are equipped for research; and in a large proportion of them the professors of biology are handicapped by having other work to do not connected with their department.

The Moss Sponge of an Alaskan Forest.—In the interior plateau of the Cordilleran and St. Elias regions of Alaska, according to Mr. C. W. Hayes, surface degradation is greatly retarded by the luxuriant growth of moss, which covers practically the entire surface of the country. The annual precipitation is largely confined to the winter months, and the water from the melting snow is held by the sponge-like moss, which remains saturated throughout the short but hot and dry summer. Thus, with a rainfall which in lower latitudes would condition an arid region, a large part of the surface is swampy, quite irrespective of slope—that is, wherever the material composing it is sufficiently compact to become impervious to water on freezing. On account of this slow and imperfect surface drainage, the slopes are not cut into the ravines and arroyas so characteristic of arid regions.

Orography of the Mount St. Elias Region.—From the vicinity of Frazer River, in southern British Columbia, says Mr. C. W. Hayes, in his Expedition through the Yukon District, the western mainland range of the Cordilleran mountain system follows the coast toward the northwest as far as the head of Lynn Canal. Here it becomes an interior range, while to the westward its place next the coast is taken by the St. Elias range. The southern Alaskan coast mountains form a broad elevated belt with many scattered peaks, of which none perhaps have an altitude of more than eight thousand or nine thousand feet, while there is no dominant chain. The southwestern front of the range rises abruptly from the waters of the inland passage, forming a rugged barrier to the interior. A few rivers have cut their channels through the range, and it is penetrated varying distances by numerous deep fiords. From the head of Lynn Canal northwestward the range decreases in altitude and probably spreads out and merges in the broken plateau which occupies the eastern part of White River basin. The elevation of the interior plateau, where it is crossed in passing from the Taku to Lake Ahklen, is about five thousand feet above sea-level. From this point it descends gradually toward the northwest. Southwest of Selkirk the same plateau extends with gradually increasing altitude to the base of the St. Elias Mountains. It is only in a general way, however, that these areas are to be regarded as plateaus. When considered in detail, the surface is extremely rough and broken. The river valleys lie from two thousand to twenty-five hundred feet below the general plateau level, while broad and rounded dome-like summits and a few sharp peaks rise from seven hundred to twelve hundred feet above it; but there appear to be no well-defined ridges or chains of peaks. For about one hundred and fifty miles southwest of Selkirk the contours are generally smooth and flowing, and the surface, except in the glaciated portion of the region, shows the effect of long-continued exposure to the action of subaërial agencies.

The Geological Collection of the National Museum.—In the arrangement of the geological collections of the United States National Museum, as described in Curator George P. Merrill's Hand-book, the wants of the specialist of facilities for study, and those of the public, in whom it is desired to arouse an interest in natural phenomena, have both been consulted. An exhibition is set up of series arranged and labeled for the general public, and accessible at the same time to the student and specialist, and a study series is stored away in drawers. The exhibition series is treated essentially according to the plan given by Prof. Geikie in the latest edition of his text-book on geology; conforming to Mr. Goode's suggestion that a museum should consist of a collection of labels illustrated by specimens, the curator has striven "to build up the exhibition series on the plan of a profusely illustrated text-book, in which the specimens themselves form the illustrations, and the text is furnished by the labels." No object has been intentionally exhibited merely on account of its beauty, rarity, or curiosity

Each, intended to illustrate some special point, forms a part of a more or less extended series tending toward the elucidation of the earth's structure and history. In the section of Systematic Geography, for instance, the several departments are devoted to the consideration of the materials of the earth's surface; to dynamical and physiographical geology, including the action of various agencies—heat, compression, tension, fracture, air, water, ice, life, etc.; to structural geology, or the architecture of the earth's crust—including stratification and its accompaniments, joints, inclination, strike, dip, igneous effects, and veins; and to stratigraphical or historical geology. The section of Economic Geology is arranged in a similar manner for illustration by specimens of building and ornamental stones, ores, and other useful mineral substances.

Relative Value of Rain and Irrigation.—Chief Fernow remarks, in his report of the Division of Forestry, that the manner in which the water of the atmosphere becomes available—rain—is not the most satisfactory. This because of its irregularity, and on account of its detrimental action in packing the ground and impeding percolation. A large amount of what would be carried off by underground drainage is thus changed into surface-drainage waters. At the same time, by this compacting the soil, capillary action is increased, and evaporation thereby accelerated. Water management, or forest management as a part of it, may be profitably studied in connection with this subject. The forest floor reduces or prevents the injurious mechanical action of the rain, and acts as a regulator of water-flow. Hitherto water management in rainy districts has mainly concerned itself with getting rid of the water as fast as possible, instead of making it do service during its temporary availability by means of proper soil management, horizontal ditches, and reservoirs—drainage and irrigation systems combined. It seems to have been entirely overlooked that irrigation, which has been considered only for arid and subarid regions, can be applied for plant production in well-watered regions with equal benefit and profit, if combined with proper drainage systems and forest management. To pave the way for a better utilization of water-supplies in the Eastern States seems as much a proper function of the Department of Agriculture as the development of irrigation systems in the Western States; and a comprehensive collection of water statistics and forestry statistics with reference to their mutual relation seems to be a desirable task.

The Public School and the University.—The policy adopted several years ago by the University of Michigan, of admitting graduates of the public schools of the State without examination, is represented by the University Record as working well. The faculty feel that, whatever may be the defects of the diploma system, there are gains that more than counterbalance them. The principal gain has been in strengthening the bond between the university and the high schools. Experience goes to show that voluntary initiative of the university and the schools can make good to a great degree the lack of an authoritative State surveillance of public instruction. In many ways the university has been able to exert a salutary influence upon the schools, while its own position before the people of the State has been very greatly strengthened by the system; and this has been done without lowering the standard of scholarship.

Graphite and Lead-pencils.—The ancients were not acquainted with any real drawing lead. The first drawings resembling those made with a pencil appeared in the later middle ages. Silver-pencil drawings by Van Eyck and Memlink are spoken of; the portrait of Petrarch's Laura was made by a contemporary in a similar style; and Michael Angelo sometimes drew with pencils that seem to have been made of a compound of lead and tin. These were exceptions to the general rule. Pens, crayons, and red chalk held the place among artists and in general use now occupied by the pencil. The famous graphite beds of Borrowdale, in Cumberland, were discovered during the reign of Queen Elizabeth in England, and with them the material which was destined to stimulate the rapid development of the pencil industry. Our lead-pencil is really a graphite pencil. The pencils made in England then were quite different from the products of the present manufacture. The graphite was sawed into small sticks and these were inclosed in wood. The Cumberland pencil was regarded till about the beginning of our century as unsurpassed, distinguished by an extraordinary softness and delicacy in the drawing, and was extremely costly. Only the best and purest material being used, this was exhausted in a relatively short time, without any new source being discovered. At last, manufacturers began to pulverize the waste and to mix it with other materials, to press the mass into hard cakes and saw it up in the old way, without getting a pencil in any way comparable with the old Cumberland brand. New beds of graphite were, however, discovered in Bohemia, the product of which was still far inferior to that of Borrowdale. After some time the art was learned of purifying the Bohemian graphite by a careful chemical process; and toward the end of the last century the happy thought occurred at once to a French and a German manufacturer of mixing purified graphite, finely ground, with moistened clay. The invention was useful in three ways: by reducing the cost of the pencils without impairing their quality; by making it possible, through variations in the proportions of the ingredients, to give the pencils different degrees of hardness; and by simplifying the manufacture, so that pencils became cheap and within the reach of all.

Native Types in Abyssinia.—Traveling in Abyssinia, M. Jules Borelli was most struck with the multiplicity of the native types, and, in fact, with the entire absence of a pure type. Thus, it seemed impossible to find a regular Abyssinian type at Shoa. This is possibly accounted for by the fact that four fifths of the people at least are the sons of slaves of various origins. The sons of the daughters of nobles, who pretend to be of the pure race, are most frequently grandsons of slaves. In many places cloths and articles of silver were found, bearing designs that pointed to an Oriental origin, which seemed to indicate that, long before the rise of Islam, southern Arabia was occupied by Persians. These were the first Asiatic races which, passing the Red Sea, drove back before them the black races, while they mingled with them, forming those innumerable varieties which now make a classification of native types impossible. The multiplicity of languages spoken in these regions is another consequence of these invasions and crossings.

Glacial Moraines in Illinois and Indiana.—In a paper on the Glacial Phenomena of Northeastern Illinois and Northern Indiana, Mr. Frank Leverett describes the moraines as terminal to the ice, but not to the drift-covered areas of those States. Four proofs of advance in the production of later moraines are cited: Buried soils *in situ* between till sheets; changes in the direction of flow as shown by striæ; change in the form of the ice lobe, as indicated by the distribution of the morainic belts and the shiftings of the re-entrant and lobate portions; and evidence of push or advance found in the moraine itself. The number of distinct moraines varies because of partial coalescence or local obliteration of portions of certain moraines by later advances. For this reason correlation is difficult. Aside from this, there is an increase in complexity in passing from older to newer moraines.

The Stone Hand-hammer.—A special study has been published by Mr. J. D. McGuire, of Ellicott City, Md., of the stone hand-hammer, which he believes was probably the tool upon which races living in the stone age relied more than upon any other object to fashion other stone implements. There is no implement, he says, more common among the relics of the stone age, none the uses of which have been less discussed by archæologists, and none more deserving of thorough discussion. The objects seem to be comprised in three types: First, a flattened or oblong ellipsoid, having a pit on one or both sides, the pits being probably intended as finger-holds to relieve the index-finger from the constant jar occasioned by quickly repeated blows on a hard surface. The periphery of these will often be found quite smooth, at other times rough, according as it has been last used as a hammer or as a rubber; for, besides using the hammer to peck his axe or celt into shape, he afterward polished his implement with it. Often one or both of the flattened sides show the effect of rubbing. A second type is the spherical implement, slightly flattened at the poles, showing a battered and commonly a smooth surface. These two types may be considered common all over the world. The third type is the grooved hammer, of the use and distribution of which little is known. It was evidently intended for hafting, and that would interfere with its use as a rubber. All three types vary greatly in dimensions, but, as a rule, the first two are of a size suitable for hand-use for hammering and for rubbing. With these hammers the author believes that other implements were dressed by pecking, and superficial effects were produced which have not been otherwise accounted for, or even remarked. He further goes on to maintain that they had a much more extensive use than has been contemplated, and that many of the Egyptian and the ancient Greek works of art were prepared and dressed with them.

Curious Feature of the Coal-borings at Manchester, England.—The Manchester coal-field, England, according to an article in Chambers's Journal, is a seat of great activity and advancement. Difficulties have been encountered and overcome there, and depths have been reached, which are not thought of elsewhere in the kingdom. The Ashton Moss mine lies at a depth of about a thousand yards below the surface. It presents the curious phenomenon of the boring passing down from one seam of coal to another one four hundred yards geologically higher. This is occasioned by the occurrence of a reversed fault, by which the seams are thrown into this curious position relative to one another. The natural temperature at the bottom of the mine, 84° Fahr., is much lower than the theoretical temperature calculated upon by the Royal Coal Commission. The barometer stands three inches higher than at the surface.

The "Typical American" Diet.—Noticing and criticising the paper of N. E. Yorke Davies, in the July number of the Monthly, on The Proper Diet for Hot Weather, the Boston Medical and Surgical Journal says that "the 'typical American' takes an early breakfast, when he indulges freely in fruit, and never omits a first course of oatmeal and milk, cracked wheat, or hominy; this is followed by dry toast or buttered toast, an egg and a little cold meat or fresh fish, and a cup of coffee sweetened with sugar, not saccharine, which is reserved for the diabetic. He would be glad of cream if it can be obtained. His dinner is the principal meal, and is always taken near the middle of the day. This is composed of soup, three or four ounces of broiled fish, roast meat, or fowl, from four to six ounces of green vegetables (green peas, green beans, stewed turnips, onions, squash), four ounces of potatoes with meat gravy, with pickles and jelly *ad lib.* The last course, the apple, custard, or berry pie of our forefathers, doubtless does not deserve all the abuse which has been heaped upon it by our English cousins, especially when it is light, without too much shortening, and with a well-cooked bottom crust. The last meal, the supper, is taken rather early (as soon as six o'clock), and is designed to be a plain, light, substantial meal of bread and butter or tea-rolls, a little stewed fruit for relish, and one or two cups of tea. The 'average American' seldom eats lunches."

NOTES.

Of the value of anthropological research, in one direction at least, Dr. Alexander Macalister says that if we should ever rise to the possession of a true appreciation of the influences which have affected mankind in the past, with such a knowledge we should be able to advance in that practical branch of anthropology, the science of education, and to make progress in sociology, a study which does for the community what the science of education does for the individual.

Among the results of the recent earthquake in Japan, as described by Prof. Milne at the meeting of the British Association, were the depression of a valley of about nineteen feet and for a distance of thirty miles, thus forming a great geological fault, and the curving of a railway line running along an embankment and bridge in the path of the earthquake.

The influence of food and surroundings on color was illustrated in a paper at the British Association by Mr. E. B. Poulton, on the colors of lepidopterous larvæ. Several members of a large brood of caterpillars of the pepper moth were exhibited which had been reared under different conditions. Those which had been confined among green leaves and twigs became green; those which had had black and brown twigs mingled with their food were brown or black; while others which had been reared among spills of white paper had made a pathetic attempt to imitate their surroundings. Experiments with artificial colors showed that both blue and red tended to produce a dark coloration, especially the former; while, strangely enough, painted twigs did not produce the same effect as those whose tints were natural. Mr. Poulton was able to show that the sensory stimulus producing the change did not act through the eye, as in the case of the chameleon, frog, and sole, but through the skin. It consists, moreover, in the formation of definite pigment, and hence is not so rapid as in those animals. It is possible to modify the color of a caterpillar only once or twice in its lifetime.

The past year, said Dr. Alexander Macalister, in the anthropological address at the British Association, had not been fertile in discoveries bearing on questions of popular interest. No new light had been shed on the darkness that enshrouded the origin of man; but in this connection Dr. Louis Robinson had, from a series of observations on the prehensile power of the hands of children at birth, arrived at the same conclusion which Mr. Robert Louis Stevenson deduced from the study of his grandfather—namely, that there still survived in the human structure and habit traces of our probably arboreal ancestry.

Of one hundred and three members of the British Association of last year who were anthropometrically examined at Cardiff, seventy-eight were men, and the mean stature of the whole was sixty-eight inches, being one inch above the average stature of the people of the British Isles.

The third report of the committee of the British Association to arrange for the collection, preservation, and systematic registration of photographs of points of geological interest says that, while the photographs collected during the past two years are less in number than those of the previous period, a greater proportion are of high scientific interest and illustrate features of real geological importance. But considerable work is yet required to be done toward the completion of a scheme for the full illustration of the geological features of the United Kingdom.

A preliminary account was read in the British Association by Dr. Buchan of oceanic circulation as deduced from the Challenger observations. The author was convinced that a thorough knowledge of the subject could only be attained after a study of the prevailing winds, as the currents followed the winds. He then described the circulation of currents in the North Atlantic, and said that these currents were lost at a depth of over five hundred fathoms, below which point the ocean had always a constant temperature at all depths. The same condition was reached at fifteen hundred fathoms in the Pacific Ocean. He went on to trace the course of the warm dense salt water issuing below the surface from the Mediterranean through the Strait of Gibraltar. This, he said, traveled northward, skirting the west coast of Europe, and thus warming the water even to the north of Norway. He considered that the current was sufficiently warm and strong to prevent the entrance of icebergs into the North Sea.

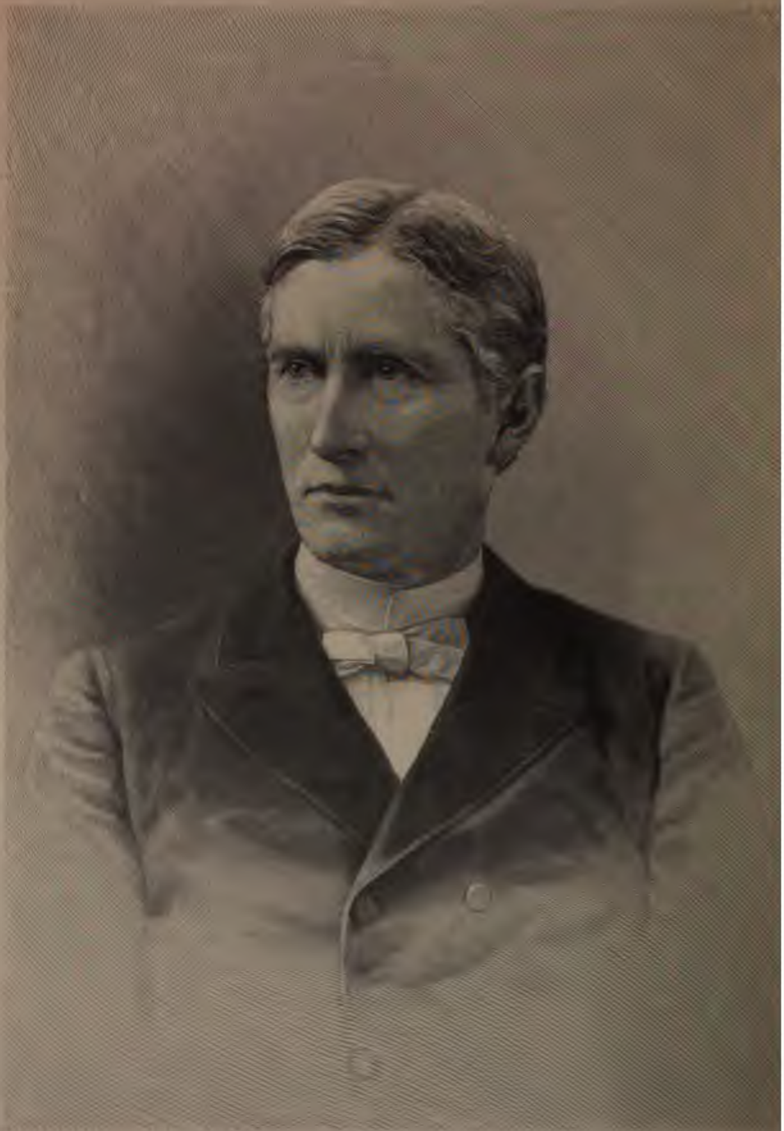
The observations of dust in the air, made eight times a day last year at the top of Ben Nevis, showed well-marked variations in the amounts present at different times of day. Further, it was found that thick, dry fogs contain a large amount of dust, whereas the thin, wet mists contain little or none.

In the course of his paper in the British Association on the Application of Interference Methods to Spectroscopic Measurement, Prof. Michaelson, of America, found that the results seemed to show that every line of the spectrum is compound, though in many cases the two components are very close together, and have very unequal intensities. The red line of oxygen has three distinct components; the red line of hydrogen is an extremely close double, with nearly equal components; and the green line of cadmium has two components, one of which is ten times as intense as the other.

In illustration of results obtained by the Rev. T. J. Smith in inductoscript (writing by induction currents), Mr. R. E. Baynes, in the British Association, caused the spark of an induction coil to be passed from a coin to a photographic plate on which it was placed. The plate was then developed, and showed an image of the coin. On performing the experiment in a vacuum no such result was obtained. The effect could be got with bromide paper as well as with plates.

The American Association voted grants of a hundred dollars each to Prof. Hart, for investigations in chemistry; to Prof. Joseph Jastrow, in psychology; and to the physical table to be located at Naples.

Describing, in the American Association, the Prehistoric Earthworks of Henry County, Ind., Mr. T. B. Redding said that there were in that county ten curiously formed mounds, surrounded by inclosures, and a number of additional ones, though some of them are not so evident as to be noticed by the casual observer. There are also six inclosures in which mounds do not appear. They may have been obliterated. The mounds range from twenty to a hundred and fifty feet in diameter, and the inclosures are from a hundred to two hundred and fifty feet in diameter. Many of the mounds crumble away on being exposed by taking off the turf covering, while others are in a good state of preservation. A number of relics and skeletons were exhibited during the reading of the paper.



G. FREDERICK WRIGHT.

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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XVIII.—FROM MAGIC TO CHEMISTRY AND PHYSICS.

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PART I.

IN all the earliest developments of human thought we find a tendency to ascribe mysterious powers over Nature to men and women especially gifted or skilled. Survivals of this view are found to this day among savages and barbarians left behind in the evolution of civilization, and especially is this the case among the tribes of Australia, Africa, and the Pacific coast of America; even in the most enlightened nations still appear, here and there, popular beliefs, observances, or sayings, drawn from this earlier phase of thought.

Between the prehistoric savage developing this theory, and therefore endeavoring to deal with the powers of Nature by magic, and the modern man who has outgrown it, appears a long line of nations struggling upward through it. As the hieroglyphs, cuneiform inscriptions, and various other records of antiquity are read, the development of this belief can be studied in Egypt, India, Babylonia, Assyria, Persia, and Phœnicia. From these countries it came into the early thought of Greece and Rome, but especially into the Jewish and Christian sacred books; both in the Old Testament and in the New we find magic, sorcery, and soothsaying constantly referred to as realities.*

* For magic in prehistoric times and survivals of it since, with abundant citation of authorities, see Tylor, Primitive Culture, chap. iv; also the Early History of Mankind, by

The first distinct impulse which lifted mankind toward a higher view of research into natural laws was given by the philosophers of Greece. It is true that philosophical opposition to physical research was at times strong, and that even a great thinker like Socrates considered certain physical investigations as an impious intrusion into the work of the gods; it is also true that Plato and Aristotle, while bringing their thoughts to bear upon the world with great beauty and force, did much to draw mankind away from those methods which in modern times have produced the best results.

Plato developed a world in which the physical sciences had little if any real reason for existing; Aristotle, a world in which the same sciences were developed not so much by observation of what is, as of speculation on what ought to be. From the former of these two great men came into Christian theology many germs of mediæval magic, and from the latter sundry modes of reasoning which aided in the evolution of these; yet the impulse to human thought given by these great masters was of inestimable value to our race, and one legacy from them was especially precious;—the idea that a science of Nature is possible, and that the highest occupation of man is the discovery of its laws. Still another gift from them was greatest of all, for they gave scientific freedom: they laid no interdict upon new paths; they interposed no barriers to the extension of knowledge; they threatened no doom in this life or in the next against investigators on new lines; they left the world free to seek any new methods and to follow any new paths which thinking men could find.

This legacy of belief in science, of respect for scientific pursuits, and of freedom in scientific research, was especially received by the school of Alexandria, and above all by Archimedes,

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the same author, third edition, pp. 115 *et seq.*, also p. 380; also Andrew Lang, Myth, Ritual, and Religion, vol. i, chap. iv. For magic in Egypt, see Lenormant, Chaldean Magic, chaps. vi–viii; also Maspero, Histoire Ancienne des Peuples de l'Orient; and especially the citations from Chabas, Le Papyrus Magique Harris, in chap. vii; also Maury, La Magie et l'Astrologie dans l'Antiquité et au Moyen Age. For magic in Chaldea, see Lenormant as above. For examples of magical powers in India, see Max Müller's Sacred Books of the East, vol. xvii, pp. 121 *et seq.* For a legendary view of magic in Media, see the Zend Avesta, Part I, p. 14, translated by Darmsteter; and for a more highly developed view, see the Zend Avesta, Part III, p. 239, translated by Mill. For magic in Greece and Rome, and especially in the Neoplatonic school as well as in the middle ages, see especially Maury, La Magie et l'Astrologie, chaps. iii–v. For various sorts of magic recognized and condemned in our sacred books, see Deuteronomy, xviii, 10, 11; and for the burning of magical books at Ephesus under the influence of St. Paul, see Acts, xix, 14. See also Ewald, History of Israel, Martineau's translation, fourth edition, ii, 55–63; iii, 45–51. For a very elaborate summing up of the passages in our sacred books, recognizing magic as a fact, see De Haen, "De Magia," Lips., 1775, chaps. i, ii, and iii, of first part. For general subject of magic, see Ennemoser, History of Magic, translated by Howitt [illegible] however, constantly mixes sorcery with magic proper.

who began, just before the Christian era, to open new paths through the great field of the inductive sciences by observation, comparison, and experiment.*

The establishment of Christianity, though it began a new evolution of religion, arrested the normal development of the physical sciences for over fifteen hundred years. The cause of this arrest was twofold: First, there was created an atmosphere in which the germs of physical science could hardly grow;—an atmosphere in which all seeking for truth in Nature as truth was regarded as futile. The general belief derived from the New Testament Scriptures was, that the end of the world was at hand; that the last judgment was approaching; that all existing physical Nature was soon to be destroyed: hence, the greatest thinkers in the Church generally poured contempt upon all investigators into a science of Nature, and insisted that everything except the saving of souls was folly.

This belief appears frequently through the entire period of the middle ages, but during the first thousand years it is clearly dominant. From Lactantius and Eusebius, in the third century, pouring contempt, as we have seen, over studies in astronomy, to Peter Damian, the noted chancellor of Pope Gregory VII, in the eleventh century, declaring all worldly sciences to be "absurdities" and "fooleries," it becomes the atmosphere of thought.†

Then, too, there was established a standard to which all science which did struggle up through this atmosphere must be made to conform—a standard which favored magic rather than science, for it was a standard of rigid dogmatism obtained from literal readings in the Jewish and Christian Scriptures. The most careful inductions from ascertained facts were regarded as wretchedly fallible when compared with any view of Nature whatever given or even hinted at in any poem, chronicle, code, apologue, myth, legend, allegory, letter, or discourse of any sort which had happened to be preserved in the literature which had come to be held as sacred.

For twelve centuries, then, the physical sciences were thus dis-

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* As to the beginnings of physical science in Greece, and of the theological opposition to physical science, also Socrates's view regarding certain branches as interdicted to human study, see Grote's Greece, vol. i, pp. 495 and 504, 505; also Jowett's introduction to his translation of the Timæus, and Whewell's History of the Inductive Sciences. For examples showing the incompatibility of Plato's methods in physical science with that pursued in modern times, see Zeller, Plato and the Older Academy, English translation by Alleyne and Goodwin, pp. 375 *et seq.* The supposed opposition to freedom of opinion in the "Laws" of Plato, toward the end of his life, can hardly make against the whole spirit of Greek thought.

† For the view of Peter Damian and others through the middle ages as to the futility of scientific investigation, see citations in Eicken, Geschichte und System der mittelälterlichen Weltanschauung, chap. vi.

couraged or perverted by the dominant orthodoxy. Whoever studied Nature studied it either openly to find illustrations of the sacred text, useful in the "saving of souls," or secretly to gain the aid of occult powers, useful in securing personal advantage. Great men like Bede, Isidore of Seville, Rabanus Maurus, accepted the scriptural standard of science, and used it as a means of Christian edification. The views of Bede and Isidor on kindred subjects have been shown in former chapters; and typical of the view taken by Rabanus is the fact that in his great work on the Universe there are only two chapters which seem directly or indirectly to recognize even the beginnings of a real philosophy of Nature. A multitude of less-known men found warrant in Scripture for magic applied to less worthy purposes.*

But after the thousand years to which the Church, upon supposed scriptural warrant, had lengthened out the term of the earth's existence had passed, "the end of all things" seemed further off than ever; and in the thirteenth century, owing to causes which need not be dwelt upon here, came a great revival of thought, so that the forces of theology and of science seemed arrayed for a contest. On one side came a revival of religious fervor, and to this day the works of the cathedral-builders mark its depth and strength; on the other side came a new spirit of inquiry incarnate in a line of powerful thinkers.

First among these was Albert of Bollstadt, better known as Albert the Great, the most renowned scholar of his time. Fettered though he was by the methods sanctioned in the Church, dark as was all about him, he had conceived ideas of better methods and aims; his eye pierced the mists of scholasticism; he saw the light, and sought to draw the world toward it. He stands among the great pioneers of physical and natural science; he aided in giving foundations to botany and chemistry; he rose above his time and struck a heavy blow at those who opposed the possibility of human life on opposite sides of the earth; he noted the influence of mountains, seas, and forests upon races and products, so that Humboldt justly finds in his works the germs of physical geography as a comprehensive science.

But the old system of deducing scientific truth from scriptural texts was renewed in the development of scholastic theology,

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* As typical examples, see the utterances of Eusebius and Lactantius regarding astronomers given in the chapter on Astronomy. For a summary of Rabanus Maurus's doctrine of physics, see Heller, Geschichte der Physik, vol. i, pp. 172 *et seq.* For Bede and Isidore, see the earlier chapters of this work. For an excellent statement regarding the application of scriptural standards to scientific research in the middle ages, see Kretschmer, Die physische Erdkunde im Christlichen Mittelalter, pp. 5 *et seq.* For the distinctions in magic recognized in the mediæval Church, see the long catalogue of various sorts given in the Abbé Migne's Encyclopédie Théologique, third series, article "Magie."

and ecclesiastical power acting through thousands of subtle channels was made to aid this development. The old idea of the vast superiority of theology was revived. Though Albert's main effort was to Christianize science, he was dealt with by the authorities of the Dominican order, subjected to suspicion and indignity, and only escaped persecution for sorcery by yielding to the ecclesiastical spirit of the time, and working finally in theological channels by scholastic methods.

It was a vast loss to the earth; and certainly, of all organizations that have reason to lament the pressure of ecclesiasticism which turned Albert the Great from natural philosophy to theology, foremost of all in regret should be the Christian Church, and especially the Roman branch of it. Had there been evolved in the Church during the thirteenth century a faith strong enough to accept the truths in natural science which Albert and his compeers could have given, and to have encouraged their growth, this faith and this encouragement would to this day have formed the greatest argument for proving the Church directly under divine guidance; they would have been among the brightest jewels in her crown. The loss to the Church by this want of faith and courage has proved in the long run even greater than the loss to science.*

The next great man of that age whom the theological and ecclesiastical forces of the time turned from the right path was Vincent of Beauvais. During the first half of the twelfth century he devoted himself to the study of Nature in several of her most interesting fields. To astronomy, botany, and zoölogy he gave special attention, but in a larger way he made a general study of the universe, and in a series of treatises undertook to reveal the whole field of science. But his work simply became a vast commentary on the account of creation given in the book of Genesis. Beginning with the work of the Trinity at the creation, he goes on to detail the work of angels in all their fields, and makes

* For a very careful discussion of Albert's strength in investigation and weakness in yielding to scholastic authority, see Kopp, Ansichten über die Aufgabe der Chemie von Geber bis Stahl, Braunschweig, 1875, pp. 64 *et seq.* For a very extended and enthusiastic biographical sketch, see Pouchet. For comparison of his work with that of Thomas Aquinas, see Milman, History of Latin Christianity, vol. vi, p. 461. "Il était aussi très-habile dans les arts mécaniques, ce que le fit soupçonner d'être sorcier" (Sprengel, Histoire de la Médecine, vol. ii, p. 389). For Albert's biography treated strictly in accordance with ecclesiastical methods, see Albert the Great, by Joachim Sighart, translated by the Rev. T. A. Dickson, of the Order of Preachers, published under the sanction of the Dominican censor and of the Cardinal Archbishop of Westminster, London, 1876. How an Englishman like Cardinal Manning could tolerate among Englishmen such an unctuous glossing over of historical truth is one of the wonders of contemporary history. For choice specimens see chapters ii and iv. For one of the best and most recent summaries, see Heller, Geschichte der Physik, Stuttgart, 1882, vol. i, pp. 179 *et seq.*

excursions into every part of creation, visible and invisible, but always with the most complete subordination of his thought to the literal statements of Scripture.

Could he have taken the path of experimental research, the world would have been enriched with most precious discoveries; but the force which had given wrong direction to Albert of Bollstadt, backed as it was by the whole ecclesiastical power of his time, was too strong, and in all the life labor of Vincent nothing appears of any permanent value. He reared a structure which the adaptation of facts to literal interpretations of Scripture, and the application of theological subtleties to Nature combine to make one of the most striking monuments of human error.*

But the theological spirit of the thirteenth century gained its greatest victory in the work of St. Thomas Aquinas. In him was the theological spirit of his age incarnate. Although he yielded somewhat at one period to love of natural science, it was he who finally made that great treaty or compromise which for ages subjected science entirely to theology. He it was who reared the most enduring barrier against those who in that age and in succeeding ages labored to open for science the path by its own legitimate methods toward its own noble ends.

He had been the pupil of Albert the Great, and had gained much from him. Through the earlier systems of philosophy, as they were then known, and through the earlier theologic thought, he had gone with great labor and vigor; and all his mighty powers, thus disciplined and cultured, he brought to bear in making a treaty or truce which was to give theology permanent supremacy over science.

The experimental method had already been practically initiated; Albert of Bollstadt and Roger Bacon had begun their work in accordance with its methods; but St. Thomas gave all his thoughts to bringing science again under the sway of theological methods and ecclesiastical control. In his commentary on Aristotle's treatise upon Heaven and Earth, he gave to the world a striking example of what his method could produce; illustrating all the evils which arise in combining theological reasoning and literal interpretation of Scripture with scientific facts, and this work remains to this day a monument of scientific genius perverted by theology.†

The ecclesiastical power of the time hailed him as a deliverer; it was claimed that miracles were vouchsafed, proving that the

* For Vincent de Beauvais, see Études sur Vincent de Beauvais, par l'Abbé Bourgeat, chaps. xii, xiii, and xiv; also Pouchet, Histoire des Sciences Naturelles au Moyen Age, Paris, 1853, pp. 470 *et seq.*; also other histories cited hereafter.

† For citations showing this subordination of science to theology, see Eicken, chap. vi.

blessing of Heaven rested upon his labors; and among the legends embodying this claim is that given by the Bollandists and immortalized by a renowned painter. The great philosopher and saint is represented in the habit of his order, with book and pen in hand, kneeling before the image of Christ crucified, and as he kneels the image thus addresses him: "Thomas, thou hast written well concerning me; what price wilt thou receive for thy labor?" The myth-making faculty of the people at large was also brought into play. According to a wide-spread and circumstantial legend, Albert, by magical means, created an android—an artificial man, living, speaking, and answering all questions with such subtlety that St. Thomas, unable to answer its reasoning, broke it to pieces with his staff.

To this day historians of the Roman Church like Rohrbacher, and historians of science like Pouchet, find it convenient to propitiate the Church by dilating upon the glories of St. Thomas Aquinas in thus making an alliance between religious and scientific thought, and laying the foundations for a "sanctified science"; but the unprejudiced historian can not indulge in this enthusiastic view: the results both for the Church and for science have been most unfortunate. It was a wretched delay in the evolution of fruitful thought; for the first result of this great man's great compromise was to close for ages that path in science which above all others leads to discoveries of value—the experimental method —and to reopen that old path of mixed theology and science which, as Hallam declares, "after three or four hundred years had not untied a single knot or added one unequivocal truth to the domain of philosophy"—the path which, as all modern history proves, has ever since led only to delusion and evil.*

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* For the work of Aquinas, see his Liber de Cœlo et Mundo, section xx; also, Life and Labors of St. Thomas of Aquin, by Archbishop Vaughan, pp. 459 *et seq.* For his labors in natural science, see Hoefer, Histoire de la Chimie, Paris, 1843, vol. i, p. 381. For theological views of science in the middle ages, and rejoicing thereat, see Pouchet, Hist. des Sci. Nat. au Moyen Age, *ubi supra*. Pouchet says: "En général au milieu du moyen âge les sciences sont essentiellement chrétiennes, leur but est tout-à-fait religieux, et elles semblent beaucoup moins s'inquiéter de l'avancement intellectuel de l'homme que de son salut eternel." Pouchet calls this "conciliation" into a "harmonieux ensemble" "la plus glorieuse des conquêtes intellectuelles du moyen âge." Pouchet belongs to Rouen, and the shadow of Rouen Cathedral seems thrown over all his history. See, also, l'Abbé Rohrbacher, Hist. de l'Église Catholique, Paris, 1858, vol. xviii, pp. 421 *et seq.* The abbé dilates upon the fact that "the Church organizes the agreement of all the sciences by the labors of St. Thomas of Aquin and his contemporaries." For the complete subordination of science to theology by St. Thomas, see Eicken, chap. vi. For the theological character of science in the middle ages, recognized by a Protestant philosophic historian, see the well-known passage in Guizot, History of Civilization in Europe; and by a noted Protestant ecclesiastic, see Bishop Hampden's Life of Thomas Aquinas, chaps. xxxvi, xxxvii; see also Hallam, Middle Ages, chap. ix. For dealings of Pope John XXII, of the Kings of France and England, and of the Republic of Venice, see Figuier, L'Alchimie et les Alchimistes, pp. 140, 141, where, in a note,

The theological path thus opened by these strong men became the main path for science during ages, and it led the world ever further and further from any fruitful fact or useful method. Roger Bacon's investigations already begun were discredited; worthless mixtures of scriptural legends with imperfectly authenticated physical facts took their place. Thus it was that for twelve hundred years the minds in control of Europe regarded all real science as *futile*, and diverted the great current of earnest thought into theology.

The next stage in this evolution was the development of an idea which acted with great force throughout the middle ages—the idea that science is *dangerous*. As we have seen in other chapters, there was evolved more and more a vivid sense of the interference of Satan with human affairs, and especially of the interference of the ancient gods whom St. Paul had explicitly declared to be devils, and who were naturally indignant at their dethronement. More and more suspicion attached to all men who attempted anything in the development of science. The old scriptural warrrant for the existence of sorcery and magic was brought in as a powerful argument against such men. The conscience of the time, therefore, acting in obedience to the highest authorities in the Church, and, as was supposed, in defense of religion, brought out a missile which it hurled against scientific investigators with deadly effect; the mediæval battle-fields of thought were strewn with such; it was the charge of sorcery and magic—of unlawful compact with the devil. This missile was effective. We find it used against every great investigator of Nature in those times and for ages after. The list of great men in those centuries charged with magic, as given by Naudé, is astounding; it includes every man of real mark, and in the midst of them stands one of the most thoughtful popes, Sylvester II (Gerbert), and the foremost of mediæval thinkers on natural science, Albert the Great. It came to be the accepted idea that as soon as a man conceived a wish to study the works of God his first step must be a league with the devil.*

The first great thinker who, in spite of some stumbling into theologic pitfalls, persevered in a truly scientific path, was Roger Bacon. His life and works seem until recently to have been generally misunderstood: he was formerly ranked as a superstitious

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the text of the bull *Spondent Pariter* is given. For popular legends regarding Albert and St. Thomas, see Elephas Levi, Hist. de la Magie, chap. v.

* For the charge of magic against scholars and others, see Naudé, Apologie pour les grands hommes soupçonnés de Magie, *passim;* also, Maury, Hist. de la Magie, troisième édit., pp. 214, 215; also, Cuvier, Hist. des Sciences Naturelles, vol. i, p. 396. For a circumstantial account of this charge of magic against Pope Boniface VIII, see Milman, Latin Christianity, Book XII, chap. iii.

alchemist who happened upon some inventions, but more recent investigation has shown him to be one of the great masters in the evolution of human thought. The advance of sound historical judgment seems likely to bring the fame of the two who bear the name of Bacon nearer to equality. Bacon of the chancellorship and of the Novum Organum may not wane, but Bacon of the prison-cell and the Opus Major steadily approaches him in brightness.

More than three centuries before Francis Bacon advocated the experimental method, Roger Bacon practiced it, and the results as now revealed are wonderful. He wrought with power in many sciences, and his knowledge was sound and exact. By him, more than by any other man of the middle ages, was the world brought into the more fruitful paths of scientific thought—the paths which have led to the most precious inventions; and among these are clocks, lenses, burning specula, telescopes, which were given by him to the world, directly or indirectly. In his writings are found formulæ for extracting phosphorus, manganese, and bismuth. It is even claimed, with much appearance of justice, that he investigated the power of steam, and he seems to have very nearly reached some of the principal doctrines of modern chemistry. But it should be borne in mind that his *method* of investigation was even greater than its *results*. In an age when theological subtilizing was alone thought to give the title of scholar, he insisted on *real* reasoning and the aid of natural science by mathematics; in an age when experimenting was sure to cost a man his reputation, and was likely to cost him his life, he insisted on experimenting, and braved all its risks. Few greater men have lived. As we read the sketch given by Whewell of Bacon's process of reasoning regarding the refraction of light, he seems divinely inspired.

On this man came the brunt of the battle. The most conscientious men of his time thought it their duty to fight him, and they fought him steadily and bitterly. His sin was not disbelief in Christianity, not want of fidelity to the Church, not even dissent from the main lines of orthodoxy; on the contrary, he showed in all his writings a desire to strengthen Christianity, to build up the Church, and to develop orthodoxy. He was attacked and condemned mainly because he did not believe that philosophy had become complete, and that nothing more was to be learned; he was condemned, as his opponents expressly declared, "on account of certain suspicious novelties"—"*propter quasdam novitates suspectas.*"

Upon his return to Oxford, about 1250, the forces of unreason beset him on all sides. Greatest of all his enemies was Bonaventura. This enemy was the theologic idol of the period: the learned world knew him as the "seraphic Doctor"; Dante gave him an honored place in the great poem of the middle ages; the Church finally enrolled him among the saints. By force of great ability in theology he had become in the middle of the thirteenth century general of the Franciscan order; thus, as Bacon's master, his hands were laid heavily on the new teaching, so that in 1257 the troublesome monk was forbidden to lecture; all men were solemnly warned not to listen to his teaching, and he was ordered to Paris, to be kept under surveillance by the monastic authorities. Herein was exhibited another of the myriad examples showing the care exercised over scientific teaching by the Church. The reasons for thus dealing with Bacon were evident: First, he had dared attempt scientific explanations of natural phenomena, which, under the mystic theology of the middle ages, had been referred simply to supernatural causes. Typical was his explanation of the causes and character of the rainbow. It was clear, cogent, a great step in the right direction as regards physical science: but there, in the book of Genesis, stood the time-honored legend regarding the origin of the rainbow, supposed to have been dictated immediately by the Holy Spirit; and, according to that, the "bow in the cloud" was not the result of natural laws, but a "sign" arbitrarily placed in the heavens for the simple purpose of assuring mankind that there should not be another universal deluge.

But this was not the worst: another theological idea was arrayed against him,—the idea of satanic intervention in science; hence he was attacked with that goodly missile which with the epithets "infidel" and "atheist" has decided the fate of so many battles—the charge of magic and compact with Satan.

He defended himself with a most unfortunate weapon—a weapon which exploded in his hands and injured him more than the enemy. For he argued against the idea of compacts with Satan, and showed that much which is ascribed to demons results from natural means. This added fuel to the flame; to limit the power of Satan was deemed hardly less impious than to limit the power of God.

The most powerful protectors availed him little. His friend Guy Foulkes, having in 1265 been made pope under the name of Clement IV, shielded Bacon for a time; but the fury of the enemy was too strong, and when he made ready to perform a few experiments before a small audience, we are told that all Oxford was in an uproar. It was believed that Satan was about to be let loose. Everywhere priests, monks, fellows, and students rushed about, their garments streaming in the wind, and everywhere rose the cry, "Down with the magician!" and this cry, "Down with the magician!" resounded from cell to cell, and from hall to hall.

Another weapon was also used upon the battle-fields of science in that time with much effect. The Arabs had made many noble discoveries in science, and Averroes had, in the opinion of many, divided the honors with St. Thomas Aquinas; these facts gave the new missile—it was the epithet "Mohammedan"—this too was flung with effect at Bacon.

The attack now began to take its final shape. The two great religious orders, Franciscan and Dominican, then in all the vigor of their youth, vied with each other in fighting the new thought in chemistry and physics. St. Dominic solemnly condemned research by experiment and observation; the general of the Franciscan order took similar ground. In 1243 the Dominicans interdicted every member of their order from the study of medicine and natural philosophy, and in 1287 this interdiction was extended to the study of chemistry.

In 1278 the authorities of the Franciscan order, assembled at Paris, solemnly condemned Bacon's teaching, and the general of the Franciscans, Jerome d'Ascoli, afterward Pope, threw him into prison, where he remained for fourteen years. Though Pope Clement VI had protected him, Popes Nicholas III and IV, by virtue of their infallibility, decided that he was too dangerous to be at large, and he was only released at the age of eighty, but a year or two before death placed him beyond the reach of his enemies. How deeply the struggle had racked his mind may be gathered from that last affecting declaration of his, "Would that I had not given myself so much trouble for the love of science!"

The attempt has been made by sundry champions of the Church to show that some of Bacon's utterances against ecclesiastical and other corruptions in his time were the main cause of the severity which the Church authorities exercised against him. This helps the Church but little, even if it be well based, but it is not well based. That some of his utterances of this sort made him enemies is doubtless true, but the charges on which St. Bonaventura silenced him, and Jerome of Ascoli imprisoned him, and successive popes kept him in prison for fourteen years, were "dangerous novelties" and suspected sorcery.

Sad is it to think of what this great man might have given to the world had ecclesiasticism allowed the gift. He held the key of treasures which would have freed mankind from ages of error and misery. With his discoveries as a basis, with his method as a guide, what might not the world have gained! Nor was the wrong done to that age alone; it was done to this age also. The nineteenth century was robbed at the same time with the thirteenth. But for that interference with science the nineteenth century would be enjoying discoveries which will not be reached before the twentieth century. Thousands of precious lives shall be lost in this century, tens of thousands shall suffer discomfort, privation, sickness, poverty, ignorance, for lack of discoveries and methods which, but for this mistaken dealing with Roger Bacon and his compeers, would now be blessing the earth.

In two recent years sixty thousand children died in England and in Wales of scarlet fever; probably quite as many died in the United States. Had not Bacon been hindered, we should have had in our hands, by this time, the means to save two thirds of these victims; and the same is true of typhoid, typhus, cholera, and that great class of diseases of whose physical causes science is just beginning to get an inkling. Put together all the efforts of all the atheists who have ever lived, and they have not done so much harm to Christianity and the world as has been done by the narrow-minded, conscientious men who persecuted Roger Bacon, and closed the path which he gave his life to open.

But despite the persecution of Bacon and the defection of those who ought to have followed him, champions of the experimental method rose from time to time during the succeeding centuries. We know little of them personally; our main knowledge of their efforts is derived from the endeavors of their persecutors.

In 1317 Pope John XXII issued his bull, *Spondent pariter*, leveled at the alchemists, but really dealing a terrible blow at the beginnings of chemical science. That many alchemists were knavish is no doubt true, but no infallibility in separating the evil from the good was shown by the papacy in this matter. In this and in sundry other bulls and briefs we find Pope John, by virtue of his infallibility as the world's instructor in all that pertains to faith and morals, condemning real science and pseudo-science alike. In two of these documents, supposed to be inspired by wisdom from on high, he complains that both he and his flock are in danger of their lives by the arts of sorcerers; he declares that such sorcerers can send devils into mirrors and finger-rings, and kill men and women by a magic word; that they had tried to kill him by piercing his waxen image with needles, in the name of the devil. He, therefore, called on all rulers, secular and ecclesiastical, to hunt down the miscreants who thus afflicted the faithful, and he especially increased the powers of inquisitors in various parts of Europe for this purpose.

The impulse thus given to childish fear and hatred against the investigation of Nature was felt for centuries. More and more chemistry came to be known as one of the "seven devilish arts."

These declarations of Pope John were echoed for generation after generation, until nearly three hundred years later there came the yet more terrible bull of Pope Innocent VIII, known as *Summis Desiderantes*, which let inquisitors loose upon Germany, and armed them with the *malleus maleficarum*, to torture and destroy men and women by tens of thousands for sorcery and magic.

Under such guidance the secular rulers were naturally vigorous in the same policy. In 1380 Charles V of France forbade the possession of furnaces and apparatus necessary for chemical processes. Under this law the chemist John Barrillon was thrown into prison, and it was only by the greatest effort that his life was saved. In 1404 Henry IV of England issued a similar decree, and in 1418 the Republic of Venice followed these examples.

But champions of science still pressed on. The judicial torture and murder of Antonio de Dominis were not simply for heresy; his investigations in the phenomena of light were an additional crime. Pierre de la Ramée fell in the massacre of St. Bartholomew as a heretic, but his teachings had previously been stopped by a royal edict, sought by the Church on account of his breaking away from the old theological methods.*

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* For an account of Bacon's treatise, De Nullitate Magiæ, see Hoefer. For the uproar caused by Bacon's teaching at Oxford, see Kopp, Geschichte der Chemie, Braunschweig, 1843, vol. i, p. 63; and for a somewhat reactionary discussion of Bacon's relation to the progress of chemistry, see a recent work by the same author, Ansichten über die Aufgabe der Chemie, Braunschweig, 1874, pp. 85 *et seq.*; also, for an excellent summary, see Hoefer, Hist. de la Chimie, vol. i, pp. 368 *et seq.* For probably the most thorough study of Bacon's general works in science, and for his views of the universe, see Prof. Werner, Die Kosmologie und allgemeine Naturlehre des Roger Baco, Wien, 1879. For summaries of his work in other fields, see Whewell, vol. i, pp. 367, 368; Draper, p. 438; Saisset, Descartes et ses Précurseurs, deuxième édition, pp. 397 *et seq.*; Nourrisson, Progrès de la Pensée humaine, pp. 271, 272; Sprengel, Histoire de la Médecine, Paris, 1865, vol. ii, p. 397; Cuvier, Histoire des Sciences Naturelles, vol. i, p. 417. As to Bacon's orthodoxy, see Saisset, pp. 53, 55. For special examination of causes of Bacon's condemnation, see Waddington, cited by Saisset, p. 14. On Bacon as a sorcerer, see Featherstonhaugh's article in North American Review. For a brief but admirable statement of Roger Bacon's relation to the world in his time, and of what he might have done had he not been thwarted by theology, see Döllinger, Studies in European History, English translation, London, 1890, pp. 178, 179. For a good example of the danger of denying the full power of Satan, even in much more recent times and in a Protestant country, see account of treatment of Bekker's Monde Enchanté by the theologians of Holland, in Nisard, Histoire des Livres Populaires, vol. i, pp. 172, 173. Kopp, in his Ansichten, pushes criticism even to some skepticism as to Roger Bacon being the *discoverer* of many of the things generally attributed to him; but, after all deductions are carefully made, enough remains to make Bacon the greatest benefactor to humanity during the middle ages. For Roger Bacon's deep devotion to religion and the Church, see citation and remarks in Schneider, Roger Bacon, Augsburg, 1873, p. 112; also, citation from the Opus Majus in Eicken, chap. vi. On Bacon as a "Mohammedan," see Saisset, p. 17. For the interdiction of studies in physical science by the Dominicans and Franciscans, see Henri Martin, Histoire de France, vol. iv, p. 283. For the suppression of chemical teaching by the Parliament of Paris, see Henri Martin, Histoire de France, vol. xii, pp. 14, 15. For proofs that the world is steadily working toward great discoveries as to the cause and prevention of zymotic diseases and of their propagation, see Beale's Disease Germs, Baldwin Latham's Sanitary Engineering, Michel Lévy's Traité d'Hygiène Publique et Privée. For a summary of the bull *Spondent pariter*, and for an example of injury done by it, see

To question the theological view of physical science was, even long after the close of the middle ages, exceedingly perilous. We have seen in this chapter how one of Roger Bacon's unpardonable offenses was his argument against the efficacy of magic, and in chapters preceding how centuries afterward Wyer, Flade, Bekker, and a multitude of other investigators and thinkers suffered confiscation of property, loss of position, and even torture and death, for similar views. I will refer, then, to but one more case as typical.

In the last year of the sixteenth century the persecutions for witchcraft and magic were especially cruel in the western districts of Germany, the main instrument in them being Binsfeld, Suffragan Bishop of Treves.

At that time Cornelius Loos was a professor at the university of that city. He was a devoted churchman, and one of the most brilliant opponents of Protestantism, but he finally saw through the prevailing belief regarding occult powers, and in an evil hour for himself embodied his idea in a book entitled "True and False Magic." The book, though earnest, was temperate, but this helped him and his cause not at all. The texts of Scripture clearly sanctioning belief in sorcery and magic stood against him, and these had been confirmed by the infallible teachings of the Church and the popes from time immemorial; the book was stopped in the press, the manuscript confiscated, and Loos thrown into a dungeon.

The inquisitors having wrought their will upon him, in the spring of 1593 he was brought out of prison, forced to recant on his knees before the assembled dignitaries of the Church, and thenceforward kept constantly under surveillance, and at times in prison. Even this was considered too light a punishment, and his arch-enemy, the Jesuit Del Rio, declared that but for his death by plague he would have been finally sent to the stake. His manuscript, hidden away in the archives at Treves, was supposed to be lost until within the present decade. After three centuries what remains of it has been brought to light by an American scholar.*

Schneider, Geschichte der Alchemie, p. 160; and for a studiously moderate statement, Milman, Latin Christianity, Book XII, chap. vi. For character and general efforts of John XXII, see Lea, Inquisition, iii, 436, also 452 *et seq.* For the character of the two papal briefs, see Rydberg, p. 177. For the Bull *Summis Desiderantes*, see previous chapters of this work. For Antonio de Dominis, see Montucla, Hist. des Mathématiques, vol. i, p. 705, Humboldt, Cosmos, Libri, vol. iv, pp. 145 *et seq.*

* Prof. George Lincoln Burr, of Cornell University, whose copy of Loos's MS. is now in the library of that institution. For a full account of the discovery and its significance, see the New York Evening Post for November 13, 1886. The facts regarding the after-life of Loos, were discovered by Prof. Burr in the archives at Brussels. For Weyer, Flade, Bekker, and others, see the chapters of this work on Demoniacal Possession and Insanity, and Diabolism and Hysteria.

MODERN INSTANCES OF DEMONIACAL POSSESSION.

By Prof. E. P. EVANS.

PERHAPS few persons are fully aware of the official attitude of the Papal See toward beliefs which modern science has rejected as absurd, and toward institutions which the progress of civilization has abolished as injurious. In a recent review of Cesare Cantù's voluminous Universal History, the Jesuit Father Giuseppe Brunengo criticises this popular work from a Catholic point of view, and censures its deviations from the teachings of the Church.*

Cantù, now in the eighty-eighth year of his age, is himself a devout Catholic, and scrupulously abstained from reading any books condemned by the Congregation of the Index, however necessary they might be to his historical researches, until he had obtained permission from the Pope. He also submitted his History to the scrutiny of the aforesaid Congregation, and declared his willingness to expunge any passages that should not be regarded as strictly orthodox. Indeed, he performed this unpleasant and onerous task in 1867, and again in 1886, and won thereby the warm commendation of Leo XIII, formally expressed in an apostolical brief dated June 3, 1886. But the Holy Office, more papal than the Pope, was not satisfied with the expurgations that had been so gratifying to his Holiness.

In a series of articles first printed in the Civiltà Cattolica, and now republished in a separate volume, Brunengo re-examines Cantù's work, and, while praising in general the "Christian and catholic spirit" which pervades it, points out many statements and conclusions at variance with the doctrines of the Church. In the first place, he seems to think that no Catholic historian should record anything derogatory to the character of any pope; at least, he blames Cantù for not speaking well of Sergius III, John X, and John XI, notoriously licentious pontiffs of the tenth century, whose rule is known in ecclesiastical history as the pornocracy, and reproves him for not emphasizing the wickedness of Savonarola in opposing Alexander VI. On the other hand, no Catholic historian should praise a Protestant or a heretic; and in accordance with this principle Cantù is severely reprehended for admitting that Calvin was a man of pure morals and improved by his teaching and example the morals of the Swiss; that Scipio Ricci, Bishop of Pistoia, was "pious and learned"; that the Jansenists were not wholly devoid of good qualities; and that Döllinger was

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* Osservazioni sopra la storia universale di Cesare Cantù del P. Giuseppe Brunengo, D. C. D. G. Rome, 1891, pp. 150.

erudite and virtuous. Such concessions are marks of mental obtuseness or moral weakness, and ought never to be made.

Again, Cantù is censured for questioning the strictly historical character of hagiological narrations, and for assuming that many of the stories told of St. George, John of Neponuk, Hermenigilda, and other canonized persons, are mere legends; also for animadverting on some of the actions attributed to the saints as unworthy of holy men.

Cantù maintains that the Spanish, unlike the Roman Inquisition, was an institution not of the Church but of the state, and therefore feels himself more at liberty in describing and condemning its proceedings. Brunengo declares this view to be wholly untenable, and proves conclusively that the Inquisition in Spain was not a political but an ecclesiastical tribunal, created and conducted by the apostolical authority of the Pope in the interests of the Roman hierarchy.

Having settled this point, he asserts, in opposition to Cantù, that the Inquisition was an immense boon to Spain, and that whatever material loss may have been incurred by the expulsion of the Moors and other skillful and thrifty artisans was more than made good to the nation by the great treasure of religious unity which the Holy Office secured.

So, too, the right of the Pope to depose sovereigns and to absolve their subjects from allegiance rests upon the supreme and universal dominion conferred by Christ upon his vicar, and can not be changed by circumstances nor abrogated by human enactments. The same holds true of the temporal sovereignty of the Pope, which ungodly revolutions and sacrilegious usurpations may put temporarily in abeyance, but can never annul and permanently abolish.

Still more antagonistic to the enlightened spirit of the age is Brunengo's defense of the reality of witchcraft and diabolical possession as dogmas of the Catholic Church. He sharply rebukes Cantù for treating this belief as an "error," and adds: "There are one hundred and three papal bulls which served inquisitors as a rule of procedure in prosecutions for witchcraft, magic, and other sorceries. If the Popes, who published these edicts, had doubted even for a moment the truth and reality of the enormities ascribed to magic; if they had believed with Cantù or entertained the slightest suspicion that the belief in a direct intercourse of the devil with man is a mere fancy or illusion, they would have expressed themselves very differently in those bulls, and endeavored to explain to the faithful the vanity and inanity of all magic arts. But because they had no doubt of the reality of these things they used an entirely different language. Now, whom are we to believe—Cantù, who absolutely contests the actuality of witchcraft; or the popes, bishops, and synods that have unanimously, with the necessary limitations, established it as a Catholic doctrine?"

There are doubtless many sincere Catholics, like Cantù, who repudiate the belief in demoniacal possession, but Brunengo is unquestionably right in affirming that this view is opposed to the plain teaching and actual practice of the Church on this subject. Leo XIII is justly regarded as a man of more than ordinary intelligence, and more thoroughly imbued with the modern spirit than any of his predecessors, yet he composed and issued, November 19, 1890, a formula of *Exorcismus in Satanam et Angelos Apostatas* worthy of a place in any mediæval collection of conjurations. His Holiness never fails to repeat this exorcism in his daily prayers, and commends it to the bishops and other clergy as a potent means of warding off the attacks of Satan and of casting out devils. In 1849 the Bishop of Passau published a Manuale Benedictionum for the same purpose; and in 1851 there was printed at Munich, in Bavaria, a work entitled Rituale Ecclesiasticum ad usum clericorum ordinis S. Francisci, by Pater Franz Xaver Lohbauer, in which the theory of demoniacal possession is maintained, and the method to be pursued in such cases minutely prescribed—*Modus jurandi afflictos a dæmone.* The author of this ritual distinctly declares that nearly all so-called nervous diseases, hysteria, epilepsy, insanity, and milder forms of mental alienation, are either the direct result of diabolical agencies or attended and greatly aggravated by them. A sound mind in a sound body may make a man devil-proof, but Satan is quick to take advantage of the infirmities of men in order to get possession of their persons. The adversary is constantly lying in wait watching for and trying to produce physical derangements as breaches in the wall, through which he may rush in and capture the citadel of the soul. In all cases of this sort the priest is to be called in with the physician, and the medicines are to be blessed and sprinkled with holy water before being administered. Exorcisms and conjurations are not only to be spoken over the patient, but also to be written on slips of consecrated paper and applied, like a plaster, to the parts especially affected. The physician should keep himself supplied with these written exorcisms, to be used when it is impossible for a priest to be present. As with patent medicines, the public is warned against counterfeits, and no exorcism is genuine unless it is stamped with the seal of the bishop of the diocese. According to Father Lohbauer, the demon is the efficient cause of the malady, and there can be no cure until the evil one is cast out. This is the office of the priest; the physician then heals the physical disorder, repairing the damage done to the body, and, as it were, stopping the gaps with his drugs so as to prevent the demon from getting in again. Here we have an example of the reconciliation and harmonious co-operation of religion and science, which so many earnest thinkers of to-day are rather futilely striving after.

The latest expression of the views of the Catholic Church on demoniacal possession is contained in a pamphlet just printed at Munich, in which the casting out of a devil in Wernding is fully and officially reported by the exorcist himself, Father Aurelian, and the case "critically elucidated for the people" by Richard Treufels. (Die Teufelsaustreibung in Wernding. Nach dem Berichte des P. Aurelian für das Volk kritisch beleuchtet von Richard Treufels. München: Schuh & Cie., 1892. Pp. 14. Treufels is doubtless a pseudonym chosen by the author to indicate that his feet are planted on the rock of faith.)

The report itself is substantially as follows: On Shrove Tuesday, February 10, 1891, a boy, ten years of age, named Michael Zilk, the eldest son of a miller living near Wernding, in Bavaria, began to act in a very strange manner. He could not say his prayers nor hear another person pray without falling into fits of rage. The same effect was produced by the sight of a crucifix or of holy water, and by passing near a sacred shrine or a church. A physician was consulted, but without avail; equally ineffective were the benedictions pronounced by Parson Seitz, of Dürrwangen; finally, recourse was had to the capuchins of Wernding, where Father Aurelian took the case in hand, and, after a long process of spiritual or magical diagnosis, consisting in the utterance of various forms of benediction and incantation, declared that all the symptoms indicated demoniacal possession. This opinion was indorsed by the Right Reverend Bishop Pancratius, of Augsburg, who saw the boy May 12, 1891, and, "in the full consciousness of his episcopal power and dignity," called upon the unclean spirit to come out of him, but the obstinate imp refused to obey. At length, after special permission was obtained from Bishop Leopold, of Eichstadt, to whose diocese Wernding belongs, the ceremony of exorcism was solemnly performed.

We need not here enter into a detailed description of the hocus-pocus, which began on the morning of July 13th, and ended with the expulsion of the demon or demons (for there seem to have been ten of them) on the evening of the next day. So great was the strength imparted to the boy by the indwelling devils that half a dozen men could hardly carry him into the presbytery of the cloister church, where the conjuration was to be performed in the presence of the parents and a few friars and devout laymen. The results, however, were wholly unsatisfactory, and in the afternoon the scene of the ceremony was transferred to the choir of the church; but even then no response was elicited, until Father Aurelian threatened to bring in the monstrance and compel the demon to worship it. This was more than the devil could stand, and he cried out in a terrible rage, "The boy is possessed!" The good monk lays peculiar stress upon this incident, as furnishing conclusive proof of the real presence of Christ in the holy sacrament. Further interrogatories brought out the fact already mentioned, that the demons were ten in number, although the answers were always given in the first person singular and in the Bavarian dialect. Thus, when conjured to go out of the boy, the demon replied, "I mog net" (*Ich mag nicht;* I don't want to).

Father Aurelian, having now got the devil so far under control as to make him speak, felt sure of a brilliant success, and on the morning of July 14th threw the church open to the public. Wernding, it must be remembered, has not only a sulphur-bath for the periodical purging of the profane, but also a wonder-working shrine, to which thousands of pious pilgrims resort in order to be purified from sin. On this occasion the persons who filled the church were chiefly penitents of the latter class, and constituted a fit audience of eager and credulous witnesses fully in sympathy with Father Aurelian and the marvelous work he had undertaken to perform, howling, moaning, and praying, and wringing their hands as the priest went on with his exorcisms.

The following is the substance of the dialogue between the capuchin and the devil:

C. You must depart from the child; there is no help for you.

D. I can't.

C. Why can't you?

D. Because she is always banning.

C. Who is banning? Some woman?

D. Yes.

C. What is her name?

D. Herz.

On hearing this, the parents lifted up their arms and exclaimed, "She is our neighbor!"

C. Why did she send you into the child?

D. Because she was angry.

C. Had the child done her any harm?

D. No.

C. How long have you possessed the child?

D. Six months.

C. When are you going to get out?

D. I don't know.

C. Why don't you know?

D. Because this woman Herz keeps on banning, and so long as she does this I can't go.

This conversation, repeated again and again with slight variations, occupied the whole forenoon.

When the exorcism was resumed at one o'clock in the afternoon, the devil was evidently considerably dispirited; occasionally he roused himself and "tore" the boy, but less violently than before, and no longer showed his spite by spitting at the priest. After having gone through with the usual forms of conjuration with the cross, and having brought the magic power of the Host to bear upon the stubborn imp, the capuchin called upon him in the name of God, and the mother of God, and the holy archangel Michael, to say whether he would now depart, and received the answer uttered in a humble tone, "Yes." This question was repeated three times, with the same result. "The first time," says Father Aurelian, "that the devil expressed his willingness to go out of the boy, I conjured him not to enter into any of the persons present nor into any living creature, not even into the woman Herz, who had banned him into the boy, but to depart to the place which God had assigned him. After a short pause I put the question, 'Have you departed from the boy?' and received the answer, 'Yes.' 'And also your companions?' 'Yes.' 'For the third time I conjure you to tell the whole truth: have you and your companions departed from the boy?' 'Yes.' 'Where are you now?' 'In hell.' 'And your companions, too?' 'Yes.' 'In the name of the most holy Trinity, and this sign of the cross, I conjure you to confess whether you and your companions are really in hell!' 'Yes, we are in hell!' was the horrifying reply. And it really seemed as though the voice came from hell. In his former answers the demon had spoken in a sharp and insolent tone, but this last response was utterly subdued and extremely mournful."

Michael Zilk, thus freed from the unclean spirit, quietly kneeled before the altar, kissed the crucifix, partook of the holy sacrament, and devoutly repeated the *Pater noster* and *Ave Maria*. A *Te Deum* was sung at the high altar, and on the following morning a special service of thanksgiving, consisting of high mass with rosary, was held in recognition of the "mighty work" that had been so successfully accomplished.

To Father Aurelian's mind, such as it is, the cause of the demoniacal possession is perfectly clear, and he states his views without reserve. The father of the boy, he says, was a Catholic, and the mother a Protestant; they were married by a Protestant clergyman, and the children were educated in the Protestant faith. The father afterward repented of his grievous fault, and endeavored to repair it by sending his three children to a Catholic school. This step excited the anger of his Protestant neighbors, one of whom, a woman named Herz, took to cursing and banning, and sent the devil into the eldest child by giving him on Shrove Tuesday a quantity of dried pears (*Hutzeln*) to eat, over which the witch had doubtless muttered wicked spells. Fifty dried pears—and this is the number the boy is said to have eaten—one would think, might suffice to play the devil with his stomach, without supernatural aid or intervention. It is the old story: If the child suffers from a surfeit of sweetmeats, it is not the goodies, but the goody, who is at the bottom of it, and who must have sprinkled her gift with devil's powder in saccharine disguise, or manufactured the sugar-plums at midnight out of witches' butter.

We are further informed that the father, after frequent conferences with the capuchins, has made good his unfortunate marriage: the nuptial ceremony has been performed again according to the Catholic ritual, and the children have been rebaptized by a Catholic priest. The mother, too, has been persuaded to join the Catholic communion, or rather driven into the fold by the persecutions of a violently bigoted mother-in-law, who was evidently the real demon of the household.

A "mixed marriage," although recognized as legitimate by the law of the land, has never been regarded by the Church as just and valid, but is characterized in ecclesiastical legal terminology as *matrimonium legitimum sed non ratum*. It has been reserved, however, for Father Aurelian to discover that the offspring of such unions easily come under the influence of evil spirits, and are peculiarly liable to demoniacal possession.

As convincing proof of diabolic agency, the exorcist makes the following assertion: "When I sprinkled the possessed boy with holy water, he sprang toward me in rage; if I used ordinary water, he kept perfectly quiet. In like manner, when I uttered a prayer of the Church in Latin, he became furious; if I repeated a passage from a Latin classic, he remained perfectly calm." Besprinklings with the foul contents of an *aspercorium* might excite the wrath of even a gentler spirit than a goblin from Tartarus; and although it may be true, as a popular proverb asserts, that "the devil is an ass," he would also seem to be a good Latinist (a union of the twain is not so rare a phenomenon as the unlearned are apt to suppose), and a sensitive purist quick to detect and to resent any forms of expression less correct and elegant than strictly classical locutions. Unfortunately, however, for Father Aurelian's argument, another priest who examined the boy positively denies this statement, and declares that, when Michael Zilk was sprinkled with holy water secretly from behind, the indwelling devil gave no sign. In concluding his report, Father Aurelian uses the following strong language: "Whoever denies demoniacal possession in our days, confesses thereby that he has gone astray from the teaching of the Catholic Church; but he will believe in it when he himself is in the possession of the devil in hell. As for myself, I have the authority of two bishops."

It was formerly held by both Catholics and Protestants that unbaptized children were in the power of the devil, and the Catholic ritual still prescribes the following formula of exorcism, to be used before baptism: "I exorcise thee, unclean spirit, in the name of the Father, and the Son, and the Holy Ghost, that thou departest and goest forth from this servant of God; for he who walked on the sea, and extended his right hand to the sinking Peter, commands thee, O damned one! Therefore, accursed devil, know thy doom, and give honor to the living and true God, give honor to Jesus Christ and to the Holy Ghost, and go out of this servant of God, whom God and our Lord Jesus Christ have deigned to call by his grace and mercy to the fountain of baptism. [Here the priest makes the sign of the cross on the child's forehead with his thumb.] And this sign of the cross which we place on his forehead, thou accursed devil shalt never dare to violate."

It is stated on good authority that ninety-nine out of one hundred of the peasants in Wernding and the adjacent country believe in witchcraft, and are wont to attribute murrain and marasmus and all kinds of pestilence to this cause. To their minds epidemiology finds its simple and satisfactory solution in demonology. It is also an interesting fact illustrating the local persistence of superstition that the people of this region were notorious three centuries ago for the zeal and cruelty with which they persecuted and prosecuted witches. Thirty-five old crones were burned as witches in Nördlingen between 1590 and 1594, and equal ardor was shown in Neuburg and other towns on the Danube. One "witch," Maria Holl, was put to the torture fifty-six times without extorting a confession, and escaped further racking only through the intervention of Ulm, her native city. Had the woman Herz lived in those times she would have been unquestionably the food of fagots. She has the reputation of being an estimable person, and her husband has brought a suit for slander before the court at Anspach.

The author of the pamphlet in which Father Aurelian's report is embodied does not maintain that Michael Zilk was actually possessed; on the contrary, he is inclined to think that Father Aurelian may have been deceived. What he strenuously insists upon, however, is the reality of demoniacal possession, which, he affirms, can not be questioned by any Catholic or Protestant or Jew who believes in the truth of his Holy Scriptures. "It is an incontestable fact, confirmed by the traditions of all nations of ancient and modern times, by the unequivocal testimony of the Old and New Testaments, and by the teaching and practice of the Catholic Church." The criterion, *quod semper, quod ubique, quod* *ab omnibus*, he thinks, applies here with peculiar force and fitness, for there is no philosophical or theological tenet resting upon a broader basis of universal consent. Christ, he says, gave his disciples power and authority over all devils to cast them out, and this same power is conferred upon every priest by his consecration, although he is never to exercise it without the permission of the bishop.

Incidents like that which took place at Wernding have been of comparatively frequent occurrence even in recent times. In cloistral and episcopal archives there are many records of this sort that have never excited public sensation because they were not reported by the press. In 1842 a devil named Ro-ro-ro-ro took possession of "a maiden of angelic beauty" in Luxemburg, and was cast out by Bishop Laurentius. This demon claimed to be one of the archangels expelled from heaven, and appears to have rivaled Parson Stöcker in antisemitic animosity. When the name of Jesus was mentioned, he cried out derisively: "O that Jew! Didn't he have to drink gall?" When commanded to depart, he begged that he might go into some Jew. The bishop, however, refused to give him leave and bade him "go to hell," which he forthwith did, "moaning as he went, in melancholy tones, that seemed to issue from the bowels of the earth, 'Burning, burning, everlastingly burning in hell!' The voice was so sad," adds the bishop, "that we should all have wept for sheer compassion, had we not known that it was the devil."

A more recent case in point is that of a lay brother connected with an educational institute in Rome, who on January 3, 1887, became diabolically possessed, and was exorcised by Father Jordan. In this instance the leading spirit was Lucifer himself, attended by a host of satellites, of whom Lignifex, Latibor, Monitor, Sefilie, Shulium, Ritu, Haijunikel, Exaltor, and Reromfex were the most important. It took about an hour and a half to cast out these demons the first time, but they renewed their assaults on February 10th, 11th, and 17th, and were not completely discomfited and driven back into the infernal regions until February 23d, and then only by using the water of Lourdes, which, as Father Jordan states, acted upon them like poison, causing them to writhe to and fro. Lucifer was especially rude and saucy in his remarks. Thus, for example, when Father Jordan said, "Every knee in heaven and on the earth and under the earth shall bow to the name of Jesus," the fallen "Son of the Morning" retorted, "Not Luci, not Luci—never!"

It would be easy to multiply authentic and official reports of things of this sort that have happened within the memory of the present generation; but they all offer in the main the same features, being characterized by grossness and grotesqueness, wi singular poverty of imagination, and would be rather monotonous and unedifying reading.

The principal signs of demoniacal possession, as given in ecclesiastical and most fully in monastic rituals, are the ability to speak or to understand foreign tongues unknown to the possessed, to tell where objects are hidden (like a mind-reader), the exhibition of supernatural bodily strength, intense aversion to holy places and to consecrated objects and persons, and the power of moving through space in defiance of the laws of gravitation.

A boy, who showed all these symptoms, was brought to Parson Kneipp, a Catholic priest, who has a much-frequented hydropathic establishment in Bavaria. Two priests had already declared the boy to be possessed, and had tried to exorcise him, but without effect. Parson Kneipp, who had learned to look upon phenomena with medical rather than with theological eyes, took a rational view of the case, and by a sytematic water-cure treatment healed the patient in six weeks.

It is true that the devil has been eliminated from the passion play at Oberammergau, in which he once took a prominent part, and amused the public by his clownish tricks. This change has been cited in proof of the progress of enlightenment among the peasants of the Bavarian highlands. No inference could be more incorrect. The devil disappeared from the stage, much against the will of the Oberammergauers, in 1810, by command of the Bavarian Government, which refused to permit a further representation of the play except on this condition. The text was then thoroughly revised and the performance remodeled by Dr. Ottmar Weiss, and Satan utterly banished from the scenes. The mass of the peasantry, nevertheless, believe in the devil and the reality of diabolic interference in human affairs as firmly as ever.

Modern science is doubtless doing a great work in diminishing the realm of superstition; but there are vast low-lying plains of humanity that have not yet felt its beneficent influence. "The schoolmaster is abroad"; but where he wears the cassock or the cowl, or is placed under strict clerical supervision, as the recent Prussian Education Bill proposed to do, the progress of intelligence in the direction indicated will be exceeding slow.

Mr. C. W. Kempton remarks, in Science, that on a study of Schiaparelli's chart of Mars the systems of "canals" resolve themselves, in many cases, into groups of six, making hexagons, and giving the idea that the planet may be solidified into a mass, with tendency to hexagonal crystallization—the canals, for instance, being fissures on the lines of the angles of crystallization. This would account for many of the peculiarities of their appearance, while in no way opposing the present existence of atmosphere, water, snow, ice, and vegetation on the planet.

[redacted]

CONTOUR AND GLACIAL MAP
OF THE
BRITISH ISLES
SCALE OF MILES
0 20 40 60 80 100
ELEVATIONS.
From Sea Level to 250 Feet.
250 to 500 Feet.
500 to 2,000 Feet.
Above 2,000 Feet.
Track of Lake District Rocks other than Shap Granite.
Track of Ailsa Craig Granite.
Moray Firth
20 FATHOM LINE
Longitude West from Greenwich

RECENT GLACIAL DISCOVERIES IN ENGLAND.

THE accompanying map, prepared for Prof. Wright's new work on Man and the Glacial Period from data furnished by the latest investigations in Great Britain, embodies a vast amount of information, and for the most part tells its own story. It is largely the outcome of the work of the late Prof. Carvill Lewis, whose untimely death left his large collection of English notes still unpublished. But, in response to the interest aroused by him, a society embracing the most active geologists of northern England was formed to follow out and complete his work. The president of this society is Prof. Percy F. Kendall, now of Leeds, who prepared the chapter on the glacial geology of Great Britain for Prof. Wright's book, and who has furnished the principal data for the construction of this map. We are glad to be informed also that the field notes of Prof. Lewis, under the joint editorship of Rev. Dr. Crosskey, of Birmingham, and Prof. Kendall, are soon to be published by Mrs. Lewis in England.

Prof. Lewis was the first one to attempt a careful delineation of the boundary of glacial action in England and Ireland, as he was one of the first to do this work in the United States. Soon after Profs. Cook and Smock, of New Jersey, had published their map of the terminal moraine in New Jersey, Profs. Lewis and Wright took up the task of following it out through Pennsylvania. The results of their work there are embodied in Volume Z of the Geological Report of that State. Upon completing this work the two professors, by previous arrangement, divided the work of exploration—Prof. Wright carefully surveying the line westward to the Mississippi River, and with more or less care to Alaska, while Prof. Lewis went to England to do the work of which we have spoken there. Last year Prof. Wright also went to England, at the request of those who were following up Prof. Lewis's work there, and went over a large part of the most important ground under their lead; hence an unusual degree of confidence can be placed in the results which have been for the first time systematically presented in this map and the accompanying description. Space will permit us to give but the very briefest summary of the conclusions respecting English glacial geology, some of which are really revolutionary.

In the first place the investigations demonstrate beyond controversy that the glacial phenomena in the British Isles are the product of land ice, and not of floating ice. This may not seem very important to American geologists, who are all of one mind, but in England it means a good deal, where there are many who still cling to the old idea that icebergs and not glaciers were the agency which scored the rocks and distributed the bowlders over the island. In the second place, these investigations have explained away, in a very complete and satisfactory manner, the evidence which had been supposed to prove that there was a submergence of the northern part of England and Wales during an interglacial period amounting to fourteen hundred or two thousand feet.

This evidence consisted of shell-beds inclosed in true glacial deposits eleven hundred feet above the sea at Macclesfield, near Manchester, and fourteen hundred feet above the sea at Moel Tryfaen, on the northern flanks of Snowdon, in Wales. Prof. Lewis, and those who have followed out the clews which he started, have proved that these shell-beds were not direct deposits during a submergence of the country, but rather beds washed out of true glacial deposits which had been shoved along by the ice in its passage over the bottom of the Irish Sea. The shells were pushed up with the mud from the sea-bottom, as pebbles are known to have been in so many instances. The melting of the ice furnished the water necessary for partially working over the original deposit and sorting out and stratifying the inclosed gravel and shells.

The demonstration of this theory of Prof. Lewis consists in showing that the deposits of shells are limited to those portions of the glaciated area which can be proved, by the transported bowlders, to have been overrun by ice which passed over the sea-bottom. Over this area shells are more or less mingled with the till, or bowlder clay, just as pebbles are, and limited beds of gravel and shells are of frequent occurrence, though the shells for the most part are very much broken up. An additional point of evidence of great weight is found in the fact that the shells are not such as would collect in the same place under water. In these beds rock-haunting and mud-loving species, and shallow-water and deep-water species are indiscriminately mingled together.

The course of ice movement is clearly shown on the map by the lines indicated in the transportation of bowlders. Briefly stated, the movements were as follows: Scandinavian ice flowed westward over the shallow basin of the German Ocean until it reached the coast of England from Flamborough Head to the latitude of London. It was warded off from Scotland and the northern coast of England by the glaciers which had preoccupied that region. Scandinavian bowlders are found scattered over the eastern counties of England, and there is evidence that the ice from that direction penetrated to the vicinity of London and up nearly to the head-waters of the Ouse and of the South Branch of the Humber. Meanwhile a glacial movement had been in progress from the mountains of Wales, reaching eastward to Birmingham. But the two movements did not quite join. An unglaciated area was left between.

During all this time the Irish Sea was slowly filling up with the ice which was shed from the mountains of northern England, southwestern Scotland, and Ireland. This finally reached the obstruction presented by the mountains of Wales and divided—one branch of the ice-current going southwestward along the channel of the Irish Sea, and the other southeastward through the vale of Chester into the upper part of the Severn Valley. The bowlders transported by this movement are distributed down to a very definite line as marked in the map, and they overlie those from the Welsh mountains. It is in this area, containing bowlders from the lake district and southwestern Scotland, and in that covered with Scandinavian ice, that shells are found in the glacial deposits. Over the uncolored portion of the map and outside the limits of these two movements there is nothing to suggest a glacial or interglacial submergence. For a popular but full and comprehensive statement of the facts in the case the reader must consult Prof. Kendall's chapter in the volume from which we are permitted to copy this extremely interesting map.

CANINE MORALS AND MANNERS.

By LOUIS ROBINSON.

IT is always interesting to trace the various habits and attributes of our domestic animals which form the bond of their association with us back to their natural origin. In doing so we can hardly fail to reach some suggestive inferences which bear upon our own early history as well as upon that of the animals we study.

Most of our dumb companions and helpers have become modified by changing circumstances since the partnership began even more than ourselves, and have become partakers with us of the advantages and disadvantages of our civilization. This is especially so in the case of the dog, man's closest associate and earliest ally. The many who happily respond to his affectionate and loyal service by regarding him as worthy of the consideration of a valued friend will, it is hoped, follow with pleasure a few thoughts here put forward which have arisen from a study of the habits that now characterize him as compared with those of his wild relatives.

We must remember that although the dog is now our friend, with interests in the main in harmony with ours, he was not always so. The wild dog and wild man might have been chance allies when, for instance, a fatigued quarry pursued by the pack was struck down by a flint weapon, and the greater part of the carcass left to the original hunters; or when a wounded animal escaped its human foe to be followed up and devoured by the dogs. But, as a rule, the interests of dog and man would be conflicting, as is still the case where wild dogs exist, such as the dingoes of Australia, the dholes of India, and the hyena-like wild dogs of central and southern Africa.

It must be borne in mind that in dealing with these primitive canine creatures the word "dog" is used in its widest sense, and must include such animals as wolves and jackals, which undoubtedly share in the ancestry of our familiar domestic breeds.

Probably the partnership first began through small, helpless whelps being brought home by the early hunters, and being afterward cared for and brought up by the women and children. The indifference with which almost all savages regard their dogs seems to negative the idea that primitive man took the trouble to tame and train adult wild animals of this kind for his own purposes. The young dog would form one of the family, and would unconsciously regard himself as such. The reason why he should so regard himself will be discussed later when we come to consider the probable canine view of the relationship.

It would soon be found that his hunting instinct was of use to his captors, for while wandering abroad with them his keen nose would detect the presence of hidden game when the eyes of his savage masters failed to perceive it; and when a wounded animal dashed away, his speed and instinct for following a trail by scent would often secure what would otherwise have been lost. The dog in his turn would find an easier living and a better shelter while associated with man than if he were hunting on his own account, and thus the compact would be cemented by mutual benefits.

Now let us consider why the dog should so readily fall into the position of the companion and subordinate of man. What "stock and good-will" did he bring into the partnership besides his swiftness and powers of scenting and seizing his quarry? Let us look for a moment at his life at home as apart from his duties while hunting. In the first place, he evidently regards the dwelling of his master as his own place of abode in which he has certain vested interests, and, while he is complaisant and submissive to the regular inhabitants, he looks upon strangers of all kinds with suspicion, and regards their intrusion as an infringement of his rights or of his rudimentary sense of what is lawful. Although watch-dogs have doubtless been valued for many generations, and their distinctive qualities cultivated by artificial selection, it seems clear that here we are dealing with an original instinct.

The pariah dogs of Constantinople and other Eastern cities, which are practically as untamed as their fellow-scavengers the vultures, crows, and jackals, and which probably have only in the slightest degree ever come under direct human influence, have the same habit.

Each street is the recognized dwelling-place of an irregular pack, and dogs—and in some cases even men—from other quarters are warned off or attacked if they cross the boundary.

It is said also that the wild dogs of India will drive off a tiger if he strays into the neighborhood of their chosen habitat. Even tame wolves will, without being taught, threaten a stranger if he comes near their master's house, but will take no notice of the coming and going of the regular inmates.

It would seem, therefore, that the watch-dog's peculiar virtue is directly traceable to the old instinct for guarding the lair of the pack. And in following this instinct the dog indicates that it is not his custom to act single-handed. The very fact that he growls or barks at a stranger shows that a vocal intimation to his fellows of the presence of a possible enemy is part of his plan. Every one has noticed that the barking of one dog will set off others within hearing, so that on a still night an alarm at one spot will disturb a whole suburb. Although no wolves or wild dogs are known to bark in the true canine manner, it is impossible to imagine that so distinct and almost universal a habit of the domestic varieties can have been deliberately initiated by man. Several instances are recorded of Eskimo dogs, and even dingoes and wolves, learning to bark by spontaneous imitation of domestic dogs. Foxes make a noise very like barking when they challenge one another among the hills at night, and it is not difficult to provoke an answer by imitating the sound under appropriate conditions. It seems probable, therefore, that the common ancestor of our domestic dogs and their wild relatives, which no doubt lived under somewhat different conditions from any modern feral creatures of the kind, was a barking animal.

As I have already said, the very fact that the dog barks when alarmed is an indication that he is a creature of gregarious instincts, and that he is accustomed to act in concert with others. The sound is a signal to his comrades as well as a threat to the intruder. If this be not so, what can be the meaning and intention of the different tones he adopts according to the nature of the provocation, which are capable of conveying to ears afar off an idea of the measure and nearness of the danger?

Most of our domestic animals, and all which act under our orders and give us willing obedience, are gregarious in their habits when in the wild state. A little thought will show that many of the qualities for which we prize them are dependent upon this fact, and that we are the gainers by turning to our own use the stock of tribal virtues and morals which they bring with them into our service, just in the same way as we gain by appropriating the winter food-store of the bees, and the supply of starch and gluten laid up for future use by many plants. An animal of a troop has perforce certain social duties and obligations, which, as can be shown, are necessary for his own existence as well as for the welfare of the community. He must learn to give and take, and be prepared to follow and obey the members of greater capacity and experience. It is essential that he should be of a peaceable disposition, as a general rule, among his mates, so as to preserve the harmony of the band; since a pack of dogs, like a house, divided against itself will soon prove its unfitness, and be eliminated according to law. He must also be prepared to stand by his fellows, defend them or any of them if attacked, and warn them if danger approaches.

Seeing that most wild animals of the canine tribe prey upon quarry swifter and larger than themselves, their common welfare depends upon systematic and intelligent co-operation. A single hound following a trail by scent, will frequently be at a loss; for every now and then it will overrun and miss the line; but when several are together this will seldom happen, and the pace of the pursuit will consequently be much greater and the chance of a meal more certain. In searching for prey it is necessary for the pack to separate, so as to range a wider area, but the instant a "find" takes place it is important that all should be informed at once, so that a united pursuit may be taken up while the scent is warm. Among all hounds and many wild dogs the signal is given by the voice, but, as will be shown later, the dog has another and very perfect method of signaling in addition to this. For the canine tail, when considered philosophically, turns out to be nothing but an animated semaphore, by means of which important news can be telegraphed to the rest of the pack, in much the same way as messages are exchanged between different detachments of an army by the modern development of military signaling, popularly known as "flag-wagging."

Of course, in hunting all large and swift animals, a great deal can be done by strategy, and this involves a common plan of action often of an elaborate kind, and the giving and taking of orders by the leaders and other members of the band respectively. The value of quick perception and general intelligence, as well as of a readiness to co-operate, here at once become apparent, for without these qualities no such combination could be successfully carried out. Again, when the prey is within reach, it often requires the united efforts of the whole pack, acting intelligently in concert, to pull it down. If a number of wolves or wild dogs were scattered over a district, each acting for himself independently, as cats do, large animals, such as the elk or bison, would be of no use to them as articles of diet, and they might starve in the midst of plenty. But if they combine and act under the guidance of experienced leaders they can at once utilize what would else be, in canine economy, a waste product.

As has been pointed out, this needful co-operation at once involves the elements of politics and morals. The obedience of the young and inexperienced to their leaders, and the observance of certain rules of conduct, are a *sine qua non* of the success of any strategic combination.

It follows, therefore, that the young of gregarious animals of all kinds, and especially those of this type, are submissive and teachable, and have thus the very qualities we desire in creatures which are to be trained for our special use. In fact, we have here the natural basis for that docility and readiness to obey which is such a noticeable and invaluable characteristic in dogs as we know them.

They must also be faithful to their fellows in word and deed. A hound which gives tongue when he has no quarry before him (and such canine liars are not unknown, as any huntsman will testify) may spoil a day's hunt and send the whole pack supperless to bed. It is interesting and amusing to observe the evident contempt with which the hounds of a pack regard an untruthful member. His failing becomes perfectly well known, and, let him bay as he will, not one of his companions will rush to the spot as they do the moment they hear the slightest whimper from a trusted and experienced finder.

Loyalty to one another is also a virtue which can not be done without. Thus we see that, however great the emulation between the individual members of the band, while the hunt is on it is kept strictly within bounds, and is subordinated to the common purpose. It is only after the game is captured and killed that contests of individuals for a share of the plunder commence. The very fact that an invitation is given to join in the pursuit as soon as the quarry is started, instead of the finder stealing off after it on his own account, is an illustration of this; and if one of the pack is attacked by the hunted animal at bay or by an enemy, his howls and excited outcry are instantly responded to by all within hearing.

Every one has noticed the uncontrollable power of this instinct when the yells and shrieks of a canine street brawl are heard. Dogs from all sides rush to the spot and immediately take part in the quarrel. The result generally is a confused free fight of a very irregular description, and each dog is apparently ready to bite any of the others. It will easily be seen that this confusion is owing to a disarrangement of natural politics, caused by the disturbing and arbitrary influence of human institutions. If two of the combatants happen to be comrades, they will hold together and treat all the rest as enemies. In the wild state the sounds of strife would mean either a faction fight, or a combat with some powerful enemy of the pack, and probably in the former case every dog within hearing would be a member of one or other of the contending parties. By adopting dogs into our families and separating them from their fellows we upset canine political economy in many ways; but still the old loyal instinct to rush to the support of supposed friends in distress is so strong that a ladies' pug has been known to spring from a carriage to take part in a scrimmage between two large collies.

Among wild dogs the prosperity of the community might be fatally impaired by a lapse of this instinctive loyalty. All who have had to do with hounds know that every pack contains certain individuals whose special talents are invaluable to the rest. Generally one or two of a pack of beagles do most of the finding when driving rabbits in the furze, and in the case of a lost trail another individual will be, as a rule, the successful one in making skillful casts forward to pick up the line of scent. Another, again, will possess quicker vision and greater swiftness in running than the others, and the instant the game comes into view will cease the more tedious method of following, and dash forward at full speed to seize it.

Among wild dogs pursuing large and powerful game, the need and scope for such specialists would be even greater and more important. If one of these were lost through not being well backed up in time of peril, the whole pack would be the sufferers in a very material degree; for it would often fail to start, or lose during pursuit, some animal which might otherwise have been captured.

The study of this communal canine morality is very interesting when considered along with Mr. Herbert Spencer's theories of ethics. It is here dwelt upon, however, merely to explain, on scientific principles, many traits of our domestic dogs which (as is too commonly the case with those who receive benefits) we are liable to profit by and take for granted.

The great naturalist Cuvier observed that all animals that readily enter into domestication consider man as a member of their own society and thus fulfill their instinct of association. The probable view of the fox-terrier or the dachshund which lies upon our hearth-rug, therefore, is that he is one of a pack the other members of which are the human inhabitants of the house.

Most interesting would it be, were it possible, to get the dog's precise view of the situation. The chief bar to our doing so is owing to the difficulty of putting our human minds, even in imagination, within the restricting limits of the canine thinking apparatus. Thus we constantly see, when anecdotes of the cleverness of dogs are told, that the narrator is quite unable, in estimating the supposed motives and mental processes, to get out of himself sufficiently to escape the inveterate tendency to anthropomorphism; and he almost invariably gives the dog credit for faculties which it is very doubtful if it possesses. When we come to consider how few persons have that power of imaginative sympathy with their own kind which enables us to see to some extent through another's mental spectacles, it is no matter of surprise that a human being should generally fail in trying to think like a dog.

Thinking, after all, is, like flying, an organic process, dependent in every case on actual physical machinery; and dissimilarity of brain structure therefore absolutely precludes us from seeing eye to eye, mentally, with the lower animals.

But this structural difference of brain with its inevitable consequences, although it balks us in one way, comes to our aid in another. As has been said, our custom of ascribing human faculties and modes of thought is an involuntary and invariable one when we are dealing with the mental processes of other beings. Even when we speak of the supernatural the same habit is manifest, and human passions, emotions, and weaknesses are constantly ascribed to beings presumed to be infinitely more remote from us in power and knowledge than we are from the dog. Thus we see in the not very distant past, roasted flesh and fruits were thought by men to be acceptable to the gods; doubtless because they were pleasing to the palates of the worshipers, who reasoned by analogy from the known to the unknown. This should teach us to bear in mind that there is, affecting the dog's point of view, almost undoubtedly such a thing as *cynomorphism*, and that he has his peculiar and limited ideas of life and range of mental vision, and therefore perforce makes his artificial surroundings square with them. It has been said that a man stands to his dog in the position of a god; but when we consider that our own conceptions of deity lead us to the general idea of an enormously powerful and omniscient *Man*, who loves, hates, desires, rewards, and punishes, in human-like fashion, it involves no strain of imagination to conceive that from the dog's point of view his master is an elongated and abnormally cunning dog; of different shape and manners certainly to the common run of dogs, yet canine in his essential nature.

The more one considers the matter the more probable does this view become. If we, with our much wider range of mental vision, and infinitely greater imaginative grasp of remote possibilities, the result of our reading and experience, are still bound by the tether of our own brain limits to anthropomorphic criteria when endeavoring to analyze superhuman existences, still more is it likely that the dog, with his mere chink of an outlook on the small world around him, is completely hedged in by canine notions and standards when his mind has to deal with creatures of higher and mysterious attributes.

At any rate, it will not be difficult to show that the dog's habits are generally consistent with this hypothesis. As far as mental contact is concerned, he treats his master and the human members of the household as his comrades, and behaves in many ways as if he were at home with the pack. Thus all the tribal virtues previously mentioned come into play. He guards the common lair and becomes a watch-dog, and by his barking calls his adopted brethren to his aid. He submits readily to the rules of the house because an animal belonging to a community must be prepared to abide by certain laws which exist for the common good. He defends his master if attacked—or, possibly, if not a courageous dog, gets up a vehement alarum to call others to his aid—because he has an instinctive knowledge of the importance of loyalty to a comrade, and because, as has been shown, loyalty to a leader is especially necessary. He is ready in understanding and obeying orders, owing to the fact that, when acting in concert with wild companions, it was absolutely needful that the young and inexperienced should comprehend and fall in with the purpose of the more intelligent veterans. The same ancestral habits and tendencies render him helpful as a sporting dog, and in herding or driving sheep and cattle. This last employment is very much like a mild kind of hunting, under certain special rules and restrictions, and with the killing left out. It has been observed that the Indian dholes will patiently and slowly drive wild animals in the direction of their habitat during their breeding season before killing them, so as to have the meat close at home; and this could only be accomplished by the whole pack exercising a patient self-control, and by the leaders constantly keeping in check the fierce impulse of the younger members to rush in and kill the weary and bewildered quarry.

The peaceable disposition and readiness to submit to discipline are also tribal virtues of which we take advantage. The dog, when he slinks away with drooping tail when reproved, or rolls abjectly over on his back and lies, paws upward, a picture of complete submission, is still behaving to his master as his wild forefather did to the magisterial leaders of the troop, or a victorious foe of his own species.

Jesse states that when a pariah dog of one of the Eastern cities desires to pass through a district inhabited by another pack, he skulks along in the humblest fashion, with his tail depressed to the utmost, and, on being challenged, rolls over, and there remains, limp and supine, submissively awaiting leave to proceed. The same thing can be observed when a large and fierce dog makes a dash at a young and timid one. This expressive and unmistakable method of showing submission is calculated to disarm hostile feelings, and contributes to peace and harmony, and therefore to the unity and prosperity of the body politic.

Although it would seem that the canine imagination from its very feebleness transforms man into a dog, yet, as we should expect, arguing from the cynomorphic hypothesis, it does not stop here. In Darwin's most interesting account of the shepherd dogs of the Argentine, given in Chapter VIII of his Voyage of the Beagle, he shows that, by a careful system of training, the herdsmen have taught the dogs to regard their charges as fellows of the same pack with themselves; insomuch that a single dog, although he will flee from an enemy if alone, will, as soon as he reaches the flock to which he is attached, turn and face any odds, evidently with the notion that the helpless and frightened sheep ranged behind him are able to back him up just as if they were members of a canine community of which he was leader. The passage is too long for quotation, but all who are interested in the subject should refer to it.

An instance of the operation of the cynomorphic idea can be seen in the behavior of a dog when a bone is given to him. He will generally run off with it to some quiet spot, and is supicious of every one who comes near him, evidently having the notion that what is to him a valuable possession is likely to be regarded as such by his human associates. Few dogs when gnawing a bone will allow even their masters to approach without showing signs of displeasure, and a fear of being dispossessed of their property, only consistent with the idea that the bipedal "dog" wants to gnaw the bone himself.

Every one has noticed the elaborate preliminaries which go before a canine battle. Teeth are ostentatiously displayed, the animals walk on tiptoe round one another, and erect the hair on their backs as if each wished to give the impression that he was a very large and formidable dog, and one not to be encountered with impunity. Frequently hostilities go no further than this, and one turns and retires with a great show of dignity, but plainly with no wish to fight.

When we come to analyze these proceedings, it will be seen that the ends of battle are often gained in a bloodless manner by this diplomatic exhibition of warlike preparations and capabilities.

The primary object of a hostile meeting between dogs (as well as between higher animals) is to decide a question of precedence, either general or particular. Now, if we could only settle which was the best man in any dispute by duels *à outrance*, a great deal of blood would be shed unnecessarily, and many valuable lives lost to the community. The introduction of moral weapons is therefore a great point gained, for injury to one is injury to all. The quick recognition of the superiority of a foe, and the perception of when submission should take the place of valor, is plainly of advantage to the individual, since a pig-headed obstinacy in resistance would frequently lead to elimination. Where in the serious business of life there is an interdependence of individuals associated for common ends, any influence which lessens the severity of internecine conflicts tends to the general well-being. Just as commanding officers have forbidden duels between members of an army in the field, so Nature has among gregarious animals, and especially those of predatory habits, discountenanced strife which might weaken the general efficiency of the pack.

Few animals excel the dog in the power of expressing emotion. This power is a sure sign of an animal which is habitually in communication with its fellows for certain common ends. Although probably long association with and selection by man have accentuated this faculty, a considerable share of it was undoubtedly there from the beginning, and was of service long before the first dog was domesticated. It is easy to see how important it is for the general good that the emotions of any one member of a pack of dogs should be known to the others. If, for instance, one of the number should perceive an enemy, such as a snake or leopard, lying in ambush, his rapid retreat with depressed tail would instantly warn the others of the danger.

There are many reasons for the tail being the chief organ of expression among dogs. They have but little facial expression beyond the lifting of the lip to show the teeth and the dilatation of the pupil of the eye when angry. The jaws and contiguous parts are too much specialized for the serious business of seizing prey to be fitted for such purposes, as they are in man. With dogs which hunt by scent the head is necessarily carried low, and is therefore not plainly visible except to those close by. But in the case of all hunting dogs, such as fox-hounds, or wolves which pack together, the tail is carried aloft, and is very free in movement. It is also frequently rendered more conspicuous by the tip being white, and this is almost invariably the case when the hounds are of mixed color. When ranging the long grass of the prairie or jungle, the raised tips of the tails would often be all that an individual member of the band would see of his fellows. There is no doubt that hounds habitually watch the tails of those in front of them when drawing a covert. If a faint drag is detected suggestive of the presence of a fox, but scarcely sufficient to be sworn to vocally, the tail of the finder is at once set in motion, and the warmer the scent the quicker does it wag. Others seeing the signal instantly join the first, and there is an assemblage of waving tails before ever the least whimper is heard. Should the drag prove a doubtful one, the hounds separate again and the waving ceases; but if it grows stronger when followed up, the wagging becomes more and more emphatic, until one after another the hounds begin to whine and give tongue, and stream off in Indian file along the line of scent. When the pack is at full cry upon a strong scent the tails cease to wave, but are carried aloft in full view.

The whole question of tail-wagging is a very interesting one. All dogs wag their tails when pleased, and the movement is generally understood by their human associates as an intimation that they are happy. But when we attempt to discover the reason why pleasure should be expressed in this way, the explanation appears at first a very difficult one. All physical attributes of living beings are, upon the evolutionary hypothesis, traceable to some actual need, past or present. The old and delightfully conclusive dictum that things are as they are because they were made so at the beginning no longer can be put forward seriously outside the pulpit or the nursery. No doubt, in many cases, as, for instance, the origin of human laughter, the mystery seems unfathomable. But this only results from our defective knowledge of data upon which to build the bridge of deductive argument. The reason is there all the time could we but reach it; and almost daily we are able to account for mysterious and apparently anomalous phenomena which utterly baffled our predecessors.

Probably the manner in which domestic dogs express pleasure is owing to some interlocking of the machinery of cognate ideas. In order to understand this better it may be helpful to consider some analogous instances with regard to habits of our own species.

One of the most philosophical of living physicians, Dr. Lauder Brunton, has clearly and amusingly shown that the instinctive delight and eagerness with which a medical man traces an obscure disease step by step to its primary cause and then enters into combat with it, is referable to the hunter's joy in pursuit, which doubtless characterized our savage ancestors when they patiently tracked their prey to its lair and slew it for glory or for sustenance.*

Mr. Grant Allen, I believe, first suggested that our apprecia-

* The Method of Zadig in Medicine, p. 5. Macmillan & Co. 1892.

tion of bright and beautiful colors, and therefore of the splendors of the flower garden or of the sunset tints in the sky, might be owing to the frugivorous habits of our very early progenitors, to whom the sight of red or golden ripe fruit was naturally one of acute pleasure. Supporting this startling inference (which is perhaps not so far-fetched as appears at first sight) is the very curious fact that occasionally, when we feel an acute thrill of pleasure from looking at a beautiful picture, or sunset, or indeed any harmonious combination of color which gives exquisite enjoyment through the eye, the salivary glands appear to be automatically stimulated, and "our mouths water" while we look. It is as if the old track of an out-of-date reflex between the part of the eye which takes account of color and the mouth—proceeding *via* what may be called the "pleasure centers"—were still open in spite of many centuries of disuse.

Another apposite illustration is the delight we derive from all manner of contests of wits and muscles, so that all our games, from whist to football, partake of the nature of strife for the mastery. A game is of course a systematic and recognized method of obtaining pleasure, and if we take a survey of all the most popular forms of enjoyment of this kind, we shall find that none of them are free from the element of that struggle for supremacy which has been a chief factor in the evolution of the human race, especially throughout the ages of barbarism.

Now if arboreal man took delight in discovering and devouring luscious and gorgeous fruits, and savage man in finding and hunting down wild animals, and barbarous man in fighting his rivals or the foes of his tribe—and all these ancient habits leave an impress upon our modern ways of seeking and showing pleasure—we can see that the dog's manner of manifesting pleasurable emotions may be traceable to certain necessary accompaniments of remote wild habits of self-maintenance.

As with man, so with the dog: civilization has made existence much more complex. The sources of pleasure of the savage man are few compared with those of the cultured and civilized, yet we find that the means of expression which we possess are but elaborations of those existing long before civilization began. We must, therefore, look at the dog's past history and find out what were his most acute pleasures, and what the gestures accompanying them, when he was a pure and simple wild beast, if we wish to elucidate his manner of expressing pleasure now.

There can be no question that the chief delight of wild dogs, as with modern hounds and sporting dogs, is in the chase and its accompanying excitement and consequences. One of the most thrilling moments to the human hunter (and doubtless to the canine), and one big with that most poignant of all delights, anticipation of pleasurable excitement combined with muscular activity, is when the presence of game is first detected. As we have seen in watching the behavior in a pack of fox-hounds, this is invariably the time when tails are wagged for the common good. The wagging is an almost invariable accompaniment of this form of pleasure, which is one of the chiefest among the agreeable emotions when in the wild state. Owing to some inosculation of the nervous mechanism, which at present we can not unravel, the association of pleasure and wagging has become so inseparable that the movement of the tail follows the emotion, whatever may call it forth.

An explanation of a similar kind can be found for the fact that dogs depress their tails when threatened or scolded. When running away the tail would be the part nearest the pursuer, and therefore most likely to be seized. It was therefore securely tucked away between the hind legs. The act of running away is naturally closely associated with the emotion of fear, and therefore this gesture of putting the tail between the legs becomes an invariable concomitant of retreat or submission in the presence of superior force. When a puppy taken out for an airing curves its tail downward and scuds in circles and half-circles at fullest speed around its master, it is apparently trying to provoke its pseudo-cynic playfellow to pursue it in mock combat. It may be observed that this running in sharp curves, with frequent change of direction, is a common ruse with animals which are pursued by larger enemies. The reason of it is thatthe centrifugal impulse acts more powerfully on the animal of larger bulk, and so gives the smaller an advantage.

Several years ago there was a good deal of discussion of the distinctive peculiarity of the pointer and setter, in The Field and other papers. It was suggested that the habit of standing still as soon as game was scented, instead of springing forward at once to seize it, was an instance of the manner in which a natural instinct might be absolutely reversed by training. One of the explanations attempted at the time for this apparent anomaly was, that the immovable position of the dog was comparable to the pause which most beasts of prey make before a final spring. But we must recollect, when considering this theory, that few of the *Canidæ* pounce from an ambush suddenly upon their prey after the manner of cats. And although a terrier will stand immovable before a rat-hole for hours together, his patient, watchful attitude is very different from the rigid and strained position of the pointer or setter; which position also has nothing in it suggestive of crouching, preparatory to a rapid bound forward, as is seen when a cat stalks a bird, and then gathers herself together before the final *coup*.

Not infrequently the tail of a young setter when it sets game may be seen trembling and vibrating as if it had a disposition to wag, which was kept in check by the supreme importance of not disturbing the hare or covey. The tail also is held out in full view like a flag, whereas a rat-catcher's dog on the watch at a hole will often droop its tail.

I think that there can be no doubt that the pointer and setter, in acting in their characteristic manner, are following an old instinct connected with an important piece of co-operative pack strategy, although the peculiarity has been enhanced by human training and selection, and the sportsmen with their guns have supplanted, and therefore act the part of, the dog's natural comrades in the chase.

The writer, during his boyhood, had charge of a small pack of beagles at a South Down homestead, several of which were allowed to run loose at night as a guard against the foxes. Among these was an old dog, a part bred Skye terrier, very sagacious, and well known in all the country round as a sure finder when the pack were used to drive rabbits in the gorse.

Old Rattler (what a throng of memories the name calls up!) was the recognized leader of the others, and not infrequently he would conduct them on a private hunting expedition, in which he served as sole huntsman and whip. Often on a still night his sharp yapping bark, accompanied by the clearer, long-drawn music of the beagles, might be heard among the hills, as they drove a predatory fox from the farm-buildings, or strove to run down one of the tough South Down hares. It soon became evident that this pack had a certain regular system of co-operation, and, like the African wild dogs, well described by Dr. S. T. Pruen, in his recent book, The Arab and the African, they made a practice of playing into one another's hands, or rather, mouths. Old Rattler would generally trot on ahead, surveying every likely tuft of grass or ling, and exhibiting that inquisitiveness and passion for original research so characteristic of the terrier. On arriving at a small outlying patch of furze he would invariably proceed to the leeward side, so that as the wind drew through the covert it would convey a hint of whatever might be there concealed.

He would give several critical sniffs, with head raised and lowered alternately, and then would either trot indifferently away, or else stand rigid with quickly vibrating tail and nose pointing toward the bush. The other dogs seemed to understand instantly what was required of them, and they would quickly surround the covert. When they were all in their place, and not until then, the cunning old schemer would plunge with a bound into the furze, and out would dash a hare or rabbit, often into the very jaws of one of the beagles.

By this artifice, which had never been taught them by man, the pack when hunting for themselves would doubtless often secure a meal, preceded by the delight of killing, without the wearisome process of tiring out a hare.

Now it appears to me that this habit of the leader of the pack —a habit which, from its similarity to what has been observed in the case of such widely separated *Canidæ* as the dingo, wolf, and hyena dog, is one that is traceable to very remote wild ancestors —is the basis of that peculiar talent in the pointer or setter which adds to the piquancy of a day's shooting and to the weight of the bag.

Let us endeavor to look at the part played by a pointer in the light of cynomorphic theory.

"Ponto" goes out with his pack (often a very scratch one), his comrades walking on two legs instead of four like ordinary dogs, and carrying their tails, or organs of a somewhat similar aspect, over their shoulders. The pack separate and advance in line, he being appointed to explore in the van and to search the turnips or rape for a tell-tale whiff of the scent of game. The covey is detected, but, being a co-operative and loyal dog, he does not rush in and try to catch for himself. He therefore stands and waits for his partners to perform their share of the stratagem. All that he has to do is to show them in an unmistakable manner that there is quarry worth having in front of his nose. The pack advance, he generally taking careful note of their approach, the covey rises, the "tails" of the bipedal dogs explode, and Ponto is rewarded by holding in his mouth a palpitating mass of feathers, with perhaps the stimulating flavor of blood, and by a public intimation that the community or pack approve of his conduct and esteem him, what he dearly loves to be thought, "a good dog."

When we come to consider the very long period during which dogs have been domesticated and under the influence of deliberate selection, it is surprising to find how much in their behavior they resemble their wild brethren. The rule seems to hold good here as elsewhere, that the outward form is much more plastic to the influence of environment than the character and mental habits which are dependent upon the nervous system. Thus, although the deer-hound and pug are so different in external appearance that it is difficult to believe that they are related, yet if we watch them we find that their mental and moral qualities are of a similar cast. The fine gray wolf in the Zoölogical Gardens, Regent's Park, and the performing wolves recently exhibited in London, when in a good humor, had precisely the same methods of expressing pleasure as the domestic dogs, and would wag their tails and gambol about in a manner which made one doubt for the moment whether they were not in reality Scotch collies masquerading as wild beasts.

There are many other traits in our domestic dogs suggestive of their ancestral habits which can not be dealt with in this article, but which offer a most interesting field for study to every one who possesses a dog and a taste for research in this direction.

In concluding it may be well to notice briefly the chief points of dissimilarity between the wild and tame *Canidæ*. In the first place, there is a general difference of aspect and bearing which it is difficult to describe exactly. The wild animal has an alert, independent look which the tame one has lost, chiefly owing to its long-continued habit of dependence upon man. Although, of course, all breeds of tame dogs have been at some time or other deliberately adapted by training and selection for special purposes, yet there seem certain characteristics which have risen spontaneously, or because the parts in which they are manifest are correlated with some others where an intentional change has been brought about. Darwin gives an instance of this in the hairless dogs, which at the same time are deficient in teeth. This question of correlation is one of the most interesting and obscure problems of natural history, and perhaps we are at present a little too ready (with our hereditary tendency to take refuge in an imposing mystery whenever our reasoning powers fail us) to ascribe to it certain phenomena, the explanation of which by the ordinary laws of evolution is most clear.

Most probably the drooping ears of our domesticated hounds and hunting dogs primarily arose from the fact that the savage huntsman, disregarding shape, picked those dogs to breed from which manifested the keenest powers of scent, and that in these individuals the ears were not so much in use as with others. Again, in every litter of whelps the surly, independent, and ill-tempered brute would always be more likely to be eliminated than those which were confiding and tractable; and so, from age to age, the chief outward traits which distinguish the dog from wolves and jackals would tend to increase.

Finally, the instinct of association has, in the case of the domestic dog, become more exactly fitted to the new conditions of environment. He makes himself thoroughly at home with us because he feels that he is with his own proper pack, and not among strangers or those of an alien race. The wild animal, on the contrary, which refuses to become domesticated, still has the perception that those who would palm themselves off as his comrades are creatures of a different nature. He sturdily refuses to become a party to the fraud, and remains suspicious of their intentions; and, whatever they may do to propitiate him, he keeps on the *qui vive* as against a possible enemy.—*The Contemporary Review.*

PROTECTIVE DEVICES AND COLORATION OF LAND SNAILS.

BY HENRY A. PILSBRY,
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THIRTY years ago, when Bates wrote his modest observations upon the protective mimicry of the butterflies of the Amazons, few naturalists could have foreseen the vital and far-reaching influence those now classic pages would have upon the future of biology. But the new doctrine, taken up by Darwin, Wallace, and others, and illustrated by hundreds of examples among insects, birds, and mammals, has already taken its place among the established canons of zoölogy.

The general principles of the subject of mimicry are now familiar to the laity as well as to scientists; but much still remains for observation at our very doors, to supplement the known facts, and to extend the underlying principles of mimicry and protective resemblance to the less-known groups of animals, among which are the land mollusks.

We have been made familiar with many cases of what may be called true mimicry, occurring among the insects; such as the conspicuous resemblance some moths, which are of course both defenseless and edible, bear to wasps and other stinging insects; and the instances of edible butterflies mimicking in their colors nauseous species are also well known. A more striking case of this phase of mimicry has quite recently been noticed in tropical America. In the forests of this region, leaf-cutting ants live in countless numbers. They strip whole trees of their foliage, carrying the leaves in fragments to their formicaries. Now, among these ants have been found insects belonging to an entirely different order, which mimicked the ant *and its leafy burden!* The back of the mimicking insect is green, and pinched up into a flat, thin plate, quite the counterpart of the leaf-fragment carried by the ant.*

A much more simple case is represented by the dead-leaf butterfly of Java, which, when it alights upon a bush, presents so close a resemblance to a dead leaf that even so experienced a naturalist as Wallace was long deceived by it. This resemblance of an animal to its surroundings may be called "protective resemblance," rather than mimicry.

Instances such as these might be multiplied indefinitely, were we to confine ourselves to the insect world. The great variety of

* See the article by Edward D. Poulton on this insect, Proceedings of the Zoölogical Society of London, 1891.

their *external* modification offers endless opportunities for the action of natural selection in producing mimicking forms in this great branch of air-breathing invertebrates. In the other great branch of invertebrate life, the land mollusks, the modifications of structure have been mainly *internal*. Outwardly they present comparatively few types. This sameness in exterior features has been unfavorable to the development of mimicking forms of mollusks; but, while true mimicry is rare among them, most interesting cases of *protective resemblance* and of special protective structures occur not infrequently.

I well remember hunting the snail *Helix thyroides* upon the wooded bluffs along the Mississippi. Both shell and soft parts of this mollusk have the brown tint of the fallen oak and hickory leaves with which the forest floor is thickly carpeted. Indeed, the colors correspond so closely that a person standing can scarcely distinguish snail from leaves, even when knowing where to look.

The assimilation of this snail to the general color-scheme of its environment must prove very beneficial; although one occasionally finds a heap of empty shells by the side of a fallen log or stump, showing that the jays and crows sometimes find enough of them for a meal.

It may be stated as a general rule that snails which live quite upon the ground have dark or dull-colored shells, while the shells of those living in exposed situations are bright. Turning to the tropics, where all Nature flaunts attire more gaudy than in the sober North, we find many illustrations of this rule. In the Philippine Islands there is a group of arboreal snails (*Cochlostyla*), some of which are vivid green in color, like the foliage whereon they live. It should be noted that these snails are so exclusively arboreal that they even deposit their eggs in a bag made by twisting leaves!

In tropical America we have a group of tree-climbing snails which subsist chiefly upon fruit. Like the Philippine Island species they are vividly colored; but in this case the colors are the most brilliant hues of yellow, orange, and red, corresponding admirably to the tints of the ripe fruits upon which they live.*

It is a noteworthy fact that certain ground-living allies of these brilliantly painted snails are dull colored, as are ground snails generally.

All the foregoing are instances of what has been called *cryptic* —that is, *concealing*—protective coloration. In other words, the

* Specimens of *Helix picta*, *H. alauda*, *H. marginella*, and other bright-colored fruit-eating snails of the West Indies, are occasionally imported to the Philadelphia and New York markets upon banana bunches.

color of the animal corresponds with the prevailing color of the environment, and thus it escapes the notice of its enemies.

A more complex state of affairs exists in those animals which make use of external objects for their own concealment. A case in point is the hairy snail (*Helix hirsuta*), a species commonly found throughout the Northern States, living around decaying logs in the forests. These little fellows have a clothing of short hair all over the shell, and this hair holds so much of the soil that they look more like small pellets of earth than like snail-shells. The disguise is effective enough to deceive more acute shell-collectors than the birds.

FIG. 1.—HELIX HIRSUTA. Showing hairy cuticle.

An altogether similar attempt at deception is practiced by a marine mollusk, the so-called "carrier." This gastropod has a broad spiral shell, to the upper surface of which it cements shells or pebbles, until finally it appears to be nothing more than a heap of shell-fragments, not distinguishable from any other irregularity of the sea-bottom. Another instance may be mentioned, as it illustrates the extension of this general principle to widely different groups of animals. The sea-urchins of our coasts have often been observed to cover themselves completely with small stones, so that nothing can be seen but a heap of pebbles.

Coming back to our hairy Helix, we may perhaps credit its hirsute coat with an additional function besides mere dirt-gathering. Poulton has observed that some insectivorous animals have an excessive repugnance for hairy insect larvæ, even when they

FIG. 2.—THREE-TOOTHED SNAIL, HELIX TRIDENTATA. Illustrating the simplest form of obstructing teeth.

FIG. 3.—CARACOLUS LABYRINTHUS—a South American forest snail. Showing extreme development of lip-teeth.

are not otherwise repulsive. The marmoset, for instance, can not be induced to touch *any* hairy larva. It is not improbable that small mammals, such as moles and field-mice, find the hairy covering of *Helix hirsuta* disagreeable, although we know that they eat other snails.

An old collector, who had spent most of his life within the tropics, once related to me an experience of his in the West Indies, that throws light upon another phase of snail life, and reminds one of precisely similar incidents among the *Lepidoptera*. This naturalist had a habit of holding small snails in his mouth when collecting upon cliffs or trees where climbing was difficult. The light or dull colored species of *Cylindrella, Helicina*, etc., caused him no inconvenience, but the snails with conspicuously bright and shining shells, such as occur in the groups *Streptostyla* and *Varicella*, were so intensely bitter that he soon learned to let them remain unless he could carry them elsewhere. It is reasonable to conclude that birds find them equally unpalatable. The facts, as far as they are known, seem to indicate that this is an example of "warning coloration," such as many conspicuous but nauseous butterflies possess.

It may be remarked that the custom of holding specimens between the lips is not so rare with field naturalists as fastidious persons might suppose. I confess to having once swallowed a small and very rare specimen while so holding it for a moment. The creature was, alas! not my own property, and its outraged owner has not yet forgiven me.

A protective device totally different in kind from those just described has been observed in certain slug-like snails, which have the ability to amputate their own tails, just as a lizard does when seized by that appendage. Dr. Carl Semper has noticed this peculiarity in snails of the genus *Helicarion*, in the Philippine Islands; and a species of the genus *Prophysaon*, of California, has lately been seen to lose its tail in the same manner.*

FIG. 4.—AN INDIAN SNAIL, ATOPA ACHATINA. Broken, to show the internal folds.

It is probable that the explanation is the same in the case of both lizards and snails—viz., the tail is likely to be the part seized by an enemy just as the escaping creature is disappearing into a sheltering crevice. The advantage of saving the head, even at the expense of the tail, is obvious.

Protective coloring and protective resemblance are, however, a defense only against the larger enemies of the mollusk, which hunt their game in the open, such as birds, field-mice, and incidentally, conchologists. But, besides these, snails have smaller foes which meet them upon their own ground. The omnipresent *Insecta* are

* See article by W. J. Raymond, Why does *Prophysaon* shed its Tail? The Nautilus, May, 1890.

the most troublesome of these, if we may judge by the elaborate means which have been evolved for protection against them. Beetles, especially those of the family *Carabidæ*, are not outdone by a Provençal vintner in their appreciation of a toothsome Helix; and it is interesting to watch the celerity with which a beetle of the genus *Cychrus* or *Dicælus* eats a snail out of his shell.

Various organs have been modified or developed to prevent intruders from entering the aperture of the shell. In one group of land snails there is a calcareous plate, called the operculum, secreted upon the upper surface of the fleshy foot of the animal. This plate is the last part to enter the shell when the animal retracts itself, and it fits closely into the aperture, closing it like a valve or door. Examples of this structure are seen in the common *Helicinas* of America and the genus *Cyclostoma* of Europe.

FIG. 5.—ATOPA ACHATINA. Broken, to show the narrowness of the passage between the folds.

The majority of air-breathing snails, however, are far removed genealogically from the operculum-bearing group, belonging, indeed, to quite a different phylum in which the operculum has never been developed. Failing this, a completely different structure has been adapted to the same use. From the rim or lip around the aperture spring processes of the shell substance, projected into the opening of the shell and decidedly narrowing it. An example of this structure in its primitive form is seen in the three-toothed snail, *Helix tridentata*, and its allies. The projecting "teeth," as these processes are called (although they have nothing to do with the true mouth of the animal), are prominent enough to exclude the larger beetles, and insects sufficiently small to be admitted would be drowned in the viscid mucus or slime freely exuded by the snail.

More complex is the obstructing mechanism in many of the snails of the Southern States and of South America. In some species—the *Caracolus labyrinthus* of Panama, for example—one wonders how the snail himself can get in or out of his own shell, so tortuous is the passage. These Southern forms represent the highest development of the three-toothed type of aperture. The meaning of this increasing complexity appears, when we remember that the regions where the most complicated types of snails are found are known to be practically coincident with the regions producing carnivorous *Coleoptera* in the greatest numbers and the most exuberant variety of forms. The writer once confined in a box with carnivorous beetles a number of snails with strongly "toothed" apertures (*Helix uvulifera*) and a number having open, unprotected apertures (*Helix clausa*).* The former were found to be alive after several days, but the unprotected snails were eaten from their shells during the first night.

From tropical America we will now follow a great circle half round the globe, pausing in India or Ceylon. Here, too, the snails are exposed to the conditions of free competition for life in a tropical climate. What structures have been evolved in this totally dissimilar snail-fauna, corresponding to the evolution-products of American life under similar climatic conditions? As we would expect on *a priori* grounds, the protective structures, while strictly *analogous*, are in no way *homologous*, having arisen wholly independently in the two hemispheres. The Asiatic snails, instead of developing projecting teeth upon the edge of the aperture, have a system of calcareous blades or folds situated a distance within the shell, behind which the animal retreats when needful. The figures tell, better than any description, the extreme degree of complication which has been attained by the more highly organized forms. Beetles have occasionally been found sticking in the interstices of the folds, unable either to force their way into the interior or to extricate themselves and retreat.

The culminating point in the series of obstructive structures is perhaps reached by the narrow-throated snail of China (*Stegodera angusticollis*). In this bizarre form, the last of the spiral whorls is distorted and crowded against the preceding volution, producing an extremely narrow passage into the more spacious interior, as shown in the figure.

FIG. 6.—CHINESE NARROW-THROATED SNAIL. The narrow throat is shown by the dotted line.

But, in spite of these various expedients for the protection of the snail, they have some enemies able to overcome or to evade all obstacles. It is sad to learn that in this case, too, civil wars are the bloodiest; the most deadly of the "malacophagi" are brother snails of the genera *Selenites* and *Glandina*. When the hungry Selenites discovers a temptingly juicy snail, a Helicina perhaps, the victim retreats into his shell, barring the entrance with his strong door or operculum. The Selenites thereupon sets to work cutting a hole through the large whorl of the Helicina, in order to gain entrance behind the barricade. The tongue-like odontophore with

* The *Helix uvulifera* is a Southern, the other a Northern species.

which the mouth of the Selenites is provided acts like a file, being beset with minute teeth, each of the shape and sharpness of a bayonet; so that the cutting of a hole through the shell is only a question of time. Presently the shell wall is broken through, and Selenites feasts upon Helicina served raw on the shell.

So life is not without its tragic side, even with creatures so lowly organized as these!

THE ENVIRONMENT OF GRECIAN CULTURE.

BY GEORGES PERROTT.

THE more closely we study the works of the ancient Greeks, and penetrate the secret of the thought which they loved to conceal under the veil of symbol and myth, the more plainly we recognize that their wise men half-saw by a kind of rapid divination many of the truths which have been demonstrated to modern philosophy only by series of methodically connected observations and experiments. There are few among the present theories of Nature, its forces and laws, of which some hint does not appear to have occurred, for a moment at least, to some of the philosophers of Ionia, Sicily, or continental Greece. In the study of man as living in society, or as what Aristotle calls the political animal, they pushed the rigor and subtilty of their analysis very far. How precisely Thucydides described the chronic or acute maladies of the moral sense and the changes it underwent, as at Corcyra amid revolutions that confused all established notions, and at Athens, when a fatal epidemic, offering the prospect of inevitable and immediate death to every one, impelled it to break from all constraint, and excited a thirst for pleasures to which there could be no immediate satisfaction!

The Greeks should also be credited with having outlined the doctrine that now holds the highest place in what we call the philosophy of history, of the influence exercised by the medium upon a race and a people. That theory, usually ascribed to Montesquieu, was foreseen by Aristotle, who accounted for the superiority of his countrymen by the intermediate position which Greece occupied between the cold regions of northern Europe and the warm countries of Asia; whereby, he said, the Greeks combined the energy of the northern barbarians with the mental vivacity of the Asiatics. The same doctrine was in fact presented a century earlier by Hippocrates, in his treatise on Air, Water, and Places, in which the last twelve chapters are occupied with it. Summarizing the results of a comparison between

Europe, or Greece, and Asia, and accounting for the differences he has determined, he says: "You will find as a rule that the form of the body and the disposition of the mind correspond to the nature of the country. . . . All that the earth produces is conformed to the earth itself," understanding the term earth in its most comprehensive sense, and regarding in its definition less the configuration and qualities of the surface than those of the climates that prevail and modify the fauna and flora. "If Asiatics," he affirms, "are of a more gentle and less warlike nature than Europeans, the cause lies chiefly in the equability of their seasons." And further, "A perpetual uniformity fosters indolence; a variable climate gives activity to the body and the soul."

We shall therefore only be following the counsel and the example of the great minds of Greece if we seek, in studying its history, to ascertain how and how far the character of its people has been affected by the action of "the air, the water, and the place." In our inquiry into the character of the medium in which the tribes called Hellenes in the eighth century before the Christian era were developed, we have enjoyed the advantage of a long residence in Greece, during which we have observed the people in their struggles with a Nature which gives nothing without being paid down, in labor of mind and muscle.

The peoples who figured in history before the Greeks, occupied territories clearly defined by Nature. Egypt was the lower part of the valley of the Nile, and did not extend materially beyond it. Chaldeo-Assyrian civilization was developed in the spacious basin of the Euphrates and Tigris; a much larger field, but still one that had definite boundaries—in the Taurus Mountains on the north, the rampart of the Zagros on the east, the Persian Gulf on the south, and the Arabian and Syrian Deserts on the west. The Phœnicians, indeed, had more than one capital, and carried their trade through all the then known world, but their capitals succeeding one another, each received its knowledge and art from the one that preceded it, and gave them to the one that followed it, and their intercourse with the world was animated by the commercial spirit only. Their industry never drew its inspiration from an intense and vigorous living art; and all that was essential in them was the product of the narrow strip of land between the sea and Mount Lebanon. All Hebrew art was restricted to a still narrower area in the circuit of Jerusalem and the little kingdom that depended upon it. There were other peoples in western Asia and Asia Minor who made their influence felt abroad: but within themselves each formed a compact mass, inhabiting a concrete portion of the continent, and it is within that limited territory that we have to look for evidences of their genius and work.

Greece, on the contrary, was multiple and diverse in space and in time. The name is more particularly applied to the easternmost of the peninsulas that the European continent projects into the Mediterranean toward Africa, in which the Grecian race, while it spread itself widely abroad, was most compactly settled; in which its cities of greatest influence and most immortal fame were built; and where were celebrated the Olympian, Isthmian, and Nemean games, to which all the scattered members of the Hellenic family periodically resorted. But, besides the peninsula of Hellas, as it was called, there were other Grecian lands, less eminently conspicuous, perhaps, which also performed their part, and that not an unimportant one, in the general movement of the race. There was Asiatic Greece, which by virtue of its brilliant and supple genius was more precocious than European Greece; which engaged first in the flights of poetry and art, and in general and distant voyages. There was a Greece in Africa, at Naucratis and the other cities among the mouths of the Nile, and in Cyrenaica cities, protected by the desert against invasion, and with its caravan-roads radiating in every direction into the interior, made it as a door opening toward the mysteries of the Southern continent. Thence a curiosity constantly on the alert brought data by means of which the limits of the known world were pushed further back, and the idea of the variety of men and climates was fostered.

On the opposite shores were the Grecian colonies fringing the gulfs and promontories of southern Italy, with their advanced posts pushed to the coasts of Gaul and Spain. They had the honor of being the earliest educators of Rome; and the monuments of architecture and sculpture which they have left are no less beautiful than those which originated on the soil of the mother-country. Between these Grecian lands, forming four well-defined groups on the mainland, each of which had its distinct existence, there was an insular Greece in the sea, including Sicily, the islands of the Adriatic, the islands south and east of Hellas—Cythera, Crete, the Cyclades and Sporades, Rhodes, Cyprus, Chios, Lesbos, the islands near Thrace, and many others, large and small. Men and merchandise, raw materials and manufactured goods, sacred images with the ideas and feelings they represented, the products of industry, and plastic types, were circulated and exchanged among these colonies with extraordinary facility; and happy meetings and fruitful contacts occurred in these hospitable archipelagoes, between Greeks and barbarians, and between Greeks of different stocks.

The race that was developed in this fortunate situation, favored by circumstances and by the medium in which it grew up, was perhaps the best endowed one that has participated in the work of civilization. The Greeks had in the highest degree the genius for invention in letters and the arts. The other great peoples of their time reached a certain point and stopped there, afterward only repeating the types which they had created during their earlier period; or else were content to borrow and adapt; and, finishing their useful work before they lost their independence, continued to exist long after they had ceased to live and bring forth.

But Greece has always been progressive, or at least moving. Even when subjugated by the Romans, and when its series of original creations seemed to have been exhausted, it still cultivated science and history; attempted criticism; extended and sounded more deeply the ancient systems of philosophy; and took a part in the elaboration of the dogmas of Christianity.

In art, while its master sculptors and painters were extinct, its architects still produced great works without copying Ictinus and Mnesicles. The basilicas of Ravenna and the noble structure of St. Sophia are comparable in merit with the highest classical forms.

No organic development in the history of the human mind has been better known, or has been richer and at the same time more simple, than that of the Grecian genius. Notwithstanding the extent to which the Hellenic population was scattered, and the distances which separated the various groups, the evolution, taken as a whole, was governed by the same laws and exhibited the same phases in like order and under like conditions, in all the lands in which the Greek language was spoken. The different stocks were like trees of the same species, destined to produce the same fruits, the color and taste of which were liable, it is true, to be modified by local influences, but the variations were kept within narrow bounds. So these peoples were kept from greatly diverging by their constant communication with each other, which was aided by the forms and relations of their lands—promontories jutting out toward one another, and frequent islands; so that the sailor between distant ports was hardly ever out of sight of some Grecian headland. Nowhere else does the Mediterranean offer such a disposition; and there was in this geographical feature a direct provocative of the spirit of adventure.

The Hellenic peninsula is divided into two masses of nearly equal size—central Greece and the Peloponnesus—each of which is in turn divided into secondary peninsulas that have curiously irregular contours; while the islands are often so near to one another that one can pass between them or to the mainland with a few strokes of the oars. The waters in the sinuosities of the straits are always smooth; the deep bays lying in the recesses of the hilly shore; the narrow creeks concealed in the serratures of the rocky coasts; the beaches on which vessels can be run to rest on the sands; landlocked harbors like that of the Piræus, capable of accommodating hundreds of ships—make Greece a country where the sea is so mingled with the land, insinuates itself into it and penetrates it in so many ways, that the inhabitants could not fail to trust themselves upon it as soon as they could hollow out a pirogue, familiarize themselves with the sea, and make it their highway. When the Greeks first appeared to view—in their epic poems—they were already bold sailors, fond of telling of the arduous voyages they had made and of the distant countries they had visited. They still keep their compact with the sea and excel as sailors; and their marine is an important element of Mediterranean commerce.

The roughness of their land made the Greeks all the more ready to accept the invitation offered them by the sea. The whole country is a single mountain mass of complicated construction and irregular expanse, the different summits of which have their several names; furrowed and carved by innumerable ravines and split by deep chasms, which often present precipitous walls. It has no high, broad, table-lands or large valleys; what are called plains there, except in Thessaly, where they are larger, being only narrow spaces nearly hemmed in by the mountains around, and notched by their intruding spurs. Where one must be always climbing, and descending to go up again, and is stopped at every few steps by some formidable obstacle, communication by land is not easy. It was therefore of great advantage and assistance to have the sea at hand to take one wherever he might wish to go, and, in order to enjoy it to the fullest, the Grecian colonists established themselves in such situations that each group should have at least one seaport. Only one considerable community, the Arcadians, had a wholly inland home, and they were regarded as generally behind the others in enterprise, learning, and civilization. Without the sea and the outlets it offered, the peoples who occupied the Hellenic peninsula would probably have continued in a condition of barbarism and anarchy, like that with which their relatives, the Albanians, are still struggling; without it they must have been doomed to that indefinite state of division in which the clan rules. The passage by land from one district to another was always arduous and often impossible. The local groups seemed doomed to live in perpetual isolation, with no room for a truly large and fruitful national development. That their influence became more prominent than might have been anticipated was because of a special feature that modified the effects of the general configuration of the land. Nearly all the mountain-walled districts of Greece had one side open to the sea, and that gave passage to everything—persons, goods, and ideas. Storms could close this road only a few days at a time, while through all other seasons the ships could sail freely, promoting an incessant exchange of visits and mutual favors among districts between which Nature had within placed the restrictions of numerous and high barriers.

The attachment of the Greeks to the sea was confirmed by the regularity and mildness of the winds. This sea and these winds favored the moral unity of Greece, which it enjoyed till the time of the Roman conquest without ever having political and administrative unity. Until the capture of Corinth by Mummius it was divided into a number of cantons separated from one another by Nature, which were as many independent states. This universal presence of the sea furnishes a means of accounting for the superiority of the part which Greece has played in the world. The country, while it was free, had no roads, and did not need them. It was easier and more convenient to spread sail, in order to go from one place to another, than to climb the mountains and coast along the precipices. It would have been hard to find, even outside of the very numerous class of professional sailors, a Greek who had not, once at least in his life, left his native village or city for purposes of war, commerce, pleasure, or piety. The last two motives were confounded in practice. The desire to consult a renowned oracle, or to attend the festivals celebrated in honor of the great national deities, caused the movement, every year, of thousands of Greeks, many of whom came from a great distance—from remote parts of Asia, Europe, and Africa. These festivals held a place in the lives of the Greeks of which we, subject to the tyranny of professional duty and the cares of business, can hardly form a conception. We can imagine that the attendants upon them, during the few hours they passed together, would have much to tell one another and to learn, and would improve the opportunity. Can anything be fancied better than these removals and meetings to awaken the mind and keep it on the alert, and thus to forestall the estrangement with which the race was threatened by reason of the dispersion and wide separation of its branches? The Greeks of Hellas could refresh and increase their knowledge by conversation with those of their brethren who, like Ulysses, had "seen cities and learned the thoughts of many men." The citizens of the most remote colonies, those who lived in small groups among barbarians or in the oases of the desert, having taken part in the periodical solemnities at Athens, Delphi, or Olympia, could return more Greek in feeling and thought, manners and language. Like the giant of one of their fables, they had recruited their strength by touching the mother's bosom of the country of which they were children.

Greece was thus at once central and scattered; central in Hellas, scattered and multiplied in the periphery. The great body had its interior circulation; its blood was sent out to the extremities, and from the limbs returned to the heart to be purified there and charged anew with the nutritious elements that kept up the life and originality of the race, and gave it its superior energy. It had the mobility of the waves, which, after they had sown the Grecian colonies all along the shores of the Mediterranean, were incessantly bringing them back to their native country. The sea, when they were still an infant and savage race, brought them the germs of civilization from the East. Through it they received the figures and the rites of divinities, the worship of which was destined to bring men together and make them social—writing, metals, and the processes and implements of the principal arts. The sea placed the Greeks in relations of the most favorable character with foreign nations; in such relations as are suggestive and not oppressive. It permitted frequent intercourse and prolonged visits, but did not lend itself readily to attempts at invasion. The peril from this source was the less in the early days of Greece, because the chief military powers of those times had no navies on the Mediterranean; and when Persia was ready to send armed fleets to achieve its conquest, Greece had become mature and had capable commanders and well-managed fleets.

Greece was further protected in the days of its development, on the continental side, by the formidable chain of Hæmus or the Balkan Mountains, behind which it was enabled to work out its destiny unobserved and unmolested by the barbarian peoples who were moving and marching beyond them in the valley of the Danube. South of these rise in succession the mountains that envelop Thessaly with their ramifications westward, and the Cambunian Mountains, both crossed only by narrow and difficult passes. When these were forced, and the enemy was in Thessaly, he had to scale other barriers no less difficult in order to reach the plains of Bœotia; and then, to get from each small state to the next, he had to surmount the other considerable chains that severally separate them, where he was constantly liable to be exposed to the eyes and arrows of the native population. Even if, after overcoming all these obstacles, a conqueror succeeded in penetrating to the end of the last redoubt, a slight accident might any day turn his triumph into a disaster. All the doors which he had opened might be closed upon him in an instant. "Greece," says M. Michelet, "is made like a trap with three bottoms: you find yourself caught in Thessaly, then between Thermopylæ and the isthmus, and at last in the Peloponnesus." It is a great advantage to a people to feel that it is secure in the country it lives in.

This peculiar disposition of their territory further enabled the Greeks to try the experiment of municipal government, and to demonstrate the excellent results it can give to a happily endowed people. This government is that in which the idea of the city and that of the state are merged; in which each city is a living body, all the members of which take a more or less direct part in the administration of public affairs.

It is not without some surprise that we learn from history how at once intense and scattered was life in the whole Hellenic world, from the eighth to the third century B. C., and what organic potency, what intestinal activity, and what expansive force were possessed by each of the little states which the vigor of Grecian genius had scattered over all the Mediterranean shores. This municipal life was endowed with a mobility and variety that were not exhibited elsewhere. The minds of the people, easily receptive to the beautiful and the true, were stimulated to reflection by letters, philosophy, and science, and matured rapidly. Rhetoric, placed at the service of private and public interests, bred an eloquence which was fed by broad ideas that raised the dignity of party strifes. On all the theatres of action, before which the attention of the audience was never relaxed, the politician, artist, poet, writer, or orator—the man always in sight and in action—never ceased to display his passionate energy; while the lively emulation of these cities, at once rivals and sisters, none of which would submit willingly to be less than the others, or let them achieve a glory in which it could not have a part, augmented the ardor of the universal effort. Thus we find in the creation of the city the source of the high originality of Greece, and the stimulant to its real work—the building up of ancient civilization.

The relief of the land in the Hellenic peninsula and its dependencies gave rise to the city. The nature of the country and the climate had a salutary influence on the development of what Alfieri calls "the human plant." The land co-operated with the sea in promoting the supple and robust development of the body and the alert action of the mind. The life of the sailor inures the limbs and adapts them to all kinds of motion; with its constantly imminent perils, it exacts coolness and watchfulness and makes the mind quick to perceive and precise in observation. There were few Greeks who had not lived more or less on the sea and received some education of this kind.

Even those Greeks whose occupations kept them habitually ashore were subjected to somewhat similar influences. The land is one of sharp contrasts. One can pass in a few hours' walk from the vicinity of almost eternal snows, through forests of beech and fir, to plains where the palm-tops wave. Marked contrasts appear in the distribution of water. Gravelly ravines, in which ribbons of verdure, of laurels and tamarisk, are the only sign of the existence of a stream beneath the surface, are a predominant type; on the western slopes of Hellas are limpid streams, flowing in little cascades like the Neda, or full to the banks like the Ladon; rivers like the Alpheus and Achelous, which can not be forded even in the dry season; with Lake Phenæa, in the Peloponnesus, resembling the lakes of Switzerland. Yet water is rare and inestimably precious; and that explains the worship that was given to the nymphs of fountains, and the care that was taken in art to give them forms of beauty corresponding to the honors which popular piety rendered to them.

The climates are as various as the physiological characteristics of the landscape. On the shores of the bays and on the islands the difference is slight between the mean temperatures of the cold and the warm seasons; but in the interior, in the closed valleys, the winters are severe and the summers hot. With such varieties of land with its hundred faces, and the sky with its hundred caprices, body and mind are kept under perpetual strain to adapt themselves to the complex and mobile conditions of media that are modified with a rapidity that discounts all forecasts. Within a very narrow space are men of the same race and language leading very different lives accordingly as they dwell on the mountains, the high pastures, the cultivated slopes, or the shore. One who removes from one of these zones to another is obliged to modify his habits, to add or take off something of his clothing or his food, and perhaps to learn and exercise a new occupation. This tends to stimulate the organs and give elasticity to the mind, which is constrained by the force of circumstances to improvise the methods of action which the conditions demand. Thus everything concurred to develop personal energy among the Grecian people, and to fortify and build up the race by virtue of the law of the survival of the fittest. While infant mortality has always been very high, in consequence of the abrupt contrasts, those constitutions which succeeded in adapting themselves to them acquired a singular elasticity.

The marvelously clear atmosphere and bright skies of Greece give the vision a delicacy which the sense can not attain where all the contours are enveloped in vapors. There is thus developed in it the habit of studying, comparing, and measuring forms from a distance; and it acquires in that practice those qualities of a just perception and a quick feeling of the exact relations of the different parts of a whole which, in the age when they were applied to the interpretation and reproduction of the living form, contributed to make the Greeks the first artists in the world.

Artistic excellence was further favored by the very composition and nature of the rocks of Greece. The rocks of some districts, when disintegrated, furnish an excellent plastic material, equally suitable for bricks or tiles, and for modeling under the fingers of the potter and sculptor; and when they retain their consistency and hardness, although of unequal quality, they readily adapt themselves, with a little care, to the purposes of the artist. Certain shell tufas were convenient for use as a stucco, to cover deficiencies of material and give it color. A solid stone, such as is found at the Piræus, was adapted for precise cutting and exact joining, to a rhythmical arrangement of the blocks and a firm accentuation of the moldings. More careful pains was encouraged when marble of a finer grain was used. It was a material that inspired the workman with a kind of involuntary regard, for it assured him that none of his intention, no delicate stroke of the chisel would be lost; and this gave that wonderfully accurate execution so much admired in the sculptures. There were, further, marbles of different colors, which could be combined and arranged for the best effects. The adaptability of these materials to the sculptor's work was hardly a less potent factor in the development of Grecian art than were the natural genius of the race and the conditions of its environment.

On the other hand, Greece was poor in metals, the lead and silver mines of Laurium being the only mines on the peninsula that have been worked with profit. The fact brought its advantages. The people could not do without metals; they needed them for domestic luxury and ornament. The metallic treasures found at Mycenæ and other evidences are in proof of the power of their taste for gold, and they shrank from no danger to get it. Both it and the humbler metals had to be got from abroad; and the necessity must have contributed to the development of business and enterprise. It would dispose the people to welcome the foreigner bringing them the commodities they desired, and then to go in search of them in the countries where they occurred or were brought in by trade. All dependence, including dependence in trade, is a bond; and it is important that it shall not operate to reduce one of the two parties brought into association by it into vassalage to the other. That danger was not to be apprehended in Greece. The situation and configuration of the country were calculated to foster individuality and independence in all things, and to protect the beginnings and favor the development of the nation which should first establish and hold itself there as in an impregnable fortress.—*Translated for The Popular Science Monthly from the Revue des Deux Mondes.*

Mr. Conway, who is exploring in the Himalayas, finds the peaks difficult in their lower parts; the region above seventeen thousand feet is easy, but in bad weather one is cut off from the upper region by the next seven thousand feet below. There are numerous and vast glaciers descending to between eight thousand and nine thousand feet above sea-level.

PREHISTORIC CANNIBALISM IN AMERICA.

By Rev. A. N. SOMERS.

IN the summer of 1888 I took a club of young people belonging to my church to the famous ruins of the mound-builders at Aztalan, Wis., for a day's outing, and exploration of the mounds of that once great village. A superficial survey soon convinced me that it had been a very populous village, as it covered at different times as much as two hundred acres, down to an area of a little more than seventeen acres, which was skillfully and strongly fortified, representing the increased intelligence and caution of several generations constantly shrinking under the ravages of war and possibly cannibalistic devastations.

A first effort located the communal refuse-heap, where had been thrown the refuse and garbage of the village, when it covered an extent of nearly one hundred acres for a very long period of time.

In these heaps one generally learns more of the manner and means of subsistence of the prehistoric people than from all other sources of conjecture combined, for in them are thrown the bones and refuse of their meat-supply, and the broken cooking and other utensils. Broken weapons and ornaments likewise find their way to the garbage-heap, just as with us. But when the mound-builder broke his tools, weapons, and ornaments, they could not be reduced back to raw material, to enter into the construction of something else, as do many of our worn-out or broken implements, for they were made of material, in the main, that would not permit of such transformations. Those, then, no longer useful were thrown, along with the bones and other insoluble and almost imperishable refuse, into a common heap in some convenient place where they would afford the least annoyance.

A few hours' work in this heap was rewarded by over five hundred valuable relics, including broken pots, arrows, ornaments, hoes, and bones—no less than one hundred of which were human bones, in about equal proportion with the bones of beasts, birds, and fishes.

A subsequent trip to the same place, in company with Prof. J. Q. Emery, Principal of the High School at Fort Atkinson, added nearly one thousand more bones to the collection. Another trip to the place, in company with an amateur collector of relics, added about six hundred more bones to the collection; I now have nearly two thousand bones from the refuse-heap, forty per cent of which are human, while the remainder are evenly divided between birds, beasts, and fishes.

This refuse-heap covered a space about one hundred feet long by forty wide, in a low place where a ravine emptied a surplus of surface water into the river at wet seasons of the year. The accumulations were often covered by clay from the hillside, so as to have stratified it to a depth of eight feet in the lower part of the original ravine, making it later almost level with the surrounding river bottoms.

The bones other than human are bear, raccoon, buffalo, moose, deer, squirrel, woodchuck, rabbit, wolf, pigeon, quail, ducks, reed-bird, turtles, pickerel, pike, perch, bull-head, and suckers.

The crushed shells of land snail, periwinkle, and the fresh-water clams were in great abundance.

Several of the strata show the action of fire on their surface, as if the attempt had been made to burn them over, to destroy the refuse.

The human bones in this heap were subject to the same treatment as those of the beast, and lay often in actual contact with them, and in every one of the strata.

The bones containing marrow were all either broken into short pieces or split open. The mark of the stone knife and axe is to be seen on most of them, where they were hit to break or split them, or in severing the joints. The ribs were cut into short bits, seldom over three inches in length; and always the knife-marks are seen on the inside, except where they were severed from the vertebral connection. This treatment is the same in both those of the beasts and men.

Among the number of human bones thus found one can identify many different skeletons. Some of the skulls were very thin and compact, showing a large and uniform curvature, while others were thick, spongy, and of irregular curvature.

The largest and coarsest bones, and those lying in the topmost strata, bear a striking resemblance to the bones of the Fox and Winnebago Indians slain in the Black Hawk war, many of which I have examined and compared with these.

In contact with one of the skeletons of the highest type, I found beads cut from the shell of *Busycon perversum*, a marine shell-fish, an inhabitant of the Gulf of Mexico. In another garbage-heap similar to this one, twelve miles distant, on the same stream, two whole shells of the *Busycon* were found by another man some years previous.

A beautiful paint-dish, or mortar, was found by another party in the same locality.

I found broken bone awls, stone drill-points, and half-finished arrow-heads, as well as thousands of pieces of broken pottery. Many weapons of war and implements of agriculture have been found scattered over the entire surface of the village site, and the hundreds of acres of garden-beds adjoining it.

The only implements of a warlike nature found in the garbage-heap were in the topmost strata, from which fact I would infer that their early occupation of this place had been a peaceful one, with the introduction of wars with rival tribes at a later date, forcing them to learn warfare as an art of defense.

The shrinking of the village site from so large an area to so small a one as the last walled in for more sure defense indicates the rapid depopulation of the village and increased danger of assault.

In one quarter of what I regard as the second epoch of the community I estimated as many as two thousand foundations of tepees. In that same portion of the village site, Dr. Lapham, in 1853, or about that time, took out of a grave in one of their temple foundations fragments of cloth made from vegetable fiber. They seem to have been a comparatively civilized people, among whom agriculture and manufacturing were carried on, and great order displayed in laying out their village and defending it with walls and other devices.

Of their cannibalism there can be no doubt after these discoveries. Had they been slain and eaten by their enemies, or by other tribes conquering them, their bones would not have been mingled with those of beasts, birds, and fishes taken in the same locality, and evenly distributed through eight feet of accumulating silt carried from the hills by a stream that only had water in it at extremely wet and short periods of the year, where the accumulation is not over three inches in a century, since the timber has all disappeared, and the plow has turned the soil every year for about forty years.

That the flesh of those bodies was eaten there can be no doubt, for no savage would go to the trouble to mutilate the dead bodies of friend or foe, to the extent of separating all the joints with a knife, chopping the bones three or four inches long, and splitting all those and only those containing marrow, and then finally mixing them with the bones of the animals he undoubtedly used as food, and throwing them into one common heap.

The diversity of the skeletons as indicated in their texture and physiological configurations would suggest to my mind that the persons eaten were probably taken prisoners in battles, with possibly some of their own number eaten as a sacrifice in their festivals and orgies, of which they must have had many, as indicated by the temple-like structures that existed among the variety of structures built by them. Their social life must have been highly developed, to hold them together in one village, and to create such strong defenses as its walls indicate, and to carry their industries to so high a degree of perfection as is indicated by the relics referred to above.

The government of so large a body of primitive people would call for an elaborate mythology to invest its rulers with the necessary civil power to hold the society together, and wield its combined strength against its foes from behind the walls that protected its women and children, and to till the soil and make its wares. The pottery, of which there must have been great quantities, from cooking-pots over twenty inches in diameter down to drinking-pots not over three inches in diameter, seems to have all been made from clay taken from three or four pits, and all baked in a single kiln.

There was probably some division of labor among them; some making pots, others tilling the fields, while still others made tools of various sorts, and still others may have followed the chase for meat-supplies. All the birds of which I found bones are migratory, and are found in that locality only during the period of the year in which the crops would need attention. The same is true of some of the fish upon which they fed.

Whatever led to cannibalism among them fixed the habit so permanently in their lives as to lead them to relish human flesh. Every part of the body seems to have been eaten, which would not be true of those cannibals that eat their enemies for revenge or in religious sacrifices. In those cases they seldom eat more than small portions selected according to the demand of some superstition that does not apply to all of the body, even to the marrow.

The fact that such ornaments as the shell beads, which must have been highly prized by their owners, were thrown with the bones into the common garbage-heap of the village would seem to indicate that the person eaten, and whose bones and ornaments found a common fate among the bones of food-animals, was alien to the eaters.

Then, too, very wide differences of anatomical conformations exist between the bones in the garbage-heap and those buried in the burial mounds adjacent to the village. This confirms the notion that the victims eaten must have been taken by the chase, or as prisoners of war. The bones indicate all ages, from children of tender years to aged men and women. There seems to have been no discrimination as to the age and sex of the victim, as is generally the case when a human body is eaten in religious or social orgies. Such are the facts in confirmation of this habit having existed among a people of a high order of barbarism.

The manner in which, and the length of time it was practiced by them, would indicate as its cause the development of a relish for human flesh through a scarcity of food. The very fact that they were populous, and subsisting in a latitude that has hard and long winters, together with the uncertainties of the returns from their primitive agriculture, would confirm the notion that hunger was its cause, and that its pressure never was unfelt until the relish for human flesh had been fully acquired, after which it would continue its hold upon them, even if the need of it was slight.

The Indians of the Northwest have been known to eat their enemies slain in battle, yet the practice never extended to the consumption of the entire body, down to the particular habit of cracking the bones to get the marrow.

RECENT APPLICATIONS OF PAPER.

By M. EMMANUEL RATOIN.

THE year 1891 was certainly one of those in which new industrial applications of paper were most numerous. The idea of using paper in place of stone in the construction of houses is already old; but paper to take the place of glass in windows, of clay in flower-pots, of iron in railway rails, wagon-wheels, and horseshoes, of porcelain in laboratory ware, of wood in barrels, it having already taken the place of that material in small boats, paper in pulleys, are applications as novel as bold. The manufacture of window-panes of paper was first tried in the United States. The panes have the appearance of milky glass, and the property of intercepting the light-rays while letting the heat-rays through, which makes them suitable for greenhouses. It is estimated that a paper window-pane ninety-four by sixty-three centimetres in dimensions in a wooden sash with iron appliances, will cost about eighty-five cents, and last on the average four years.

One of the most ingenious of the new applications of paper is in pulleys. These pulleys, the invention of M. Burot, have a center of cast iron and spokes of iron, bearing a bracing on which the paper felloe rests. This bracing supports the felloe during its manufacture, and thus gives it more firmness. The paper, of a special quality, is glued, rolled, and compressed upon the bracing in a single operation. The crown should then be dried and dipped in a mixture of linseed oil and resin. These pulleys, much lighter than those of iron, are also appreciably cheaper. They are used for the transmission of forces of from a half horse power to four horse powers.

Paper flower-pots have the advantage over earthen pots of being unbreakable and much lighter. If their net cost were considerably less than that of the earthen pots, they might replace them in the immense use made of them by gardeners and forest cultivators. They are imputrescible, impermeable, and shed the water. Like similar articles in terra cotta, they are adapted to ornamentation. Covered with a coat of enamel, or painted, they have the advantage over ornamental earthen pots of lending themselves more readily to the fanciful forms which manufacturers like to impose upon them.

M. A. Petit, engineer, has described to us the processes of manufacturing them thus: A paper pulp is taken composed of eighty-five parts of wood pulp and fifteen parts of rag pulp, and is shaped in molds to the desired form. The pneumatic or the centrifugal process of molding is used, according to circumstances, and does not differ essentially from those employed in porcelain factories. The articles are dried in air and then desiccated in a current of warm air; after which they are placed in an iron cylinder of one cubic metre capacity, which can be hermetically closed. A vacuum is formed in the cylinder in order to withdraw the air from the objects which are placed in it, and is maintained for four hours, after which a liquid composed of petroleum essence, colophony, linseed oil, and paraffin is admitted; this liquid being heated to a temperature of 75° C. before it is let into the cylinder. The articles are kept immersed in it for a quarter of an hour, when they are withdrawn and placed in a similar cylinder heated to 100° C., for the purpose of expelling the petroleum and recovering the solvent for use in other operations. The articles having been dried, are exposed in a stove for five hours, at 75° C., in a current of electrified air, or air containing a considerable quantity of ozone, for the oxidation of the linseed oil which fills the pores of the pulp. They are then plunged for an hour in a bath of linseed oil, castor oil, and colophony; exposed again in the stove to air and ozone, after which they are completely impermeable, flexible, and proof against acid.

The adaptability of paper for the construction of canoes has been proved by the strictest tests, and the canoes have been found to be practicable boats; but the manufacture of them has not been as prosperous an industry as might have been anticipated.

On the other hand, the application of paper in house-building has been crowned with success. A builder's establishment founded several years ago took for its device "*Neither wood nor iron*"; and its houses, built almost exclusively of pressed paper, are curious specimens of what may be done with that material. The element of the construction is a panel, usually three metres by one metre and sixty centimetres, and a tubular beam ten centimetres in thickness, and composed of two walls of pressed paper four millimetres in thickness, fixed upon a frame, likewise of paper. The pieces composing this frame are V or U shaped; and these devices, capable of giving extremely light joists or beams, are not one of the least original of the conceptions of the system. The elementary panels do not weigh more than forty kilogrammes apiece; they are easily handled, and they fit at their edges so as to constitute the wall. The roof is composed of similar panels fastened in pairs. They rest on the walls against which the corner-pieces of paper abut. Although the thrust is weak enough, the two parallel walls are connected by a number of tie-beams composed of thin wire of galvanized iron, particularly if the construction consists of a long hall without any bearing wall. By means of the double walls, which inclose a cushion of air all around the construction, we get houses nearly insensible to variations of temperature, and consequently very comfortable to live in. The floor is composed of panels about a metre and a half square, constituting a wall of paper six millimetres thick, nailed to V-shaped wing-beams.

The use of these houses may be particularly commended for temporary constructions. They are remarkably well adapted to

Hospital on Wheels. (Espitallier system.)

places used for exhibitions, for ambulance services, military campaigns, etc. Hospitals made upon this system appear to have given very satisfactory results. Besides the general advantages accruing from a rapid building, the particular fact may be taken account of that the paper used in the construction of the walls may be made with antiseptic water, which will communicate to it the precious quality of not harboring germs of infection.

[An ingenious portable hospital or barracks of paper, the invention of M. Espitallier, captain of engineers, is described in another number of La Nature, by M. J. Comportey. Its interior dimensions are sixteen by five metres, and it will accommodate twenty beds. Folded up, it forms a load for three two-horse trucks.

When it is to be set up, the three trucks, the length of which is equal to the width of the building, are brought up so as to be parallel in line and a few metres distant from one another, and are arranged so that their floors, which are to form part of the floor of the building, shall be on a level. Light T-shaped joists of iron are stretched across the intervals, supported by trestles when necessary, to receive the paper panels completing the floor. The other details of the structure are substantially as described by M. Ratoin. The interior of this building is entirely satisfactory, without visible framework, and without posts to interfere with the arrangement of the beds or with the circulation of the air. The walls, and the ceiling, which is inclined according to the inclination of the roof, are closely jointed and varnished, and consequently easy to wash and disinfect. The only open joints are the vertical couplings, which can be inspected and cleansed by simply taking them apart. The windows are of wire gauze covered with a transparent coating so as to avoid the inconveniences of glass. Ventilation is effected through holes bored at the angle of the ceiling and the wall.—Ed. P. S. M.]

We do not purpose here to review all the new applications that have been made of paper, but have intended only to take notice of some of the principal ones, and to call attention to some of the improvements that have been made in them. To the other uses—in wagon-wheels, barrels, horseshoes, etc., mentioned in the beginning of this article—we may add a notice of the experiments that have been made in the use of paper in the manufacture of some articles of furniture, such as tables and folding chairs, the principal advantages of which evidently lie in their lightness. These experiments have been timid enough; but no long time will elapse before paper, which already has its masons and its carpenters, shall also have its cabinet-makers.—*Translated for The Popular Science Monthly from La Nature.*

Recent analyses of the air of larger towns, made by a committee of the British Association for the Advancement of Science, and reported by Mr. G. A. Bailey, show: 1. That in clear, breezy weather the amount of sulphurous acid is less than one milligramme per one hundred cubic feet of air. 2. That in anti-cyclonic periods it rises very considerably, and in times of fog, *maxima* of thirty-four and fifty milligrammes have been recorded for the worst districts of Manchester and London respectively. 3. That wherever an open space or a less densely populated area occurs there is a very marked diminution in the amount of impurities in the air. 4. That an increase in the amount of sulphurous acid is accompanied by at least as large an increase in the amount of organic impurities in the air. 5. That smoke, promoting as it does the formation of fog, and preventing free diffusion into the upper stratum of the air, must be regarded as the principal cause of the impure state of the atmosphere in large towns.

DEAFNESS, AND THE CARE OF THE EARS.

By ABRAM MILLS FANNING, M.D.

IT is astonishing to realize how little is known by the laity of the simplest rules for the preservation of health.

It would be amusing if it were not so shocking, because so ignorant, to know of some of the curious remedies used by people otherwise intelligent. Owing to this widespread, dense ignorance of simple medical facts among our people, positive harm is done, irreparable in many instances.

Our blind asylums contain many cases of what are known to physicians as cases of "preventable blindness"—the sight forever destroyed by the use of some "old woman's remedy," as tea-leaves, for instance, persisted with until damage too great to be successfully combated by the physician is done to the sight.

It is the popular idea that the deaf and dumb are always born with that affliction. Of course it is not so. As a rule, there is no radical defect of the organs of phonation; but children born deaf can not talk because they have never heard and learned any words. Many are the children, blessed with perfect hearing and consequent speech for the first two, three, or four years of their lives, who, in consequence of improper or no attention to their ears during an attack of measles, scarlet fever, or diphtheria, have totally lost all sense of hearing; and their ability to talk has then gradually diminished and disappeared also. Our deaf and dumb asylums are filled with just such cases of "preventable deafness."

This popular ignorance of ordinary medical truths can be attributed in great part to the disinclination of reputable physicians to write popular articles for the enlightenment of general humanity. Most of what has been written of a medical nature for the general reader has been confined to advertisements of patent medicines.

Probably the two most important senses are those of seeing and hearing; and it is of these same two that the least is known by the general public, and that the greatest number of absurdly ridiculous, dangerously improper popular remedies are used. It is the purpose of this writing to correct in some measure this misconception in regard to the ears.

A recent experiment was made by the writer at one of our large eye and ear hospitals in this city to obtain some approximate idea of the proportion of people who really have perfect hearing among those who believe themselves exempt from any defect of the auditory apparatus. Without previous warning, twenty-five eye patients were selected, care being taken to have none but those who had never suffered from any, even temporary, defect of hearing. Of the twenty five, not more than five could be said to enjoy perfect hearing. Four fifths of the patients tested had impaired hearing, and had never suspected any defect whatever.

Of all the native-born inhabitants of New York and vicinity and of residents who came here in early life before their respiratory passages were fully developed, probably a not very much smaller percentage have lost some of their ability to hear perfectly.

The normal ear is capable of hearing considerably better than is necessary for the ordinary purposes of civilization; in fact, is endowed with what may be termed "superfluous hearing." Proper tests will discover the loss of even a small portion of this superfluous hearing, and warn us that we are gradually becoming deaf—in fact, already partially deaf—although we may not have noticed the slightest deficiency. This explains why it is that many victims of certain forms of chronic deafness believe their complaint to have been sudden in its beginning, when in reality it has been progressing for several years; the longer time having been occupied by the gradual loss of the "superfluous hearing," and the patient's attention not having been directed to his affliction until the "necessary hearing" was encroached upon.

The great majority of all forms of deafness are dependent upon and directly resultant from affections of the nose and throat.

In the city of New York and vicinity, owing to the extreme variations of the temperature and climate from day to day, it is indeed a rarity to find among the people who have lived here any time a perfectly healthy nose and throat. Such repeated sudden extremes of hot and cold damp weather, which are so common in this location, are ruinous to the throats of even temporary visitors with perfectly healthy respiratory organs; and the effect is so marked, the condition so universal among the inhabitants of this city, that children of catarrhal parents are born with a swollen, catarrhal condition of the inside of the nose and throat which within very few years closes the nostrils so that proper respiration is impossible, and the child becomes what physicians call a "mouth-breather." We meet these children constantly in the streets. The climate of Brooklyn is even worse in this respect.

From the condition of a "mouth-breather" it is but a short step to one of two results—more often both: deafness, and that peculiarly stupid, sleepy, inane, foolish expression of countenance so characteristic of the "mouth-breather."

To parents who have the welfare of their children at heart, such a warning as this should be of sacred importance. As soon as the child gives evidence of a tendency to breathe constantly through its mouth, just so soon should intelligent medical investigation be made of its nostrils, preferably by a proper specialist.

It is quite common for a child's mouth to drop open when asleep, although he may have been breathing through his nose when falling asleep. To correct this tendency it has long been a custom among many mothers to tie a folded handkerchief over the child's head and under its chin to keep the mouth closed. But it is cruel and dangerous to do this unless we are positive that the child can breathe easily through the nose.

Snoring also should be a warning, because snoring is usually due to breathing through the mouth, and mouth-breathing is due to the swollen, catarrhal condition of the inside of the nose; and it is this condition which is the cause of dry catarrhal deafness, which is by far the most frequent form of deafness.

Most of our population have some general ideas of catarrhal affections of the nose and throat, but very few except those who have lost their hearing from it have any conception of its intimate causal relation with deafness. The popular idea of catarrh is that it is a condition of more or less constant discharge of offensive mucus from the nose. This is so only in the most aggravated and worse forms of the disease, and fortunately is rare. Properly speaking, catarrhal affections of the nose and throat are simply an enlarged, swollen, and thickened condition of the lining membrane of the nostrils and back part of the throat. This thickened condition of the mucous membrane in the nose is usually accompanied by an increased production of mucus, which often drops backward into the throat, and, by increased moisture in the back of the throat, excites the continuous little hacking cough to dislodge it and clear the throat.

These patients are very subject to what are called "colds in the head," with complete closure of the nasal passages. The reason their colds in the head are so severe is because a very slight swelling of the inside of the nostrils, which is always the condition in this acute disease, occurring in a nose already much narrowed by a chronic permanent enlargement of its lining membrane, totally obstructs the nasal canals.

A very common but unhealthy remedy for temporary or permanent occlusion of the nose is to snuff a solution of salt and water through the nostrils. Unfortunately, this practice has been too often thoughtlessly recommended by family physicians. If the habit is prolonged, the condition for which it is used will surely be aggravated. A much better solution to use in the nose, and also as a gargle in acute sore throat, instead of chlorate of potassium, is common baking soda (bicarbonate of soda), a teaspoonful in a cup of warm water. Whatever solution is used in the nose, it is a great mistake to forcibly snuff it into the nostrils from the palm of the hand, as is too commonly done. If it is snuffed too forcibly, it is forced into the upper part of the nasal cavity, where it is very irritating, often causing headache and irritation of the eyes. The best and simplest way to use the soda solution is to bury the nose entirely in the cup of fluid, and then gently suck the solution into the nose, at the same time holding the mouth widely open. There is no risk of choking if the mouth is open and the head thrown forward, as it necessarily is in doing this, for all the fluid will run out through the mouth. A few trials will readily demonstrate the advantage of this method over all others.

Probably all the laity, so to speak, when first they realize that their hearing is diminished, believe that the wax has accumulated and has blocked the auditory canal. The sensation to them is certainly one of obstruction, and they seem justified in picking at the canal of the ear in attempting to remove the obstructing substance.

With very rare exceptions, deafness is never due to wax alone. In the majority of cases it is really due to obstruction, but this is very much farther in the head than any patient can reach, and often of too dense a nature and too long duration for even the specialist in otology to successfully eradicate. Even where there certainly exists a mass of wax entirely blocking the auditory canal, with it is always associated an underlying catarrh of the drum of the ear without any discharge from the ears whatever. The effect upon the hearing is like that caused by closure of the canal, and wax alone is suspected. In the effort to remove the suspected obstruction, matches, toothpicks, hair-pins, etc., are used in the ears, and perhaps a little of the normal wax which belongs in the canal is removed, and the patient's suspicion seems to be verified.

It must be emphasized right here that the ear-scoops and ear-sponges for sale in all drug-shops are worse than useless; they are positively dangerous. Many are the ears that have been incurably injured by such instruments. There is more wisdom than humor in the old saying that we ought to put nothing in our ears but our elbows. At any rate, let no one put anything into the auditory canal but the end of the little finger wrapped with a handkerchief or a towel.

If deafness is of sudden occurrence, accompanied by a dull, rumbling sound in the ear, similar to that caused by temporarily closing the canal of the ear by the finger, with a sensation of fullness of the canal, and absolutely painless, obstruction from accumulated wax may be suspected. But there is no means of positively determining this, except by having the ear carefully examined by some competent observer.

To remove impacted wax, the same baking soda (bicarbonate of soda) is the best preparation to use. A teaspoonful of the soda should be mixed with just enough warm water to dissolve it; this should then be dropped into the ear until it is filled, and allowed to remain in contact with the wax for five or ten minutes. It is to be repeated three times during the day; and then the ear should be thoroughly syringed with a quart of hot water. No other syringe than the fountain douche should be used.

For ordinary purposes a good douche can be extemporized from an old quart bottle by attaching a convenient length of rubber tubing to its mouth, and, filling the bottle full of the hot water, invert it and allow the water to flow through the tubing into the ear.

Other forms of deafness are too deeply seated to be dealt with by any one but a specialist.

The earliest symptom of beginning deafness in many cases is a ringing sound in the ears. Many patients describe it as a noise all through the head rather than in the ear itself. It is at first intermittent and occasional. The ringing may be present for some time, scarcely perceptible, when suddenly the sound will change, becoming much louder, and the note jumping high up in the scale, where it will continue to ring quite loudly for some minutes, and gradually die away, to appear again some time afterward. It may reappear in a few hours, as the trouble with the ears progresses. Ringing in the ears may also be the prelude to an acute attack of earache; but it is here followed very soon by pain, which so predominates over the ringing that it is no longer heard.

If the hearing is properly tested just as soon as the ringing in the ears has become more or less constant, some degree of deafness will be detected. As the case progresses, even before all the so-called superfluous hearing has been destroyed, the patient will realize that he is becoming deaf. For this condition there is nothing to be done by the patient himself. Advice from a physician should be obtained just as soon as diminution of hearing is suspected.

Much can be accomplished, however, by the patient toward preventing the deafness becoming worse. Careful attention should be devoted to the general health, to keep the nose and throat in as healthy condition as possible—to prevent "taking cold," especially colds in the head. Exposure to changes of weather should be avoided; the feet never being allowed to become wet, or, if they do become wet, the shoes and stockings should be changed for dry ones as soon as possible. Turkish baths and plenty of outdoor exercise are strongly to be recommended, to stimulate the circulation and inure the system to changes of weather.

Another great class of troubles which is sadly misunderstood by the public is the acute inflammations of the ear. There are few pains in the human body more distressing than earaches. Many have been the nights of agony passed with pain in the ear, because the proper remedy has not been known in the household.

Almost every conceivable thing has been used for earache by patients of high and low degree. With the exception of baking soda, already mentioned—and I have considerable hesitancy in trusting even that to popular use—nothing should ever be dropped in the ear except hot water. When the ear is throbbing with pain, the hot douche is the best means to employ for relief. In this condition any kind of a syringe is available, for there is not much probability of the sufferer throwing a stream forcible enough to increase his pain. Very hot water should be used. A quart of plain water as hot as can be endured should be injected, repeating it as often as is necessary—every five minutes, even.

If we happen to be beyond the reach of a physician, and the hot-water douche fails to relieve, leeching should be employed, remembering to apply the leech upon the little projection just in front of the ear, called the *tragus*. Do not ever put a poultice over the ear.

To secure rest at night and between the intervals of necessary douching, fill the auditory canal with hot water, cover the whole side of the head with a napkin wrung out in hot water, and tie a dry towel over the entire head.

Simple tenderness in front of the external ear or in the canal means either a pimple or a boil in the canal. In this condition also, hot douching and hot-water applications are the only safe remedies to employ at home. Medical advice must be sought early, to open the little abscess and allow the matter to escape.

Violent, throbbing, deep-seated earache means an abscess within the drum cavity of the ear; and this is a serious disease—often ruinous to the hearing, and even dangerous to life. The advice of a physician, preferably a specialist, is indispensable; and the above hints are not at all intended to supply his place, but merely to anticipate his arrival.

A FIFTH satellite of Jupiter was discovered by Prof. Barnard, of Lick Observatory, September 12th, and had been observed by him to October 17th on seven successive nights. It was also seen by Mr. Reed at Princeton, on October 10th, with a twenty-three-inch telescope. It is a star of the thirteenth magnitude. From three hundred micrometric observations by Prof. Barnard and the observation at Princeton, a period has been approximately deduced of eleven hours and fifty-seven minutes.

THE SYMMETRICAL DEVELOPMENT OF OUR YOUNG WOMEN.

BY C. E. BREWSTER.

WHILE reading an earnest paper upon Conversational Immoralities, by Mrs. Amelia Barr (North American Review, April, 1890), I came across the following sentences: "There are bad people in the world, but young girls should never be near enough to them to be aware of the fact"; and "Women of whose lives young girls should, at least, seem to be innocent, are topics of conversation."

Now, while I am in full sympathy with the general tenor of this article, deploring as deeply as the author the increasing flippancy of speech of both old and young on this, the gravest question of the day, the sentences noted above, together with some others scattered throughout the article, move me to offer to your candid consideration a few pertinent facts aiming to prove that, where the reverse principle obtains, the highest good inevitably results to all who come within the radius of the pure young woman's intelligent interest and sympathy.

After comparing, for years, the general influence of the purely innocent woman with that of the pure and morally intelligent young woman of our day, I am so thoroughly convinced of the more abiding influence of the latter class that my earnestness impels me to try to show you a little more clearly the moral standpoint and resultant work of this unobtrusive but most potent factor in the refinement of society. Undoubtedly in this work, as in every other field of life, numberless opportunities arise for the sensational and supersentimental to gain (in the guise of philanthropy) the notoriety dear to their hearts. Not infrequently the novelty of the work appeals to many a young woman who, through immaturity and excess of zeal, brings upon herself condemnation where she sought elevation, failure where she sought success. But shall we therefore be discouraged? Shall we change our point of view simply because the few imprudent fall short of the good which they hoped to gain, because the few sensational pervert and distort the cause which we are trying to uplift? Shall the good actually accomplished by the greater number be tabooed because of the failure of the few?

A system which aims to conceal vice, rather than to suppress it by full knowledge, in reality fosters its existence. High ideals invariably beget correspondingly high realizations. For example, in many European cities it is considered not merely a daring breach of etiquette, but a social challenge, for a young woman to walk the streets unaccompanied by a protecting person.

As a consequence of this superficial convention, it becomes absolutely unsafe for respectable women to violate its code. Compare this with the state of things in our own country. Are our young women less pure or our young men less gallant where no such artificial system obtains? Is there not rather the greatest respect here for the young woman who treads fearlessly our streets, thinking no evil? But there are many bad people abroad. Shall the pure, therefore, be kept at home, their freedom fettered, their sphere of usefulness limited, because one third, perhaps, of those whom they pass go to and fro, abetting the indulgence of vulgarity and crime?

And if in the streets a pure woman commands respect because of her dignified bearing; if in the halls of higher education she walks apace with the thinkers of the day; if in the arts and sciences she is welcome as an able participant, why should she be barred from grappling with the greatest question of existence—the mystery of life and the abuses with which it is so thickly surrounded? Will she bring thither an insight less keen, a sympathy less spiritual, a judgment less temperate, a power less practical? And if she is to cope with the subject at all, is there any time when she will be in fuller power, in greater subtilty of influence, than in her developing womanhood? That she can reform our sensual world I do not claim; but that she is an intermediary, singularly well fitted for this work, I most earnestly believe.

Do not misunderstand me. I would not urge her going with the doctor on his rounds, nor the policeman on his raids. I would not drag her unneedfully to the haunts of shamelessness and resulting torment, but I would urge that she learn the principles of this, as of all life's lessons, in her early youth; that she be gravely and reverently led on to perceive her own high usefulness in perpetuating right views of this matter, so that with full knowledge she may face the sad life around her; that the veil be gradually moved aside—not kept tightly drawn till rent asunder at a time when the awakening must inevitably result in a revulsion of affection, a cynicism of spirit, and a hardness of heart, whose exceeding bitterness only those who have suffered can know.

I claim that the idea of usefulness, the quickening to the highest form of womanhood, combined with the early revelation of God's plan, will go further to disarm sensual thoughts than any artificial innocence, however well guarded.

Does any one question the purity of our young women physicians or our trained nurses? Does their knowledge of disease and its causes take from them that nicety of feeling with which they entered the profession? In many instances a sweet seriousness of manner, a shade more of dignity, perhaps, replaces the thoughtless buoyancy of unknowing youth; but the fine edges of inherent modesty are never dulled by scientific study pursued in the interest of bettering humanity.

A broad knowledge of the temptation to break the seventh commandment, surrounding our youth—a knowledge of the awful mental and physical suffering induced even in childhood by the violation of this commandment—not only places our young women in a position to be of the greatest practical aid to their brothers, but also gives them a sympathetic approach to that broad charity which Christ himself showed to the woman taken in adultery—that sad, sweet story which has come down to us through the centuries, bringing comfort to the hopeless and fallen, stimulating the compassion of the fortunate and pitiless. How many of us, I wonder, after being touched by the "sweet reasonableness" of this lesson, in actuality say to the contrite: "Neither do I condemn thee; go and sin no more"!

Ultra-innocence condemns too severely or condones too readily. It is incapable of inquiring into the general causes which produce from time to time certain disastrous individual effects. As a case in point, I know of a young woman brought up in the conventional manner in utter ignorance of the magnitude and nearness of this form of sin. Left, later, with the responsibility of bringing up two fatherless boys, shrinking from touching on these matters, she relied upon the refinements of home to be a sufficient protection against wrong living. In her happy confidence she said, "I would rather cut my throat than speak to my boys of these matters, or show them that I could think them untrustworthy here." I saw her later, when those boys, sent early into the world, unfortified as to its temptations, had fallen into sins whose shame must follow them all the rest of their days. Had she *known* of the over-prominence of this sin, would she not have worked as well as trusted?

On the other hand, I know well a young girl left motherless, with the care of three younger brothers. Instead of dexterously parrying the questions natural to young children, she took them to her heart, unfolding to them gradually the mysteries of their being, watching carefully over their reading and associations, meeting their perplexities at every point, and warning them of the strain of temptation to which all men must be sooner or later exposed; as they grew older, enlisting their sympathies in the work of helping others, getting them to meet her naturally on her own high plane, and finally gaining their hearty co-operation in this work. Do you think she would have been able to do this had she in her earlier days, before this responsibility came to her, "dwelt outside the current in which such subjects are spoken of"? Do you think any other influence would have been as powerful in molding the lives of these young men?

It is very seldom, too, that young women can be kept in entire ignorance of the workings of this undercurrent. Nowadays the subject is much discussed; bits of information are dropped here and there by careless matrons; the sickening accounts of the infanticide of child-mothers (over the publication of the details of which accounts the daily press seems to claim an unquestioned prerogative)—all these things tend to depict, though in a fragmentary way, the workings of the other life. To assume, therefore, that our young women are ignorant of a state of things of whose existence they are perfectly well aware, is to put them at once upon the insecure basis of the dissembler. Is this simulated innocence of intrinsic value? Does it not rather dwarf growth and cripple usefulness? Unless early accustomed to viewing such matters from the truthful, helpful standpoint (and such standpoint *does* exist), our young girls become bitter and unsparing in judgment, sharers in that sweeping intolerance which half-knowledge always breeds.

Is there, I ask you in all fairness, any justice in exacting such a false social state? Here, as elsewhere, give our young women a chance to work. Do not bring them home with education "finished"—thoroughly equipped mentally, partially equipped physically, but utterly denuded of that intelligent moral accoutrement which is to make them well rounded in character, a power in their little world. Apply the strength now devoted to shielding their supposed ignorant innocence to the development of healthful views on a subject which must, sooner or later, confront every thinking woman. Many contend, I know, that our young girls are not strong enough to bear a comprehensive knowledge of this subject; that such knowledge, even though it may not rob them of their pure-conceptions, at least causes them to become depressed and utterly cast down. But I think not, told with reverence, as a whole. They must face this knowledge eventually. Is it any less cruel to encourage the building up of disproportioned ideals which must ultimately be chipped away, piece by piece?

Let us grant, for the moment, that the conditions of society are now such that it *is* possible to keep young women completely ignorant of the moral laxity all around them. Let us admit, for the present, that it *is* possible for maturing persons to acquire broader views on all other topics and still retain their childishness of view in these matters. Do you think, therefore, that their influence, as is frequently claimed, will be stronger over the men with whom they come in contact? Do you think their misinformed minds can frame wise or trenchant judgments worthy of the respectful consideration of the men in their immediate circle?

That perfect innocence disarms impurity, even among those who have fallen far below the ordinary standards of virtue, I gladly admit. None but brutish men can resist the exquisite, oftentimes unconscious pleadings of things intrinsically beautiful—whether in the form of a mother's love, a hero's exaltation of spirit, a maiden's sweetness, or

> "The fair pure soul of a little child
> Opened wide to the light of day."

Such things must touch, for the time being, the hearts of the hardened; but, alas! they are so seldom far-reaching in effect or enduring in result. In very rare instances, in the cloistered nun, possibly in a jealously guarded daughter, does complete innocence now exist. And an opening flower can not go back again to the constricting clasp of its budding life without violating the law of its natural development. Shall we surround it with artificial barriers, thereby restraining and delaying its blooming, or shall we encourage it to unfold and thrive in the air in which God has placed it? No young woman, properly impressed with the noble dignity of her calling, equipped with wholesome views of life and fearless in purpose, can fail to command the respect and admiration of all who cross her path. A licentious or loose-lipped man would cower before her earnest eyes as certainly as before the appealing innocence of a child-woman, nor ever attempt to break down the barriers with which nobility of purpose always encircles our most womanly young women.

I am glad to see that many are now awakening to the necessity of abandoning the limitations of an old method which, while throwing a halo of romance around the barbarous and superficial chivalry of our knightly ancestry, in reality fostered the growth of a system of license whose many ramifications are to-day undermining the very foundations of our social structure. The latest work of our greatest English novelist portrays, as only his master-hand can portray, the need of woman's thorough comprehension of and co-operation in the treatment of this gravest moral problem of the age.

Just how a young woman may work in this field I can indicate merely in a general outline, which the tact, native ability, and earnest judgment of those interested will fill out as circumstances permit. For the proper carrying out of this work, integrity of purpose is the primal requisite. Eliminate that, and I unhesitatingly concede to the mediæval, convention-ridden methods the undisputed right of way.

In many of our cities our college-bred and working young women are at the head of little bands whose foremost aim is to gather in the children from the streets; for in this, as in every reform, the root of the matter lies with the children. By the circulation of healthful books and papers, much is done to counteract the baleful influence of that vile printed matter which systematically inundates our public schools. Kindly, sympathetic talks are given, rarely bearing directly on these matters, but stimulating the indifferent to take advantage of all opportunities of self-improvement, and all making for the uplifting of a sin-burdened world. Care is taken, as these children grow older, to secure for them honest positions, to teach the unsuspecting to avoid those glittering pitfalls where the largeness of the salary offered is compensation in part only for service rendered—in reality is a premium upon loss of character and self-respect; to provide temporary homes for young women-immigrants landing helpless in strange cities, until suitable positions can be obtained for them; and, most important of all, care is taken to impregnate the working-girl element with the sense of responsibility devolving upon every woman as a person of influence, urging the dissemination of this thought throughout all their home work in some such ways as these. By urging the discipline of self-reliance and self-restraint, and the highest standard of purity, delicacy, and strength, equally on brothers and sisters; by discouraging the witnessing of certain popular but none the less indecent plays; by watching carefully over the reading of the younger members of the family, discountenancing the perusal of our so-called town papers by the boys as well as the girls (for no one can touch pitch and remain undefiled); by setting the example of avoiding the reading of details of popular divorce scandals; especially by guarding against that ubiquitous erotic literature which, masquerading in the attractive, fantastic garb of beautiful illustrations, claiming the prestige of realistic or classic origin, when divested of all its false trappings is, in all its hideousness, but a powerful excitant, stimulating the prurient imagination of the inexperienced, thereby starting many a child on the treacherous path down which it is so pitifully easy for the untaught to slip, and whose starting-point it is all but impossible to regain. This form of reading-matter is the most successful of all the recruiting officers from the vast army of the shameless.

To carry this work on helpfully and practically, to gain a positive algebraic sum from these many efforts, must not our young women "know of the existence" of fallen men and women! Could they increase their power, here or in their home-influence, by "seeming to be ignorant of the existence of such people"?

Ah! these young women are to be the mothers of our race: shall we not arm them with the knowledge wherewith to breast the future? Will not this knowledge in the average intelligent young woman, combined with the unsullied heart which is her birthright, make her a more worthy co-operator with her husband; a stronger spiritual sympathizer; one who will not flinch when confronted with the privilege of making noble women of her daughters, of saving her sons from falling victims to the sin which is dragging down to ruin so many of our finest young men?

"The height of the pinnacle," says Emerson, "depends upon the breadth of the base." Give, then, to our young women this broad basis of knowledge. as you wish the height attainable to be proportionate and exalted.

PROTECTIVE INOCULATION FOR CHOLERA.

By S. T. ARMSTRONG, M. D., Ph. D.

IT would be difficult to say where the idea first originated of the possibility of artificially producing occult changes in the organism of a healthy individual, so that, if exposed to a contagious or an infectious disease, there would be an acquired resistance that would prevent the development of such a disease. Tradition states that, in the case of small-pox, the custom existed in South Wales of rubbing matter from the pustules of a small-pox patient on the skin of a healthy person's arm, in order to protect the latter individual from acquiring that malady; and, for a similar purpose, it was the custom in the Scottish Highlands to wind about the wrists of children worsted threads that had been moistened with such matter. Inoculation of healthy persons with variolous matter had long been practiced in Oriental countries when Lady Mary Wortley Montagu introduced it into England. And as recently as our civil war this procedure has been employed, because the usually mild attack of small-pox following the inoculation is less dangerous than the ordinarily acquired form of that disease.

The discovery of the protection afforded by vaccination suggested new working theories; for it was as remarkable that the contagious principle of small-pox should undergo some modification in the human system as it was that it was decidedly modified in the cow. It has been demonstrated by many experimenters that, in a calf that has not had cow-pox, inoculation of small-pox virus will cause that disease; and, furthermore, that matter from the eruption on the calf's udder will, if inoculated in an unvaccinated person, produce the well-known phenomena of vaccinia. Science, accordingly, learned two facts from this: that the virus of a disease may be diminished, or attenuated, in its development in an animal organism other than that in which it found its most poisonous growth; and that this attenuated virus, introduced into the organism of an individual susceptible to the influence of the original disease, protected that individual by conferring an artificial immunity.

To these known facts regarding small-pox was added that knowledge gained during years of observation by both medical and lay men, that one attack of a contagious or infectious disease protected the individual, as a rule, from a subsequent attack if exposed thereto in later years. Little or no perceptible alteration existed in the human organism, and yet it had acquired some singular quality that enabled it to resist the infection of that disease if ever again exposed thereto.

It is to-day believed by excellent authorities that the processes by which this immunity is obtained vary as widely as do the processes of disease themselves. Each of these infectious diseases produces in the blood certain poisonous substances; and as man can be, so to speak, familiarized with a poisonous drug by the administration of doses that gradually increase from one that is harmless to one that ordinarily would be at once fatal, so there is probably a similar Mithridatic transformation in the character of the fluids of the body that have once met and conquered the toxic principle of an infectious or contagious disease.

Working on this hypothesis scientists have been experimenting with the introduction into the animal organism of the poisonous substances called toxines, toxalbumins, leucomaïnes, or ptomaïnes, that are produced by the micro-organisms of the various diseases, in order to determine the possibility of preventing the susceptibility for acquiring these diseases.

The discovery of a method that would protect an individual from cholera would be of great usefulness. For in India, the home of that disease, the average annual mortality therefrom in the cities is 3·32, and in the country 1·52 per 1,000 living. The army statistics show that 2·49 per cent of the European soldiers are admitted to the hospital for cholera, while only 0·95 per cent of the native soldiers are admitted for the disease; but the mortality, 33·69 per cent for the former, 35·5 per cent for the latter, is almost equal. In the various epidemic manifestations of cholera in various parts of the world the mortality has often exceeded 50 per cent of those attacked. In 1884 and 1885 cholera was epidemic in southern Europe, and in Spain in the latter year the official report states that there were almost one hundred and twenty thousand deaths. There were fifty-one persons affected in each thousand living, and the mortality was 36 per cent. These statistics stimulated investigators to attempt to solve the problem of affording immunity to cholera.

In March of 1885 Dr. J. Ferran, living in a small town in Catalonia, sent a communication to the French Academy of Sciences in which he described some experiments he had made with the specific organism of cholera, the comma bacillus, Koch's comma bacillus, the cholera spirillum, or the cholera vibrio, as it has been variously termed.

By experiment it had been learned that the cholera spirillum, like many other micro-organisms, would develop plentifully in certain nutritive substances, such as a very rich beef broth or jelly if kept at a certain temperature. Such an artificial propagation of a micro-organism is called "a culture" of that organism. Ferran found that the maximum virulence of the cholera spirillum was obtained in a culture of rich, slightly alkaline bouillon, and that from thirty to sixty drops of this culture would kill a guinea-pig, if inoculated under the animal's skin; but, if a smaller dose was inoculated, a local inflammation followed that might slough though the ulceration would heal spontaneously without forming pus; and this animal would not be subsequently affected by the injection of a quantity of the culture of the cholera spirillum that would rapidly prove fatal in an unprotected animal.

Ferran reasoned that if such a result could be obtained in the organism of a lower animal, why could it not be secured in the highest animal? Accordingly, he injected hypodermically in man, fifteen drops of his virulent culture: a hot, painful tumor, with local fever, and *malaise* followed, but without choleraic discharges from the bowels; and these symptoms disappeared in twenty-four hours. If a similar quantity was reinjected in the man a week later no general and few local symptoms followed. He therefore considered that by these injections of graduated doses he could arouse in each person's system that resistance to the disease that has been heretofore referred to. He did not believe that the cholera spirillum multiplied in the cellular tissue that is beneath the skin, but that it produced in the tumor formed at the point of inoculation a rapidly diffusible toxine that exercised some influence upon the nervous centers. The dangers of an attack of, and death from, cholera begin to disappear five days after the first inoculation, and each successive inoculation increases the guarantee of immunity; three inoculations, each of thirty drops of the bouillon culture, at intervals of five days, produced a profound immunity.

He continued his experiments, and in 1886 sent another memoir to the French Academy of Sciences, wherein he stated that cultures of the comma spirillum in which the living organism had been destroyed by a high temperature, would, when inoculated, confer a tolerance that successfully resisted the effects of the living spirillum. He furthermore stated that an active principle was generated by the spirillum, that could be isolated by certain familiar chemical methods, and that conferred the power of resisting the living micro-organism.

During the epidemic in Spain, Ferran's inoculations were practiced in more than thirty thousand persons. In the province of Valencia there were 62·33 cases per thousand of population, and 31·11 per thousand died of cholera. Where inoculation was generally practiced the cholera affected 76·95 per thousand, with a mortality of 33·58, of the total uninoculated; while among the inoculated 12·69 per thousand were attacked, and only 3·41 per thousand died. In other words, in the latter class 6·06 times fewer people were attacked, with a mortality 9·84 times less than that of the uninoculated.

Ferran's methods were investigated by commissions from several of the European scientific societies; and by several, notably that from France, he was condemned for having made claims that could not be demonstrated.

In 1888 Dr. Gamaleia published the results of experiments he had made with the cholera spirillum. He found that the cultures of this organism, as obtained from the human body, lose their virulence in the laboratory. In order to restore this virulence, and possibly to enhance it, Dr. Gamaleia first inoculated a guinea-pig with the cholera spirillum, and when the disease was apparent in that animal made an inoculation from it into a carrier-pigeon. This was on the principle employed by Pasteur to increase or attenuate the virus of chicken-cholera, rouget, anthrax, and rabies by inoculating different animals with the respective virus of those diseases. So toxic does the cholera spirillum become in the pigeon, that a few drops of its blood rapidly kill an animal susceptible to cholera. He also found that in a sterilized culture of the spirillum there was a principle that, administered in non-toxic doses to an animal, would afford subsequent protection from cholera. The phenomena produced by these inoculations were similar to those observed by Ferran in his own experiments, though no inoculations were made in man by Gamaleia. G. Klemperer has reported this year experiments that verify those made by Ferran and Gamaleia. He discovered that a guinea-pig could be protected against cholera by inoculating it with the serum of the blood of a rabbit that had been protected by inoculation of mild cultures of the spirillum; and in one rabbit that had been rendered immune to pneumonia as well as to cholera, its serum afforded protection from cholera to guinea-pigs, and from pneumonia to mice. He considered that these results corresponded with the immunity observed in human beings after an attack of Asiatic cholera.

During this year Haffkine has reported to the Paris Biological Society experiments that he has made with the spirillum.

One of the objections that has been made regarding the acceptance of this organism as the sole cause of cholera has been the difficulty of reproducing in animals, by injections of the spirillum, a disease that generally resembled human cholera. Haffkine adopted the ingenious plan of using diluted serum obtained from rabbits as the medium for the development of the spirillum, and transferring a few drops from this to a less diluted serum, and so on until the micro-organism lived in the undiluted serum. If the spirillum thus acclimatized, so to speak, be injected into the blood-vessels of a healthy rabbit, the animal will die with all the symptoms of cholera; this serum might be called a virulent culture. By passing an ordinary bouillon culture of the spirillum through a series of guinea-pigs he could also obtain a virulent culture that rapidly killed if injected into the abdominal cavity, but that, when injected under the skin, produces phenomena similar to those described by Ferran, and results, as the latter stated, in rendering the animal immune against inoculation with cholera in any strength whatever. Rabbits and pigeons were rendered immune in the same way. These results induced Haffkine to try the inoculations on himself and seven other persons; the phenomena observed in each of these individuals were similar to those reported by Ferran, and a second inoculation made after an interval of seven or eight days produced far less general and local disturbance than the first. While differing slightly in the methods employed, all these later experimenters, it may be seen, have confirmed Ferran's original report, although none of them mentions his name or the priority of his discovery.

What is the value of these inoculations? This may in part be answered by the question, What is the harm? All observers concur in stating that in animals, as well as in man, the inoculations, made in moderate doses, are harmless beyond producing a slight local irritation and temporary *malaise*. And any one who has been subjected to the inoculations can easily determine at any future period whether he is then protected, by receiving another inoculation; just as a later determines the protection of the individual by an earlier vaccination.

It is necessarily conceded that the factors that enter into the question of natural are not those of artificial infection. But it is necessary to recall the facts stated in the first portion of this paper; and it is seen that there are good grounds for believing that immunity against natural infection is correlated with immunity against artificial infection. There may be no exact and absolute demonstration of this fact, for no vaccinated person willingly associates with a small-pox patient, or has himself inoculated with matter from a small-pox sore, in order to determine his immunity toward that disease. The vital statistics of this century answer the question regarding the utility of vaccination. Whether those of the coming century will answer that regarding the utility of inoculation as a preventive not only of cholera, but of other infectious or contagious diseases, remains to be decided.

FALLACIES OF MODERN ECONOMISTS.*

By ARTHUR KITSON.

IN matters scientific as well as religious a conflict of opinion among professors is apt to produce skepticism among scholars. Nothing tends to discredit the teachings of a system more than want of harmony among its exponents. For such discordance is an acknowledgment of doubt and uncertainty, of failure to discover the truth. Before any branch of human inquiry can properly be dignified with the name of science, there must be some sort of general recognition of at least the fundamental principles upon which it is built—some general agreement as to what laws govern the phenomena with which it deals.

Not until conflicting theories and opinions have been settled and a uniform classification arrived at, can we be said to have entered the realm of exact science. Scientific exactness is, in fact, marked by the absence of intelligent criticism. Like religion, science has had and still has its battle-grounds, where scientist wars on scientist. Such disputes, however, are usually confined to mere speculations, undemonstrable theories, or undeveloped fields of inquiry. When once the speculation ripens into a demonstrable truth, all contention ceases. For the aim of science is the discovery of truth. Of modern sciences, none stands more discredited by the average reader than the so-called science of economics. The cause of this becomes apparent when we consider the contradictory nature of the theories taught by modern economists, the utterly discordant answers given to social problems, and the extreme divergence of the paths proposed for reaching social happiness. For instance, we are informed by one economist that the cause of all or nearly all the crime and misery surrounding us is due to the system of private ownership in land; another attributes it to the profit system, another to industrial warfare engendered by competition, another to privileges granted by governments to specially favored classes and individuals, another to the drink traffic, and so on. And the remedies prescribed are equally varied. One school directs us to nationalise

* Abstract of a lecture delivered before Friendship Liberal League, Philadelphia, June 10, 1892.

the land, another to confine taxation to land, another to nationalize all the instruments and means of production, another prescribes a system of co-operation. One favors the enlargement of the powers and scope of government, and another insists on the annihilation of all governments. Small wonder, therefore, that the reader, who has not time to penetrate far below the surface, should lack faith in the teachings of a system whose doctors so thoroughly disagree.

An interesting and somewhat amusing book, entitled The Why I Ams, published by the Twentieth Century Publication Company, comprises a collection of short essays by the representatives of most of the modern economic societies, in which the writers give their reasons for the faith that is within them. Each writer is confident that the school to which he belongs possesses the true solution to the riddle of the social sphinx, and regards his scheme for social redemption as founded on "fundamental scientific principles." Let us examine some of these "fundamental principles" upon which these societies are founded. One of the "fundamental principles" underlying Progress and Poverty is, that the fund out of which wages are paid is created by the wage-earner. It follows that, if this be so, the doctrine that wages are advanced by capital falls to the ground. Mr. George proceeds to test his theory by induction. The illustrations he gives are of two kinds. One class applies to isolated settlements and the other to modern society. The one class apparently favors his theory, the other, however, is decidedly against him. For example, he instances conditions where men are employed in picking berries, gathering eggs, catching whales, etc. In these cases he says it is customary to pay those employed in such occupations by giving them a certain proportion of the things they have brought. In certain gold-fields it has been customary to pay the miner for his labor by giving him a certain percentage of the gold he has mined. All this seems clear enough, and, if the world's industries were confined to those above cited, Mr. George's principle would undoubtedly be sustained. But when he goes on to apply it to the modern factory, ship-yard, and those industries which form the vast majority of human occupations, the facts clearly disprove his assertions.

Mr. George says: "Bring the question to the test of facts. Take, for instance, an employing manufacturer who is engaged in turning raw material into finished products—cotton into cloth, iron into hardware, leather into boots, and so on—as may be, and who pays his hands, as is generally the case, once a week. Make an exact inventory of his capital on Monday morning before the beginning of work, and it will consist of his buildings, machinery, raw materials, money on hand, and finished products in stock. Suppose, for the sake of simplicity, that he neither buys nor sells during the week, and after work has stopped and he has paid his hands on Saturday night take a new inventory of his capital. The item of money will be less, for it has been paid out in wages; there will be less raw material, less coal, etc., and a proper deduction must be made from the value of the buildings and machinery for the week's wear and tear. But if he is doing a remunerative business, *which must on the average be the case*, the item of finished products will be so much greater as to compensate for all these deficiencies, and show in the summing up an increase of capital. Manifestly, then, the value he paid his hands in wages was not drawn from his capital, etc." (Progress and Poverty, page 53.) You will observe the qualification allowed in the sentence, "if he is doing a remunerative business, which must on the average be the case"—a qualification that admits the incorrectness of Mr. George's theory applied to *unremunerative* businesses. Non-paying industries are not rare. One statistician tells us that from ninety to ninety-five per cent of all those who embark in business in this country—the majority of whom are employers of labor and pay out wages—fail. It seems extraordinary that an able thinker like Mr. George could believe he had discovered a general law which admittedly fails in so many instances. In applying the theory to the case of the Great Eastern steamship, Mr. George chooses a most unfortunate instance. He says: "Here is a machinist or boiler-maker working on the keel plates of the Great Eastern; is he not also just as clearly creating value-making capital?" Not necessarily. It depends entirely upon whether the steamship proves a success. Events since showed that she was a gigantic failure. She never earned more than a mere percentage of her cost, and was finally sold for old junk. The greater part of the wages paid to those workmen was drawn directly out of the pockets of the English capitalists, and little, if any, of it was ever returned.

The facts in all those instances selected by Mr. George simply show that under certain circumstances the wage-earner brings to his employer the fund out of which his wages are paid, and under others (probably the vastly greater number) the wages are paid directly out of the fund provided by the employer. The conclusion is, therefore, that while Mr. George has shown exceptions to the economic theory that wages are drawn from capital, he has certainly failed to establish the truth of his own.

In the broad philosophical sense, capital is always the mother of labor,* which simply means that before labor is possible there must be a stock or reserve fund of power—a certain potential force—from which labor draws its sustenance, whether it be in the

* See Prof. Huxley's essay, Capital, the Mother of Labor.

shape of money of the realm or that for which it is exchangeable —viz., food products—or the capital may take the form of ready manufactured brain, blood, nerves, and muscles.

No labor is possible without the power to work, and the power to work must be stored up in the human frame, and a sufficient supply of protoplasm housed to maintain human energy, in order to make labor possible. What else is this than capital—"wealth devoted to the production of more wealth"?

The definition of labor given by Mr. George "includes all human exertion in the production of wealth." Supposing wage-workers were limited to this definition as the standard for gauging the value of their services, what would become of those employed in unremunerative industries or in those of an experimental nature? It would mean that the time they had spent in the manufacture or construction of anything which on completion was found to be unsuccessful, could not be classed as *labor*, and for which they could make no claim—a decision which Mr. George would scarcely be prepared to allow as just.

I must now call your attention to another fallacy which is too gross to overlook, especially as it occurs in other schools of reform outside of the single-tax party. It is that of ascertaining some law applicable to a rude or elementary society, such as Robinson Crusoe and his man Friday on a desert island, and applying the same law to society in an advanced state.

Reasoning by analogy is often a very dangerous proceeding, especially when used by the unskillful. In order to show that capital is really a very useless thing and quite unessential to life, Mr. George cites instances where a number of men begin life on an island and commence without capital by picking berries, catching fish, and killing game. This may be all true in a small community, providing there happen to be the necessary game and fish and berries, the possible absence of which Mr. George overlooks. But where can a city like New York provide itself with sufficient game, fish, and berries to support life without the use of capital? Mr. George tells us that "the fundamental truth, that in all economic reasoning must be firmly grasped and never let go, is, that all society in its most highly developed forms is but an elaboration of society in its rudest beginnings, and that principles obvious in the simple relations of men are merely disguised, and not abrogated or reversed, by the more intricate relations that result from the division of labor and the use of complex tools and methods." (Progress and Poverty, page 29.) For a complete refutation of this "fundamental truth" we have an argument furnished by Mr. George himself. In his efforts to demolish the Malthusian theory, he says in Chapter II of Book II: "The globe may be surveyed and history may be reviewed in vain for any instance of a considerable country in which poverty and want can be fairly attributed to the pressure of an increasing population." You will notice how he qualifies "country" by the word "considerable." And in a foot-note he explains the meaning of the words "considerable country," by stating that there may be small islands, such as Pitcairn's, which may seem to offer examples in point. Now, if the "fundamental truth to be grasped and never let go" is, that laws applicable to a small and crude society hold equally "in its most highly developed forms," why is not the law of the pressure of population against subsistence which reigns in Pitcairn's and other small islands applicable likewise to societies everywhere? And if not, why propound such a theory?

This same style of argument occurs likewise among socialistic and anarchistic writers, and is one of the props necessary to sustain their conclusions. For example, the socialist witnessing that, with the formation of trusts, the cheapening and facilitating of production goes on wherever the combination and co-operation of capital takes place, argues that production will reach its limit of perfection by the appropriation of *all* capital and of *all* the means of production by the state—an error disproved every day by the inability of the people collectively, through their representatives, to even pave their own streets, manufacture an average quality of gas, or supply themselves with decent water.

The anarchists, observing that many laws work injustice and wrong to thousands, and that great advantages have been brought about by the repeal of them, reason that the summit of human happiness will be attained by the repeal of *all* laws and the abolition of *all* government, strangely forgetting that mankind have found both government and law essential to the organization and stability of society, forgetting also that well-merited punishment is very generally meted out to criminals by law. It does not follow that, because within certain limits the benefits of a given system are found to vary in a direct ratio with its extent of application, this same ratio will be continued *ad infinitum*. "Trees do not grow up to the skies."

The man who gradually reduced his donkey's daily rations in hopes of eventually accustoming him to do without food, succeeded in accomplishing his purpose. But the donkey died. May I ask my anarchist friends if they have contemplated under their scheme the possibility of the death of their donkey—society? *

State socialism and philosophical anarchism are generally supposed to be antipodal to each other, the one achieving its results by the welding of men into a rigid whole, the other dividing society into its units.

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* Ruskin, Government and Co-operation, p. 64.

Viewing them from a philosophical standpoint, I should say the one lacks mobility, the other cohesion. The one has a single eye to the freedom of the individual and trusts to luck as to the destiny of society; the other sees only the social union and equality of all, and trusts to chance to take care of the freedom of the individual.

I do not want to fall into the vicious error of our *a priori* friends who think they can predict exactly the results that will flow from their social prescriptions. But if human experience is to be taken for anything, neither socialism nor anarchism are destined to work out the way their advocates would have us believe. Economics is not an exact science. We have not yet arrived at that point where we can predict events. The fact that among economists there are so many contradictions is evidence of the want of a scientific basis for their theories. One cause of very much of the disagreement among modern economists is the misapplication of the law of induction. Inductive reasoning is safe only when conducted on proper lines and carried out to the fullest extent, otherwise it is, as Bacon says, "a weak and useless thing." The interminable contention between the schools of free trade and protection (or "aggression," as Herbert Spencer calls the latter) is largely due to this kind of imperfect reasoning. "Your theories are all very fine," exclaims the protectionist, "but we prove our case by facts, cold facts." And when you carefully examine his collection of instances, you find them to consist of a specially assorted lot of isolated cases that apparently favor his theory, all others being carefully avoided or rejected. For example, on the question of wages. We are told by high political authorities that high wages are a necessary consequence of high protection, while free trade produces low wages. Now for the proof. In the United States, a protective country, wages are higher than in free-trade England! The free-trader naturally asks why the protectionist confines his instances to just these two countries. If inductive reasoning is to be applied, why not collect every possible instance? The results would be as follows: Russia, Germany, Austria, France, Spain, and Italy, are all "protected" countries—some highly "protected." Wages in each of these are far lower than in Great Britain.

Again, in the free-trade colony of New South Wales wages have been, and I understand are still, higher than in this country, and in parts of Africa where no tariff exists wages are extremely high. On the other hand, in China, where "protection" has existed longer than in any other country, and where it has reached its highest stage of consistency, wages are lower than anywhere else on the face of the globe. And yet once more: "Cold facts" show that the standard of living and rate of wages among the working classes in England have been and are much higher under free trade than they ever were under "protection." Facts are unquestionably worthy of attention, but no general law can possibly be established by any such collection of isolated cases as that commonly made by the "protectionist." The same fallacious reasoning is accountable for most of the sophisms that at present becloud the minds of the disciples of this school.*

Another cause of very much of the difference of opinion that exists among economic writers and reformers lies in the indefiniteness of the terms employed. If we compare the definitions of the writers of different schools, we shall see what a hopeless confusion reigns. Land, wealth, capital, labor, wages, interest, rent, and profit all mean something different to different schools. And yet we are told by each school that it is founded upon science, that it has a scientific basis. I know of nothing more unscientific than a confusion of terms. "Land is wealth," says one. "Land is capital," says another. "Land has no value," says a third; and so on, until you begin to wonder what sort of a thing land really is. Until an agreement on terms is reached, there can be little hope of harmony in teaching, or a discovery of truth. This discord, however, shows us how difficult a problem these gentlemen are attempting to solve, they "who rush in where angels fear to tread." To my mind, it will be a long time before political economy arrives at that point where it can be dignified by the name of science—to that "great and final object of all science, predicting events," as Buckle calls it. At present we have much *a priori* speculation and little else. Every reformer thinks he *knows* exactly what his scheme will bring forth—how it will operate—"how sorrow and sighing will flee away, and tears be wiped away from all eyes." But one can not help inquiring how these gentlemen *know* that such and such results must follow the adoption of their plans. History is strewn with the wrecks of numerous enterprises founded on similar reforms, conceived, planned, and superintended by exceedingly intelligent men, such as Fourier and Robert Owen, John Ruskin, and others.

The fact is, that what we call society is such a marvelously complex machine, or animal, that its scientific treatment—analysis, synthesis, etc.—is at present utterly impossible. In fact, our treatment of society as a whole, as a huge machine, is both misleading and irrational. Society is not so much one machine as a multitude of small machines, each acted on by various forces, the resultant of which is an unknown and indeterminate quantity. These forces propel the machines in various directions—some an-

* I have already dealt at length with this fallacious mode of reasoning in The Popular Science Monthly for November, 1890, entitled Logic of Free Trade and Protection.

tagonistic to others, impinging on each other, rebounding, expending force uselessly, with endless friction, noise, and breakage. How difficult it must be to form any intelligent classification, a moment's thought must convince us. Here is a man whose motive power is love of money, who shrinks from nothing, dares all, endures all, to satisfy this passion. There is one whose sympathies are strong, who spends and is spent for others, philanthropically. Another is driven by conceit, by love of fame; another by fine clothes, and another by love of power; another sacrifices all for knowledge, and so on. All these and thousands of other types, possessing not one, but many passions in varied amounts, and probably no two individuals identical, go to make up this unit which we call society. And then we divide them into laborers and capitalists, and prescribe hard and fast rules by which we assume the conduct of each class is controlled, and on these assumptions we build a science! Such is the science of political economy!

Take, for instance, the term "laborer." To whom does it refer? "To the producer," says our economist. Producers of what? "Of wealth." And what is wealth? "Good things," says one. "Useful things," says another. And what is a useful thing? "That which in its operation conduces to human welfare or pleasure." So that the laborer is an animal or a machine, the product of which is finally resolved into terms of human pleasure. What man is there who is not a laborer? Who does not produce pleasure to others as well as to himself? Why, the very act of living requires an expenditure of labor. And from this sheer act of existence up to the hardest kind of manual labor there is a gradual *crescendo*, a line of unbroken continuity.

How, then, can you draw a complete dividing line separating producers from non-producers? Surely not at digging the earth, nor even at manual labor. Try as you will, I fail to see where a dividing line comes, save only between the dead and the living. If, for instance, you admit the school-teacher, the actor, the musician, the painter, the confectioner, or the milliner, as laborers, why should you omit the friend, the husband, the child? For the basis of the classification of the first is the satisfaction of human desires. The latter class likewise satisfy human desires! *

Again, if we attempt to draw a line separating capitalists from laborers, we are met with the same difficulty. For, as capital is the mother of labor, every laborer must of necessity be a capitalist, and from the man who possesses simply physical health, strength, and reasoning faculties, with clothes enough to cover

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* "There is no wealth but life; life including all its powers of love, of joy, and of admiration."—RUSKIN.

him, we rise by insensible gradations, by an unbroken line, to the millionaire who controls thousands of men.

A characteristic of one class of economists is their fierce denunciation of the profit system. "Profit," they say, "is robbery." They contend that if a manufacturer supply the machinery for the manufacture of commodities, an amount set apart sufficient to replace the machinery when it shall have worn out, and no more, is a just return for its use, and all over and above this is theft. Now, the question at once arises, What does the laborer do more than the machine, that he should expect more than the equivalent for the quantity of brain-matter, nerve-tissue, and muscle expended by him in his labor? In other words, if he be allowed sufficient food, clothing, and shelter to maintain him in a healthy condition so long as he gives his entire labor time, is not justice satisfied? Is not this a *quid pro quo*? Why should one class of labor be allowed a larger return for its produce than another, even though this be made of brass and iron and steel instead of blood and bone and brains? Still further, if the producer is to receive the full reward of his labor, why should not the machine that produces ten times the quantity that the laborer produces receive ten times the reward? Setting out with the term "labor" as "that which produces wealth," a term that likewise defines the function of machinery, you will see the results to which we are reasonably drawn. You will understand that your economist does not claim that the question of affection or of moral obligation should interfere with the logical conclusions at which he arrives. The grand science of economics does not recognize human sympathies.

If we distinguish between labor and machinery by defining the former as *human* exertion applied to production, we gain nothing, since political economy gives no reason *why* a difference should be made in the treatment of the two. The distinction ordinarily observed is to make labor the grand motive power of production, and machinery the mere agency for rendering labor more productive. This is not a clear nor a just distinction. For the principal function of machinery is to *displace* the laborer rather than to make his labor more productive.

Take an illustration or two. The man who, in place of using a rough knife to cut down the branches of trees, invented a saw, made something which caused his labor to be more productive—i. e., a given quantity of the same kind of his energy produced larger useful results than before. So the invention of the file, by enabling him to sharpen his saw, made his labor still further productive than if he had to use a blunt one. Tools, especially, fulfill this particular function of making labor—the same kind of energy—more productive.

Now, take the case of machinery. In place of the old-fashioned wells, with the bucket and rope—the primitive method of drawing water—you have the pumps, boilers, steam engines, and reservoirs of a modern water-works. Similarly, instead of the ancient style of propelling boats by means of oars and paddles, you have the modern steam vessels. To say that machinery in these and endless other examples is "that which renders labor more productive or more efficient" is mere folly. Human labor is here *wholly displaced*, and the principal human exertion employed is that of a totally different nature, being transferred from the muscle to the mind. Instead of ten, twenty, forty, or a limitless number of human arms pulling on as many oars, you have one or two employed in watching indicators, water gauges, and other similar contrivances. And the principal manual exertion is that required in turning a valve. Even in the case of firing boilers, the recent inventions in fuel tend to abolish human exertion. The tendency of human ingenuity in the field of production is to wholly and totally *abolish* human labor. Machinery, therefore, becomes qualitatively the equivalent of labor, inasmuch as it supersedes it—does what men's muscles do, only more economically and efficiently. Speaking logically, we have no grounds for making any distinction in economics between labor and that which possesses precisely similar functions, viz., machinery. And so long as this is the case we have no reason, from an economical standpoint, to observe the slightest difference in our treatment of the results of each. In a division of the proceeds of capital and labor, dividing them in the ratio of the amount contributed by each, how small a share belongs equitably to labor, and how large an amount to machinery, a moment's thought will make clear.

Adam Smith stated that in his time ten men could make 48,000 needles per day. This was prior to the invention of the needle machine. This machine Karl Marx mentions as making 145,000 per day of eleven hours, and that "one woman or girl superintended four such machines, which produced near upon 600,000 needles in a day and upward of 3,000,000 in a week." It would be absurd to speak of this machinery making labor *more productive*. It has entirely displaced it, and the only human exertion required is that of the girl's superintendence, which is of a vastly different character from that of the men who made needles by hand, and is really of a lower order of skill and intelligence. Dividing the gross products in ratio of the two factors employed, we find that one girl and four machines are the equivalent to twelve and a half men. If we allow the girl's labor as equal to half a man's, we have four needle machines equal to twelve men, or one machine equal to three men. It is unnecessary to multiply examples. The tendency in mechanical inventions is to totally displace labor, both manual and mental. Each improvement in machinery tends to make it more and more automatic, self-governing, and the least intelligent person is usually found capable of running some kind of machinery.

The socialist admits that the vast production of wealth which has characterized the past century is due to labor-saving machinery. But he claims that this machinery is in itself the product of labor, which it unquestionably is. He argues, however, that the inventor has no right to the exclusive enjoyment of his ideas.

If inventions were the creation of all the members of a society equally, each would be entitled to his share of the product equally, and our economist would be right. But such is not the case. Supposing in a community a number of men are engaged in weaving a certain kind of fabric by hand. After a time, by careful thought, study, and years of experimenting during his evenings, one of them succeeds in constructing a machine capable of weaving in a day as much of the fabric as ten men can do in the same time; and, supposing the amount of manual power to operate this machine is the exact amount expended by one man in his ordinary day's task, then this man and his machine perform the work of ten men in an equal time, and if he only work it one hour he has produced what previously occupied him one day. He may therefore work one hour per day and get the same return as before, or by working one day get the produce of ten men. Supposing he offers to one of the other men the privilege of working this machine in his place, which requires no greater expenditure of labor on this man's part than the work he is engaged on, and the man accepts. The inventor of the machine may offer him the produce of two days' labor as an incentive to accept employment from him. The inventor then becomes a capitalist, an employer, and gets his ten days' produce, paying his employee two days, and retaining eight himself, for which he himself does nothing. Practically his work has ceased after inventing, designing, and constructing the machine. Is it an act of injustice for him to claim the product of the machine which is his invention? And if he build one machine and employ one man, may he not build two and employ two men, and carry this on until his machines supply the entire demand? And may he not transfer his interest, or part of an interest, to another, and another, until you have a number of idle men living off the produce of the labor of the machines and employees? There is in this nothing unjust from an economical standpoint, for this man has taken nothing which did not originate with him.

But, says the reformer, were it not for the protection afforded the inventor by society, the privilege he artificially enjoys, these employees would build their own machines and each man be his own master. This, however, does not necessarily follow, for it assumes that each man would have both the ability and willingness to construct a machine. But suppose they did, would this be just? Is it any the less robbery for a man to steal another's brain produce—ideas—than to steal the products of his hands, commodities? Would the infringer not be obtaining something which he did not produce? If justice consists in giving to each man the product of his labor, and robbery consists in a man taking that which another produces, would those who copied the inventor's machine be any the less robbers?

If we are to accept the basis laid down by economists by which "rights" are determined, I do not see how you can escape from the system known as profits. You say this system is degrading and unjust. Granted. But, on the grounds that Mr. George and others have selected for determining what is right and what wrong, I can not see any escape from the "right" of profits. You may say it is inexpedient for society to continue it. That is a different matter entirely, and it may be for the welfare of society to abolish profit, rent, and interest. But, in the light of the "science of selfishness," there is nothing which shows it to be unjust, or those accepting such return as being robbers.

I have endeavored to select at random a few of the fallacies underlying many, if not all, of the modern schools of reform, that teach that the road to social bliss is by the science of economics. My contention is that much of the present evils which afflict society is due to too great a prevalence of *Nature's* laws, and to too little practice of the *moral* law. So long as reformers endeavor to work out their respective systems by an appeal to the so-called science of political economy, and persistently ignore the moral phase of the question, so long must society wait in vain for the realization of its dreams. The final teaching of economics would show that it is far more conducive to national wealth and prosperity to stimulate the production of machinery than of men!

This grand science of economy has surely had a wonderful effect. It has cheapened commodities and cheapened men, and men are now cheaper than the commodities! Since it has determined to work the problem of society out on this basis of the laws of supply and demand, and has taught man to buy in the cheapest and sell in the dearest markets, it has brought humanity itself to the same basis, and men find themselves immeshed in a web of their own weaving. The law of supply and demand now governs them, and men are bought and sold like the commodities themselves.

Is there, then, no solution to the great social problem of poverty? Can nothing be done to save humanity from itself? "It is all very well to criticise the schemes of others," may be said, "but have you anything better to offer?"

I confess I have no particular scheme of reform to offer, nor any patent method by which society can lift itself up by its boot-straps; but, in my humble judgment, most of the modern reformers are overlooking the one thing which is really the parent of much of the misery they desire to exterminate. And that cause is the parents themselves. Go into the slums and alleys where most of this poverty and misery abound, and you find them teeming with children—ragged, half-starved, hungry-eyed, semi-diseased children. What is the use of dredging a pool if, for every bucket of dirt you take out, another dumps in a wagon-load? Why, if that part of society to which this state of existence is common did not make themselves so cheap, they need be in no such condition. When there is a superabundant crop of apples, you will find the orchard strewn with them, rotting from neglect. The best are taken, and the poor ones are trodden under foot. And when these bountiful harvests of children continue with such exasperating regularity, you may expect to see the worst part of humanity cast out and trodden under foot, literally left to rot as useless, so long as society is as it is. Why should men make themselves so cheap? If ever the doctrine of "restriction" needed enforcement, if ever there was a field where its results would be productive of good, it is here, by restricting the supply and so enhancing the prices of men.

Involuntary pauperism and its attending evils will cease whenever the demand for men runs ahead of the supply.

I am not preaching Malthusianism as it is generally understood. It is *local over-population* and its accompanying unmanageability of which I speak. I have no doubt that this earth, if properly tilled and worked, will supply humanity with bread enough and to spare. But that will take many generations to accomplish. I am simply looking at things as they are, no matter how they came to be so. I can see that so long as human beings are brought into society at the present rate, and in the condition we are in, economics is not going to save them. One of the most hopeful signs in the spread of education is, that each class as it rises to a higher scale of knowledge lowers the percentage of its birth-rate. Where would your capitalists be with an extremely limited supply of labor? Given an exclusive community of millionaires, and what avail will be their millions? Riches and poverty are simply relative conditions. Your millionaire is rich only because there happens to be a herd of men extremely desirous of getting what he possesses. And a man believes himself poor if he does not possess those desirable things, even though he have enough to eat and drink and wear. One generation would suffice to settle this anti-poverty question could you but hammer this fact into men's minds. I have often wondered how men reconciled the idea of a divine and all-wise Providence with that startling phenomenon—viz., the prolificness of the ignorant and the sterility of the wise.

There are two pleas which reformers urge in justification of their claims: the one, what they call "natural" justice, founded upon the imaginary "natural rights" theory; the other, expediency.

Prof. Huxley, in one of his series of vigorous articles published in the Nineteenth Century Magazine recently, and to which I refer you, has exposed at length the utter baselessness of the theory of "natural rights." It was this doctrine that had most significance, and became most famous prior to and during the great French Revolution through the writings and teachings of Rousseau and other French economists. It had been evidently borrowed from the English philosophers by Rousseau, and from the Romans by them. It forms the basis in Progress and Poverty for the justification of Mr. George's remedy for poverty.

So far as rights go, the rights we prize so dearly are, in fact, artificial rights, *not natural*—man-made, granted and secured by society. The natural condition is slavery. The civilized, the artificial, is freedom; and the curses that still hang over society, checking progress, are the presence of "natural" feelings and instincts with which man is still endowed. The limit of freedom will be approached the further man gets away from his "natural state."

The question of expediency is a difficult one to determine. All social changes, arbitrarily arranged, work misfortune to some, and these would question the "expediency" of the change with perfect propriety. The "greatest good of the greatest number" is an extremely rough method to determine "expediency," for there would be coercion of the smaller number.

On what grounds, then, are social problems to be answered? "Natural rights" being mythical, "expediency" being often indeterminable, is there no ground upon which to decide what is best? I think so. The attractive force that has drawn so many of us to study these social questions—that, in fact, led the authors of the various schemes enumerated to devise them—is human affection. I believe that the ground, and the only one, upon which permanent results and the best can be built will be an ethical one.

The remedies prescribed for poverty, by both anarchists and socialists, are based upon the assumption that under certain conditions all men will act alike, a fallacy that scarcely needs exposing. Under socialism it is supposed that the state administration will be honestly carried out, that each and every man will do his duty, that there will be no "combines" on the part of overseers and administrators to turn the means of production to their own use and defraud the masses. For it is very certain that state socialism administered or superintended by such a class of men as that which recently met at Minneapolis to nominate *their* man, or the class that usually control the machinery of government in this "free" country, would not only fail in its purpose, but result in civil war, or the conditions of life would be worse than humanity has ever experienced.

Similarly, philosophical anarchism and the doctrine of non-invasion must fall short of its purpose unless all men confine themselves to their own business, and do not interfere with their neighbors. But the presence of a handful of men in an anarchistic community, who determined to live by plunder, would suffice to destroy either anarchism or the community.

Anarchy reminds one of a certain Chinese puzzle, the solution of which depended upon getting a number of different-shaped blocks together and dropping them at the same instant, so that they fell exactly into their respective places. If one happened to fall slightly out of place, it upset the entire number. Philosophical anarchy can only exist when all men have attained that condition where each fits his place and is content to remain in it.

I contend that no science of economics will elevate society to the condition its advocates believe, unaccompanied by a system of ethics. It is more a question of every man doing right, fulfilling obligations, guiding his conduct by some standard, than it is of the nationalization of land or the abolition of privilege. When every one is governed by his noblest impulses, in place of selfish instincts, poverty and misery will begin to disappear. Then the so-called science of economics will be rewritten, and a new basis of human action accepted. And, without this, no reform system will accomplish the purpose of its author.

"Whether it is possible," said Prof. Max Müller, at the International Oriental Congress, "to account for the origin of languages, or rather of human speech in general, is a question which scholars eschew, because it is one to be handled by philosophers rather than by students of language. I must confess, the deeper we delve the further the solution of the problem seems to recede from our grasp; and we may here, too, learn the old lesson that our mind was not made to grasp beginnings. We know the beginnings of nothing in this world, and the problem of the origin of language, which is but another name for the origin of thought, evades our comprehension quite as much as that of the origin of our planet and of the life upon it, or the origin of space and time, whether without or within us. History can dig very deep, but, like the shafts of our mines, it is always arrested before it has reached the very lowest stratum."

THE EVOLUTION OF THE ALPHABET.

By M. G. VALBERT.

STUDENTS of considerable merit have published solid and important studies on the writings of the Oriental world and the alphabet. Their work is now supplemented by the *Histoire de l'écriture dans l'antiquité*, of M. Philippe Berger (Paris, 1891), in which the attempt is made to give a comprehensive view of the whole subject. M. Berger has long been a careful student of Semitic languages and religions, and is engaged in the editorial work of the *Corpus Inscriptionum Semiticarum*. He is habitually careful in investigation, attentive to the facts alone, and is scrupulous to distinguish between what is proved and what is only half proved or has only begun to be proved. While he gives the highest credit for the introduction of the alphabet to the Phœnicians, he goes beyond them to the origin of writing in the primitive and crude processes to which thinking or almost thinking beings resorted in order to represent their mental conceptions by material and visible signs. He speaks of the notched sticks used by the Scythians and the Germans for correspondence and divining; of the wampum of the Iroquois—belts or necklaces of shells, the combinations of which formed geometrical figures, and which sometimes included as many as seven thousand pieces; of the *quippos* of the Peruvians—collections of woolen cords of different colors, in which knots were tied at different distances. Each color, and every peculiarity in the form of the knots, had its meaning. The Peruvians had employed another method before inventing the *quippos*. "It is curious," wrote the Spanish Jesuit Acosta, in the sixteenth century, "to see decrepit old men learning the *Pater Noster* with one round of pebbles, the *Ave Maria* with another, and the *Credo* with a third, and to know that that stone means 'conceived of the Holy Ghost,' and that other 'suffered under Pontius Pilate'; and then, when they make a mistake, taking them up again, looking only at the pebbles." The Iroquois made as good use of their wampum. The shells stood to them for ideas and phrases. Their messengers could convey with the aid of wampum entire speeches, which they would recite word for word on reaching their destination. But these, as M. Berger remarks, are not writing, but mnemonic expedients, methods by which an artificial memory was created. We do not write when we tie a knot in our handkerchief to keep from forgetting anything.

A closer approach to writing is pictography, or the art of exhibiting to the eyes what the mind sees or believes it sees. Man of the Quaternary epoch already practiced this art. We possess bones and reindeer horns decorated with designs and sculptures, which sometimes represented veritable scenes. These designs, besides being mnemonic aids, are capable of transmitting thought as well as of preserving it. The day that these pictures were changed into recitals, man was ready to write. A scene engraved on a rock at Skebbevall, in Sweden, helps us to witness a landing of adventurers and their establishment in the country. Beside scenes of pursuit and piracy, are files of boats which we can count, with the braves aboard of them. Disks and groups of points above the scene indicate the time of the year or of the moon when it took place. Here the design is only in outline. Most of the boats are represented by two concentric curved lines, diversified with slight parallel strokes representing the braves. From this time the figure, abridged and truncated, is transformed into a sign, and that is a mark of writing. Man after this manifested that power of abstraction which is his privilege, and which consists in holding to that which is essential in things, and suppressing the rest. Man is, perhaps, the cousin of the monkey; but a chimpanzee will never be anything but a novice in abstraction, and that is why he will never take it into his head to speak or write.

Writing, as M. Berger says, is the art of fixing speech by conventional signs, traced with the hand, which are called characters. These characters may represent ideas or spoken sounds. That writing which aims to represent ideas directly is called ideographic, and the characters it employs are figurative. Some hieroglyphics are shortened images in which we can recognize, without too much effort, the sun, the moon, a mountain, a snake, a flower, a shoe, or a mirror. Then we deal with abstract ideas, we have recourse to symbols. A man kneeling, with his hands raised, conveys the idea of adoration; a hanging lamp, that of night; an open eye signifies vigilance and knowledge; an ostrich feather gives the idea of justice, because the wing feathers of that bird are all equal. The characters of phonetic writing, on the contrary, represent, not objects but the sounds composing the words that stand for those objects; and the writing is called syllabic or alphabetical accordingly as the characters express complex articulations or simple sounds, syllables or letters.

This distinction between the two methods is only theoretically correct. In reality nearly all systems of writing have, by a curious fatality, sooner or later come to syllabism. This occurred in the five great ideographic systems of the ancient world—the Chinese, the cuneiform writing of Assyria, Media, and Persia, and the Egyptian hieroglyphics. Egypt did not stop there, but pushed the analysis of the elements of speech still further, and, having disengaged the syllable, then disengaged the letter; and from the sixth dynasty, or three or four thousand years before the Christian era, the inhabitants of the valley of the Nile had twenty-two different articulations, and used one or more alphabetical signs for each of them.

The Egyptians did not employ these alphabetical characters to the exclusion of all others. They also preserved some ideograms and a considerable number of syllabic signs, of which M. Maspero gives the list in his Histoire Ancienne. Thus, their writing was one of the most learned and most perfect, but also the most complicated, that could be imagined. The Phœnicians charged themselves with the duty of simplifying it, and they kept of the immense quantity of signs only those which corresponded with simple articulations, or consonants, and obtained twenty-two characters, which were sufficient to represent all the sounds of a language and all their possible combinations. Some Orientalists have looked for the origin of this alphabet in the cuneiform or Cypriote writing. M. Berger, discussing their theories, holds in the end, with Champollion, M. de Rouge, and M. Maspero, that the twenty-two signs were borrowed from the Egyptian writing, as it also came by natural development from the ancient pictographic writing. Greece adopted these characters, but not without adapting them to its limpid and sonorous language, which could not be satisfied with a writing exclusively composed of consonants; and, after having retouched them, it added a few signs expressive of the vowels. It gratefully acknowledged its indebtedness to the Phœnicians. It boasted of many things, but never boasted of having invented the alphabet. It called the primitive letters whence its classic writing was evolved, Phœnician or Cadmean characters, and showed its appreciation of Cadmus by making him a son-in-law of Jupiter. The Phœnician alphabet spread gradually through Asia as well as Europe, supplanting everywhere the cuneiform and hieroglyphic characters. Only China was the exception to this rule, and shut its doors against the alphabet. It has been discovered that even India, so proud of its chimerical antiquity, was indebted to the Phœnicians; and that the Sanskrit alphabet was not indigenous, but is derived, if not directly from the Phœnician, from one of its derivative alphabets, the Aramaic alphabet. "Nothing," says M. Berger, "is so imposing as this march of the alphabet to the conquest of the world. There is in it something of the irresistible and fatal character of the great invasions. In the face of the migrations of peoples which periodically precipitated the East upon the West, the Phœnician alphabet went against the current. Having established itself in the Mediterranean basin, it penetrated to the center of Asia from three sides at once; while its derivative, the Indian alphabet, occupied gradually the whole country south of the Himalayas and diverged into Thibet, and the Syriac alphabet advanced directly across the central plateau. In the North, again, the Græco-Italian alphabet, after having gone the round of Europe, in advance of modern travelers, penetrated into the plains of Siberia. All the alphabets in use on the earth are derived from the twenty-two letters of the Phœnician alphabet. It would be hard to find in the history of discovery another example of an invention that has had so extraordinary a fortune." This prodigious success is easily explained. The Phœnicians found at the first stroke the formula for universal writing. They understood that the real purpose of the art of writing was to express the sounds of speech by visible signs; and those sounds being nearly the same everywhere, the same letters, slightly modified, have served for writing all languages.

The love of the human species for the complicated is strikingly illustrated in the story told by M. Berger. The simple comes after it, and has to wait its time with enduring patience. The history also shows how easily men may dispense with real goods while setting a high store upon imaginary ones. The world had already grown old, and had written for a long time, when the alphabet was invented, about 1500 B.C. Why did it hold during so many centuries to complicated and laborious systems of writing? Because they were better adapted to its wants. Writing served in ancient times for three purposes—for engraving inscriptions on stone, for correspondence with the absent, and for fixing the winged words of the poet. Inscriptions are of much less evident utility than correspondence and books; yet, epigraphic writing was the only use of which men then felt the need. The more monumental and decorative it was, the more it pleased them; and it must be acknowledged that the hieroglyphics of the Egyptians make a better showing on a wall than the twenty-two letters of the Phœnician alphabet.

The art of expressing ideas by simple traits was long an occult science, the exclusive property of a caste, of a sacerdotal caste, of a corporation of learned men and clerks. It did not matter that inscriptions were not understood by the multitude: those who had the key to them were charged with their explanation, and could give such interpretations of them as suited their interests. There are, in northern Africa, a large number of inscriptions, of various dates, some of them being several centuries old, and others quite recent. This writing, which is still partly in use among the Tuaregs, is intelligible only to the initiated, particularly to certain women, who keep it as a family secret.

A savage, who was shown his name written in characters that could be read, exclaimed in astonishment: "Where are my legs? where is my head? I see nothing there that distinguishes me."

The profane crowd to whom the initiated explained the meaning of an inscription may have been equally astonished, and would attribute a miraculous virtue to the written word. In the Edda Brynnhild teaches Sigurd the supernatural power of the runes: "Write the runes of victory if you would have victory; write them on the hilt of your sword; write others on the blade, speaking Tyr's name twice; write the runes of the storm if you wish to save your ship amid the roaring of the breakers; write the runes of thought if you wish to become wiser than others. Odin himself invented these runes."

It was not in northern countries only that men persuaded themselves that the word signifying power was powerful by nature, and the one giving the idea of God was divine. It was held as an article of faith in all countries that a written prayer had a sovereign efficacy, and that a curse engraved on stone had infallible effects. There are few epigraphic texts among those cited by M. Berger that do not end with a curse. It has been remarked that nothing is rarer than a proclamation of police that authorizes anything; not less rare is an ancient inscription intended to bless any one.

If the human race had never employed writing except to engrave inscriptions on stone, it would never have needed the alphabet. The prime merit of writing on stone was to be architectural, and unite mystery with majesty. But when commerce sought to utilize the art to facilitate business transactions it was necessary to simplify it, and place the occult science within reach of the multitude. The object was no longer to perpetuate sentences and memorable events, but to write in the easiest way the day's thoughts, for which posterity would not care. Paper and the calamus were substituted for stone and the chisel-point, and the cursive writing appeared, which is favorable, as M. Berger remarks, to idleness of the hand, inasmuch as it permits it to make with a single running line what had been made with many distinct lines, and is conformable to the law of the least effort.

Of the systems of writing derived from the Phœnician alphabet the most cursive found most favor, and made the most rapid progress abroad. The Aramaic system held this place in the Oriental world, and was accepted by all the Semitic peoples. The Egyptians, though not a commercial people, felt the need of an easier way of writing than by hieroglyphics for the common affairs of life, and formed a current hand from the hieroglyphics, which is called the hieratic. This was further simplified between the twenty-first and twenty-fifth dynasties, and the popular or demotic hand was invented for contracts and documents, for common use. But the Egyptians did not abandon their syllabic signs and ideograms, their homophones and polyphones, and the simplest of their writings was still complicated. They had scruples against giving it up, and were inculpable of sacrificing their traditions and the love of the mysterious to the conveniences of life.

After it had become the universal tool of commerce, writing put itself at the service of writers and poets. Yet literature did without the alphabet for several centuries. The oral method sufficed for it, and verses and stories, in whatever dialect they were composed, passed from mouth to mouth. But the discovery, once launched upon the world, made a revolution in it. Suppress the alphabet, and all would be changed in the history of the human race. Three great religions, which have had a decisive influence on its destiny, would have been smothered in their cradles if the cursive writing had not served as a vehicle to carry them to distant points, and secure entrance for them. The Hebrews were acquainted with letters, and had a current writing. They were destined to be the people of one book. The law of the gospel must be a written law. Mohammed was to write, the world was to be governed by books, and these books were to make the fortune of the alphabet used in writing them. The Latin Bible, as much as the genius of Rome, carried the Latin alphabet into all western Europe. The Greek liturgy imposed the Byzantine alphabet on the Slavic peoples; and if all Africa ever learns to write and read, it will be indebted to the Koran for its knowledge of those arts.—*Translated for The Popular Science Monthly from the Revue des Deux Mondes.*

TO TIE A ROPE OF SAND.

By AGNES L. CARTER.

MORE than twenty years ago I was one of a great company of children who labored with wooden spade and pail on the beach at Long Branch. Never a corps of sappers and miners worked more industriously or more vainly. A mighty force, unhindered, or rather strengthened, by night and storm and winter, worked behind us, not merely leveling at a touch our tiny forts and mounds and trenches, but laughing at the utmost power and skill of wiser heads and stronger hands. Like Old Age, in the Norse fable, so persistent, so resistless, advances that mighty engineer, whose molding shaped our continent.

Is continent-making at an end? Did you think, O builder of hotel and cottage and esplanade, that Old Ocean had surrendered, and was under bonds not to invade the strip of white sand which borders man's territory?

When I plied my tiny spade in the Long Branch sands, a broad beach stretched below the bluff, while, above, a generous strip, mantled with beach grass, extended to the wide drive. To-day the drive is only broad enough for the easy passage of two vehicles, on the very verge of a ragged bluff. Along the top of this bluff runs a railing, originally intended to define a footpath now ruined by the breaking of the bluff. It is not now possible for any but an athlete to walk outside the rail from one end of the beach to the other.

This is merely one sample of the New Jersey beaches. All are "cut up" by every storm. Year by year the danger to property from extensive floods is increasingly apprehended. In September, 1889, the sea overran almost the entire coast of New Jersey, causing great destruction of property and some peril to life. A few landholders have at last reached the point of thinking that "something ought to be done."

In several European countries the danger from incursions of the sea has long been the theme of history and song; and with this is joined the menace from the sand dunes which, forming in many places the vanguard of ocean's forces, may by man's industry be converted into the guardians and ramparts of the coast.

In Germany, Denmark, Holland, France, and parts of Great Britain those stories of drowned cities, of convents and churches whose bells the waves are said to toll in time of storm, are not the fairy tales they seem to us, but solid history, or at worst credible tradition, the framework of poetry and unending romance. Heine sings:

"In bright moon-glances rests the sea,
The waves' soft murmur falling;
So heavy is my heart in me,
The ancient bard recalling—

"The ancient bard who sadly tells
Of cities lost in ocean,
Where sound of prayers and peal of bells
Rise through the waves' commotion.

"The ringing and the prayers, I wis,
Avail the cities never;
For that which once deep-buried is,
Returns no more forever."

Lovers of Hans Christian Andersen will recall a pathetic tale of Jutland, ending in an ancient church submerged by whirling sand from the dunes on the shore of the Baltic. This was no poetic invention. "Near the beginning of the last century the dunes, which had protected the western coast of the island of Sylt, began to roll to the east, and the sea followed closely as they retired. In 1757 the church of Rantum, a village upon that island, was . . . taken down in consequence of the advance of the sand-hills; in 1791 these hills had passed beyond its site, the waves had swallowed up its foundations, and the sea gained so rapidly that, fifty years later, the spot where they lay was seven hundred feet from the shore."

"The most prominent geological landmark on the coast of Holland is the Huis te Britten, *Arx Britannica*, a fortress built by the Romans, in the time of Caligula, on the mainland, near the mouth of the Rhine. At the close of the seventeenth century the sea had advanced sixteen hundred paces beyond it."—MARSH, *The Earth as Modified by Man's Action.*

"At Agger, near the end of the Liimfjord, in Jutland, the coast was washed away, between the years 1815 and 1839, at the rate of more than eighteen feet a year. . . . The sea is encroaching generally upon the whole line of the coast."—*Ibid.*

Facts like these have driven the Governments of Denmark, Prussia, Holland, and France to a careful consideration and study of the subject; and in all these countries a system of coast improvement has been adopted. This system does not imply a conflict with Nature, but rather a return to her earlier plan.

The sand-hills on the Prussian coast, up to the middle of the last century, were wooded to the water's edge. Old geographers, writing of the Netherlands, mention vast forests reaching to the sea. Of the fate of a Prussian forest we have the following record:

"A great pine forest bound with its roots the dune sand and the heath uninterruptedly from Dantzic to Pillau. King Frederick William I was once in want of money. A certain Herr von Korff promised to procure it for him if he could be allowed to remove something quite useless. He thinned out the forests of Prussia, which then, indeed, possessed little pecuniary value; but he felled the entire woods of the Frische Nehrung, so far as they lay within the Prussian territory. The financial operation was a success. The king had money; but, in the material effects which resulted from it, the state received irreparable injury. The sea winds rush over the bared hills; the Frische Haff is half choked with sand; the channel between Elbing, the sea, and Königsberg is endangered, and the fisheries in the Haff injured. The operation of Herr von Korff brought the King 200,000 thalers. The state would now willingly expend millions to restore the forests."—*Das Buch der Pflanzenwelt.*

It is estimated that about one million acres on the Atlantic and Baltic shores of Europe have become, since the destruction of the forests, a moving desert of sand dunes, rolling inland, burying the fertile soil, and rendering the land barren by the sand showers sprinkled over it; while, following the landward roll of the dunes, came the resistless march of the victorious sea.

The endeavor, then, of these threatened countries has been to regain, by slow degrees, the protection of the forests so rashly destroyed. First, a breakwater or dike is constructed—occasionally a mere plank fence—against which the sand from the beach soon forms long rows of dunes. These sand-hills, usually the enemies of the land, being thus hindered from drifting inland, are impressed into the service of the land, and become its coast-guard against the invading waves. The second step is to plant them with beach grass, or some other sand-loving plant, to bind the sand together, and, by the succession of growth and decay, finally to form a soil.

We are accustomed to regard sand as utterly barren, but the plants native to the coast sands of Prussia have been enumerated by naturalists, whose estimates vary from 171 to 234 varieties. Of these one of the most available is the *Arundo arenaria* (marram), which thrives only in sand and in the salt air of the beach. This in time serves to prepare the soil for larger plants.

In France 100,000 acres of dunes have been reclaimed by planting. In that country the maritime pine (*Pinus maritima*) has been planted with great success. It does not, however, thrive close to the sea. The ailantus, a tree common enough in our land, and certainly sufficiently tenacious of life in our streets and fields, is a sand-loving tree. I have seen an abandoned cellar choked with healthy ailantus trees, and have known them to spring up from the root after being cut down and rubbed with salt! It is probable, then, that if it will grow on the beach it will hold its own against the ocean or any other enemy.

Finally, forests, and even vineyards and pastures, cover the space once resigned to the barren sand. "Every seed that sprouts binds together a certain amount of sand by its roots, shades a little ground with its leaves, and furnishes food and shelter for still younger or smaller growths. A succession of a very few favorable seasons suffices to bind the whole surface together with a vegetable network, and the power of resistance possessed by the dunes themselves, and the protection they afford to the fields behind them, are just in proportion to the abundance and density of the plants they support."—MARSH.

To return to our own country: It is said that the dunes of Michigan thirty years ago were clothed with trees, where now the sands are constantly shifting, and the lake beach changing with the action of wave and wind, while the lake level grows lower year by year. The sands of Cape Cod were formerly covered with beach grass, whortleberry bushes, and a peculiar species of dwarf oak. Dr. Dwight, in his Travels, speaking of a beach in Massachusetts, says:

"Within the memory of my informant the sea broke over the beach which connects Truro with Provincetown, and swept the body of it away for some distance. The beach grass was immediately planted on the spot, in consequence of which the beach was again raised to a sufficient height, and in various places into hills."

At Sea Girt, N. J., there is a strip of beach covered with cedar bushes. These have raised a natural dike. The sand, blown up the beach, is caught by the bushes and arrested, forming a long irregular bank of considerable height. The hollows behind this bank, protected from the surf, from the sea-breeze, and from destructive sand showers, could readily be reclaimed, fertilized, and made productive. For some years clover has been planted just above another part of the beach, and has produced a heavy crop. Those who, not many years ago, first beheld with wonder beautiful rose bushes and honeysuckle vines springing from the sands at Ocean Grove, will think little of the difficulty of covering these sands with vegetation sufficiently strong to withstand the inroads of the encroaching sea.

Thus, as the slight chain forged by the swart elves securely bound the savage wolf Fenrir, so may his brother, Jörmungund, the great ocean monster, be bound by a rope of sand.

NICKEL AND ITS USES.

By J. T. DONALD, M. A.

CONSIDERABLE interest attaches to the metal nickel at the present time, principally for two reason: In the first place, experiments recently made in France, England, and America have shown that steel alloyed with a small percentage of nickel forms an alloy possessed of great strength and remarkable resisting powers. In the second place, the past few years have witnessed the discovery and initial development on a large scale of what are said to be practically inexhaustible deposits of nickel ore in what is known as the Sudbury District, of Canada.

Nickel may be said to be a modern metal, for its history goes back no further than a century and a half, although the word is much older. The origin of the name is curious and interesting. The men working in the German copper mines often came upon an ore which, though looking like copper ore, did not yield copper when smelted. Such ore they called kupfer-nickel—i. e., goblin copper—because they thought the nickels or spirits of the mine were deluding them with bad ore.

In 1751 the Swedish mineralogist Cronstedt discovered a new metal, which, some three years later, he succeeded in isolating in an impure state. Finding that his new metal was most abundant in kupfer-nickel, he allowed it to retain the name suggested by the old superstition of the German miners.

It was many years after this, however, before the metal was obtained in a state of purity and its properties satisfactorily determined, and it was much later still when nickel, in a state of comparative purity, became an article of commerce; indeed, until recently it was hardly known in the pure state outside of the laboratory. In 1804 Richter experimented with this metal and obtained it fairly pure by reducing the oxide with carbon in an earthen crucible. Almost seventy years later, Wharton, of the Camden Nickel Works, Camden, N. J., who has devoted so much attention to the metallurgy of nickel, exhibited at the Vienna Exposition vessels of pure forged nickel, which he made by strongly compressing the spongy mass obtained by reduction of the oxide. These exhibits at Vienna, and similar ones at Philadelphia in 1876, and at Paris in 1878, received but scant attention from scientific visitors. Chemists and metallurgists, as a rule, supposed they were nickel alloy, and were somewhat incredulous when informed that the objects were pure nickel; in fact, the commercial production of pure nickel by Wharton, as evidenced by these exhibits, was a genuine surprise to the metallurgical world.

A further advance in the metallurgy of nickel was made by Fleitmann, of Iserlohn, Westphalia, in 1879. He found that the purest nickel he could obtain on a commercial scale had a brittleness which did not belong to the pure metal, and in the course of investigation he was led to believe that the brittleness was caused by occluded carbonic oxide. He decided to attempt the removal of this by adding magnesium in minute quantity to the molten nickel, and was successful beyond expectation, for the nickel thus treated quickly loses its brittleness.

As to the properties of nickel, it will suffice to say that it is a hard silver-white metal with a steel-gray tinge; it may be rolled into thin plate or drawn into wire; it is not readily oxidized; it is attracted by the magnet and readily assumes a polar condition.

Turning now to consider the uses of this metal, we find that Thénard in 1825, in his Traité de Chimie, stated that nickel was not employed for any practical purpose. This statement is true only in reference to the pure metal; for, just as brass was known and used long before zinc was isolated, so nickel alloys were known and used long before Cronstedt's discovery of the metal. The Chinese appear to have been among the earliest users of nickel alloys, for as early as 1776 it was pointed out that Chinese *packfong*—i. e., white copper—is an alloy of copper, zinc, and nickel. The beginning of the manufacture of these alloys in Europe is due to a somewhat curious circumstance. In the old slags from disused copper-smelting works at Suhl in Prussian Saxony, and once known as the armory of Germany, white granules of metal were found.

These were extracted and sold as Suhlian nickel silver, and in 1823 Brande showed that these white granules consist principally of an alloy of copper and nickel, and thus originated the manufacture of the widely used nickel alloys known as nickel or German silver. This German silver, so extensively used as the basis of electroplate, is, as is well known, an alloy of copper, zinc, and nickel, the proportions varying according to the use to which the alloy is to be put. Copper is the principal ingredient, and the nickel varies according to the color desired, for it is this metal that has the property of whitening the copper. Sometimes a little iron (from two to two and a half per cent) is added to the ingredients named, with the result of producing an alloy that is whiter and harder than the ordinary composition.

Doubtless all Americans know that nickel is used in coinage, but probably few are aware of the extent to which it is so used. As early as 1837 one Dr. Feuchtwanger, of New York, called attention to the suitability of nickel for coinage, and is said to have actually issued a number of one-cent and three-cent coins made of a nickel alloy. But the first national issue of a nickel-alloy coinage was made by Switzerland in 1850, the issue consisting of twenty, ten, and five centime pieces, containing respectively fifteen, ten, and five per cent of silver, alloyed with ten parts of nickel and twelve and a half parts of zinc, copper making up the balance. In 1857 an alloy consisting of eighty-eight parts of copper and twelve of nickel was adopted by the United States for the one-cent pieces. In 1860 Belgium instituted a nickel coinage, the alloy used for the purpose consisting of seventy-five parts of copper and twenty-five of nickel. This particular alloy appears to have given much satisfaction, for we find it adopted by the United States in 1865, by Brazil in 1872, by Germany in 1873, and still later by Jamaica.

It is not only in the form of an alloy that nickel is used in coinage. Improvements in the metallurgy of the metal have rendered possible a coinage of pure nickel, and it is interesting to note that Switzerland, which was the first to adopt a nickel-alloy coinage, was also the first to issue coins of the pure metal, the Swiss twenty-centime pieces coined in 1884 being pure nickel. In 1886 the Royal Berlin Mint executed for the Egyptian Government a nickel coinage, and during the same year a Birmingham firm coined in nickel five hundred thousand half-decimos and one million centimos for the Republic of Ecuador, while in 1887 Bolivia issued a nickel coinage. It thus appears that nickel is gaining in favor for subsidiary coinage, and not without cause. It is superior to copper in color, and, being more valuable, smaller coins are obtained; both the pure metal and the alloy are hard and thus wear well, and they possess the additional advantage that they can be manipulated only by skillful workmen. In this connection it is worthy of note and illustrative of the old saying, "There is nothing new under the sun," that a coin of the Bactrian king Euthydemos,* who reigned about 235 years before Christ, is in composition very similar to the alloy adopted by Belgium, the United States, and other countries.

Nickel-plating annually calls for a large amount of the metal. The process is said to have been invented by Böttcher about 1848, and was first applied to firearms in order to prevent them from rusting, but is now applied to every description of iron and steel work. The effect, as is well known, is very fine, as the nickel, coating is white, bright, and hard, and, since it shows but very little tendency to oxidation, it retains its brightness for a long time.

Important as are the uses of the metal already indicated, the world's annual consumption has been small; not over a thousand tons was consumed in 1888, nickel-plating calling for more than half of this amount.

It is, however, in connection with one of the new uses of nickel —viz., as a constituent of nickel steel—that special interest attaches to the metal at present.

It is well known that nickel is frequently associated with iron in meteorites, and the view that the well-known and valuable qualities of meteoric iron might be due to the presence of nickel has not wanted advocates in the past.

Again, as far back as 1853, nickeliferous iron ores from Marquette, Mich., were found to produce iron possessing unusual toughness, a very white color, and a diminished liability to oxidation.

For a long time Nature's hints were neglected or disregarded, but in 1888 patents were taken out in England and France by different individuals for the preparation of nickel steel.

Tests of this alloy have been made by competent authorities, and the effect of the addition of small percentages of nickel to steel is seen in greatly reduced tendency to oxidation and increased strength. As an example of the superiority of this nickel steel, the following results of one of the tests may be given: A steel containing 4·7 per cent of nickel "showed an ultimate strength of thirty per cent and elastic limit of sixty to seventy per cent higher than those of mild steel, with a nearly equal ductility, and the valuable quality added of less liability to corosion."† The authority who obtained these remarkable results adds: "Think for a moment of this in connection with the erection of the Forth

* The Numismatic Chronicle, viii, 305; quoted by Roscoe and Schorlemmer.

† Journal of the Iron and Steel Institute, No. 1, 1889.

Bridge or of the Eiffel Tower. If the engineers of those stupendous structures had had at their disposal a metal of forty tons strength and twenty-eight tons elastic limit, instead of thirty tons strength and seventeen tons elastic limit in the one case and, say, twenty-two tons strength and fourteen to sixteen tons elastic limit in the other, how many difficulties would have been reduced in magnitude as the weight of materials was reduced! The Forth Bridge would have become even more light and airy, and the Tower more netlike and graceful, than they are at present." And Sir Frederick Abel, in his presidential address at the Leeds meeting of the British Association, remarked, "It has been shown by Riley that a particular variety of nickel steel presents to the engineer the means of nearly doubling boiler pressures without increasing weight or dimensions."

On the other hand, it must be admitted that there are those who maintain that the future of nickel steel has been painted in too rosy colors. For example, in Stahl und Eisen for October, 1889, Prof. A. Ledebeer criticises the claims made for nickel steel, and predicts that the alloys of nickel and steel "belong to that class of inventions which crop up at intervals, finally to be buried in oblivion because of their impracticability." The criticisms of this German writer were practically answered by a report in some of the trade journals immediately after the appearance of his criticism, to the effect that there existed among steel-makers a demand for several thousand tons of ferro-nickel for use in the preparation of nickel steel; and trials of armor plate made by a board of United States naval experts at Annapolis, Md., have shown that nickel steel is superior to ordinary steel for armor plate. As a result of these tests the House of Representatives at Washington made an appropriation of one million dollars for the purchase of nickel for use in the manufacture of armor for the new armored war-ships.

Coming now to consider the source of the nickel of commerce, we find it is derived principally from two classes of ores—viz., a nickeliferous pyrrhotite and a silicate of nickel. A very remarkable deposit of the latter occurs in New Caledonia, one of the New Hebrides and a penal colony of France, and since the period when productive work was begun on these deposits it may be said that the New Caledonia mines have entirely controlled the market. The ore known as garnierite is a hydrosilicate of nickel and magnesia, and is found in beds of serpentine mixed with oxide of iron, chrome iron ore, and a little cobalt. It is especially valuable on account of its entire freedom from arsenides and sulphides. Similar ores occur on this continent—for instance, in North Carolina and Oregon—but these deposits have not been developed to any extent. The discovery of the New Caledonia deposits aroused great interest in industrial circles, as it was thought cheap nickel was thereby assured. Of late, however, the center of interest has moved from nickel silicate and New Caledonia to nickeliferous pyrrhotite and to the Sudbury District in the Canadian province of Ontario. The interest attaching to this district is due, not to the discovery of a new mineral or of nickel in a new association, if we except the occurrence of small quantities of platinum arsenide in the Sudbury ore; it is due to the richness of the ore and to the vast extent of the deposits.

Attention was first attracted to these by reason of the considerable masses of rich copper pyrite found close to the surface, and it was as a region of copper ore that Sudbury first became famous. At the depth of a few feet, however, the rich copper ores were found to be underlaid by pyrrhotite, which occurs in large lens-shaped deposits in an extensive belt of diorite. Scattered through the pyrrhotite is copper pyrite in threads, in mere specks, and in masses from the size of a pea to pockets containing several tons. The nickel contents of this pyrrhotite vary considerably. Scarcely any of it is entirely free from nickel, but the percentage varies from a trace to as much as eight or nine per cent.

An idea of the average value of the ore, and of the amount of nickel the district is capable of affording, may be gained from the particulars of the smelting operations of one of the companies that are working in this district to the end of December, 1889. One furnace ran 259 days and produced 3,849 tons of matte, said to average thirteen per cent of nickel and eighteen per cent of copper. A second furnace in 73 days produced 1,210 tons of matte of equal richness. In other words, 41,000 tons of ore produced matte containing 650 tons of nickel, and which was associated with 910 tons of copper, thus showing that the ore smelted averaged about one and a half per cent of nickel together with two and a quarter per cent of copper. All the nickel produced in this district finds a ready market, being used principally in the manufacture of guns and armor plate. It thus appears that the discoveries of the extensive Canadian deposits of nickel, and of the valuable qualities of nickel steel, are complementary one to the other.

PROF. MAX MÜLLER, in his address before the International Congress of Orientalists, expressed his objections to the word "prehistoric" as a vague term, that almost withdraws itself from definition. "If real history," he said, "begins only with the events of which we possess contemporaneous witnesses, then, no doubt, the whole period of which we are now speaking, and many later periods also, would have to be called prehistoric. But if history means, as it did originally, research, and knowledge of real events based on such research, then the events of which we are going to speak are as real and as truly historical as the battle of Waterloo."

SKETCH OF GEORGE FREDERICK WRIGHT.

PROF. WRIGHT has come forward within a few years to a foremost position among authorities in geology and the antiquity of man. His studies of glacial action have been thorough, extended, comprehensive, and fruitful of results beyond those of almost any other single observer, and make singularly fitting the curious designation given him by Judge Baldwin, Secretary of the Western Reserve Historical Society, as "the apostle of the Ice Age and Early Man."

George Frederick Wright was born in Whitehall, N. Y., January 22, 1838. His parents were plain people, in moderate circumstances, not exempt from the necessity of labor, who, participating in the sentiment which that institution then represented, sent their son to Oberlin College, five hundred miles away. Thence he was graduated, from the classical course in 1859, and from the Theological Seminary in 1862. While in the Theological Seminary he responded to Lincoln's first call for troops, and enlisted as a private in the Seventh Ohio Volunteers. He served five months, and was then discharged after a severe sickness. During ten years from the fall of 1862 he served as pastor of the First Congregational Church in Bakersfield, Vt., in a parish from which, though it could pay its minister only the most modest of salaries, he was able to send many young men to the denominational colleges. Besides attending to his pastoral duties and engaging actively in revival work in his own church and in the surrounding towns, he entered vigorously into educational movements; started and presided over a vigorous farmers' club; studied the local geology and wrote articles for the country paper on the glacial phenomena of the region; read his Hebrew Bible through; and translated Kant's Critique of Pure Reason and several of Plato's philosophical works. His geological studies led to an acquaintance and correspondence with Prof. Hitchcock.

In 1871 he became pastor of a Congregational church in Andover, Mass., where he enjoyed the friendship of the professors in the Theological Seminary; made the acquaintance of Prof. Asa Gray, of Harvard; and began an active literary career. His eyes were open to the geological phenomena of the region—one of the first questions he asked upon his arrival, of a fellow-minister, relating to that subject. He was told that the country was under the glacial drift, and he soon gave his attention to that. "During his walks and drives he would stop to measure a 'kettle-hole,' or he would push far into the country to follow some gravel ridge. He made constant inquiries of fellow-ministers in other places as to the phenomena of their region. Every book that he could find bearing upon glacial work he read, and as early as 1876 we find his observations extendedly reported in the Proceedings of the Boston Society of Natural History, under the titles of Some Remarkable Gravel Ridges in the Merrimac Valley, and the Kames and Moraines of New England. In this he showed that he had found a clew to a most important kind of glacial deposits which had heretofore been misunderstood." While he was engaged in preparing this paper Mr. Clarence King gave him information concerning the terminal moraine south of New England, which directed his attention to that quarter; and after that, he says, in the preface to his great work on the Ice Age in North America, the subject was never out of his mind, and all his summer months were devoted, under favorable conditions, to the collection of field-notes regarding it. Four seasons were given to making himself familiar with the glacial phenomena of New England; after which he was invited by Prof. Lesley to survey, in company with the late Prof. H. Carvill Lewis, the boundary of the glaciated area across Pennsylvania to the border of Ohio. The report of this work constitutes Volume Z in the publications of the Second Pennsylvania Geological Survey.

In 1881 Prof. Wright became Professor of New-Testament Exegesis in Oberlin Theological Seminary. Almost the first question he asked after his arrival in Oberlin was a geological one: "What is the age of the cañon of Plum Creek?" Plum Creek is a modest stream enough, but Prof. Wright made it and its work in denudation, in his Ice Age in North America, the basis of an important and interesting calculation concerning the antiquity of the Great Ice Age. In a similar manner he made use of the waterfalls of northern Ohio to illustrate the effect of glacial action on the appearance of the landscape. In the summers of 1882 and 1883 he was engaged, with the co-operation of the Western Reserve Historical Society, Cleveland, Ohio, in continuing the survey across Ohio, Kentucky, and Indiana; the results of which work were given in his report to the society, and in an article published in the American Journal of Science for July, 1883. The report proved to be the most distinguished publication ever made by the society. It was republished *verbatim* by the State of Pennsylvania, and has been published in substance by two other commonwealths. In it Prof. Wright described the spots where seekers might most profitably look for the evidences of man in glacial times, saying, "Man lived first below the glacial limit, and fished upon the banks of streams which were periodically gorged with the spring freshets of the Glacial period, and during those floods lost his spear-heads, his hammers, his axes, and his scrapers, where they became mingled with the gravel brought down from up stream." Palæolithic implements have since been found at three of the places which he specifically pointed out.

During the summers of 1884 and 1885 he was employed with the United States Geological Survey in tracing the glacial boundary across Illinois, and in reviewing the field in Ohio and western Pennsylvania. His report of this work appeared in 1890, as Bulletin 58 of the United States Geological Survey, on The Glacial Boundary in Western Pennsylvania, Ohio, Kentucky, Indiana, and Illinois. In the summer of 1886 he visited Washington Territory and examined the Muir Glacier in Alaska, where he spent the month of August in company with the Rev. J. L. Patton and Mr. Prentiss Baldwin, collecting facts concerning the motion, size, present general condition, and probable past history and future career of the glacier. He devoted the two following seasons to the further exploration of Ohio and of Dakota, and other parts of the Northwest. "Thus," he says, "I have personally been over a large part of the field containing the wonderful array of facts" which he presents in his Ice Age in North America.

Since making these systematic explorations, while he has continued his outdoor work in various fields, Prof. Wright has devoted much attention to presenting the results of his researches to the public. He delivered courses of lectures on the subject before the Lowell Institute in Boston in the fall of 1887, before the Peabody Institute in Baltimore in 1888, and in Brooklyn, N. Y. The substance of these lectures, rewritten and much added to, was published in 1889 in his noble book, the Ice Age in North America and its Bearings on the Antiquity of Man, a large illustrated volume of 648 pages, which may be fitly described as one of the most valuable of recent contributions to the literature of geology, and as marking an important step in the advance of the science. The volume also contains an exhaustive discussion of the evidences concerning the early presence of man on the American continent, and particularly his existence during the ice age. Besides incorporating in this discussion the fruits of the discoveries of Dr. Metz in Ohio, of Cresson at Medora, Ind., and Claymont, Del., of Winchell and Miss Babbitt in Minnesota, of Dr. Abbott in the Delaware Valley, of Whitney in California, etc., he has introduced discoveries in regard to which he has himself made careful investigations; of the palæolithic implements found at Newcomerstown, Ohio, of the image found at Nampa, Idaho, under the basalt, and of a stone mortar found under Table Mountain in California. As a professor habituated to theological studies, the question of man's antiquity naturally followed him in these investigations, with the inevitable conclusion that the human period must be allowed an extension far beyond previous ideas of the subject, as well as the question of the method of reconciling the fact with the chronology of the human race supposed to be given in the Bible. This subject is discussed in his Studies in Science and Religion (Andover, 1882) and Divine Authority of the Bible (Boston, 1884), and is dismissed in the book on the Ice Age with a reference to those works as containing all that it seems to be necessary for him to say on the point, and with the additional remark that "I see no reason why these views should seriously disturb the religious faith of any believer in the inspiration of the Bible. At all events, it is incumbent on us to welcome the truth, from whatever source it may come." The summer of 1890 was spent by Prof. Wright in the lava fields of Idaho and California, in careful investigations and verification of the evidences of man's antiquity recently found there, of which mention has just been made.

In the summer of 1891 Prof. Wright visited Europe, where his fame as a specialist in glacial geology had gone before him. Meeting the British geologists, he was warmly received by them, and was able to give them, through conclusions drawn from his American studies, information and light concerning the glaciation of their own islands and to bring about a satisfactory settlement of questions that had been in controversy among them. The results of his additional studies in Europe were given in an article in the American Journal of Science for January, 1892, and are more fully stated in his volume in the International Scientific Series, on Man and the Glacial Period, just published by D. Appleton & Co. In the winter of 1891–'92 Prof. Wright gave a second course of lectures in the Lowell Institute, to uniformly large audiences.

A movement has been set on foot among the alumni of Oberlin College living in Cleveland, Ohio, to endow a chair in that institution to be known as the Cleveland Professorship in Oberlin College of the Relation between Science and Revelation, which shall first be held by Prof. Wright. The call of the committee in charge of this enterprise mentions as a motive inspiring it the desire to enlarge and extend the work of the college in the direction of scientific investigation and instruction, and adds: "There are strong local and personal reasons relating to Prof. Wright's position and future work which urge immediate action in this matter. His ability and faithful services for many years in the department of New Testament Literature are appreciated. But there are other men, it may be, who can do this work as well as he; while, unquestionably, there is a field which he has made peculiarly his own, and which he is qualified, by tastes, studies, original researches, and authorship, still further to enrich and adorn. He has gathered facts from a wide range of investigation and proposed and proved theories which make him an authority upon glacial geology, the antiquity of man, the relations of science and religion, and the proper interpretation and harmony of Nature and the Bible revelations. Having done so much for science in the vacations of his theological labors, it appears that the time has come when he should be enabled, by a transfer to such new professorship, not only to teach these special subjects, but also to pursue his studies and researches and to add to his publications respecting them. He has done the two things well, but can do the one thing better, and better than any other living man." The call goes on to give reasons why Prof. Wright and his work should not be severed from Oberlin College. The work has been carried on while in the service of that institution, and has been greatly assisted by the Cleveland (Western Reserve) Historical Society, "which has liberally promoted the studies in glacial geology which have shed new light upon the antiquities of Ohio, and enriched its collections of historical remains and the evidences of the prehistoric period. These local relations should not be disturbed." The committee specify as conditions of the endowment, which is fixed at $50,000, that the whole income be used by Prof. Wright, first for his salary at a rate fixed by the general rules of the college, and the remainder for the cost of travel, explorations, scientific books, and other aids and necessary expenses of his investigations, under the direction of the Board of Trustees of the college; that he be allowed one half of each year, free from class duties, for original work in his special field; and that his relations to the Cleveland Historical Society be continued. This plan has been approved by Prof. Wright and by the faculty and trustees of the college.

Besides his scientific publications, the more important of which have been mentioned, Prof. Wright is the author of many other works, chiefly on theological subjects. During his pastorate at Andover he published a number of articles in the Bibliotheca Sacra, notably one on the Theology of President Finney, and four on Darwinism. Numerous articles have appeared in the Nation, Advance, Congregationalist, and Independent newspapers, and others of considerable importance, in The New-Englander, The Atlantic Monthly, and Scribner's Magazine. His book, Logic of Christian Evidences, at once attained a large circulation, and is used in several schools and colleges as a text-book. He has presented the doctrines and evidences of Christianity in Studies in Science and Religion, The Relation of Death to Probation, and the Divine Authority of the Bible; and, since 1884, he has been editor of the Bibliotheca Sacra.

EDITOR'S TABLE.

THE FORMATION OF CHARACTER.

IN the preface to his Data of Ethics Mr. Spencer recognized the danger which might be apprehended from a weakening of the authority of existing moral systems before the authority of a more comprehensive and rational system should be established. The caution he thus gave fell, we have no doubt, with grave significance upon many ears. In not a few minds there must be a consciousness of more unsettlement than resettlement of moral ideas and standards; and, if so, it can hardly be that, in some cases at least, moral practice has not been unfavorably affected. Since the Data of Ethics was published, the ferment of thought in the world has been more rapid than ever; and it becomes a question of serious practical import by what means the minds and characters of the present generation, particularly of the younger portion of it, may be fortified against the perils attendant on their intellectual situation.

Let us take the case of a father whose son, brought up more or less in an atmosphere of advanced ideas, is showing a distrust of the traditional supports and sanctions of morality. The duty of the father is plainly to point out that the vitality or worth of a moral principle does not depend on the strength of the fortress which mankind in any age may have built for its defense. The principle is one thing, the wall surrounding it is another. The time must come, we believe, when all moral principles will be left simply to the care of man's enlightened reason, and when that protection will be sufficient. Meantime, as traditional defenses fall into decay, it is well to point out that walls so massive would not have been built unless the consciousness of men had told them that there was something precious to guard. Even the ceremonial observances of society, artificial and overstrained as they may sometimes appear, are the bulwarks of something that is essential to the well-being of men in their social relations. On this point Mr. Spencer, in the second volume of his Principles of Sociology, has well remarked that, "just as the abolition of religious restraints, while yet moral restraints have not grown strong enough, entails increase of misconduct; so, if the observances regulating social intercourse lose their sway faster than the feelings which prompt true politeness develop, there inevitably follows more or less rudeness in behavior and consequent liability to discord."

It is well, therefore, to say to the young, "Gain knowledge fast if you will, but remember that increase of knowledge does not always mean increase of wisdom, and may even result in its impairment if it nourishes an undue self-confidence." The poet Shelley was radical enough, yet even he confessed that the world had more knowledge than it could digest, or, in other words, rightly reduce to practice. If we compare the science of to-day with that of the opening centuries of our era, we find the difference almost immeasurable; but if we compare the wisdom of to-day, as shown in our best moral treatises or as exemplified in the lives of men, with the wisdom of that period as expressed in the works of such writers as Seneca, Epictetus, and Marcus Aurelius, and as embodied in their lives, the difference is far less marked. A man of our time who took his science from Lucretius would wander in gross darkness; but a man who took the treatise On Duties by Cicero, the contemporary of Lucretius, as his guide in moral questions would not be led far astray. This simple consideration should moderate the ardor of those who think that, because the domain of scientific knowledge has been wonderfully enlarged, all things must have been made new in the moral order as well. That is not the case: the main outlines of morality will remain as they were traced centuries ago, the reason being that they were traced not on theoretical lines, but on lines directly suggested by experience. There are not wanting voices in the present day that whisper, nor even some that shout, that the age of restraint has passed away, and that nothing is now forbidden to the emancipated spirit of man. Such teaching is dangerous, and, just in so far as it is listened to, will the wisdom of the past rise up to reprove the folly of a lawless present, and experience set its seal on the reprobation.

The wise parent will follow a just mean between inculcating unquestioning deference to established beliefs and practices and stimulating a spirit of rebellion against whatever can not produce its logical credentials in a shape suited to the critical temper of the times. Room must be left for intellectual growth, and the mind must be allowed to go on voyages of discovery of its own; but as a preparation for such voyages a disposition, not to accept with absolute submission, but at least to respect—in some measure to reverence—the principles of morality which the experience of mankind has slowly elaborated, will be found to be of no mean value.

> "Me this unchartered freedom tires,
> I feel the weight of chance desires,"

says the poet Wordsworth in his Ode to Duty. The poet felt their weight; others, less happily constituted, have experienced their danger, for not every one can join in the affirmation:

> "Through no disturbance of my soul
> Or strong compunction in me wrought
> I supplicate for thy control,
> But in the quietness of thought."

Some parents who have no wish to launch their children on too adventurous a career nevertheless help to do so by unduly stimulating, or not wisely repressing, their egotism, and by emphasizing too strongly or without due discrimination the importance of individuality. Not every seedling is worth cultivation, and a given individuality may be little better than a "freak." The true advice to give to every one is, not to abound in his own peculiar sense for the sake of being different from others, but to choose wisely an object in life and to develop his nature to the utmost in the effort to advance that object. The proof of a pudding is in the eating, and the measure of the value of an individuality is not the angle of its divergence from the normal, but the amount of effective help it can give to the work of the world.

The character of every human being will be largely shaped by heredity: the function of education is to repress as far as possible all hurtful tendencies by bringing their nature and consequences into prominence, and to call into activity such useful faculties or traits as threaten to lie dormant. The wise educator will not, however, proceed on any Procrustean plan. His aim will not be conformity to an arbitrary or conventional model, but simply the production of the best possible results from the particular type submitted to him; and he will respect individuality in this sense, that he will know that Nature sometimes does more in one stroke than education can accomplish in a hundred years. It is hardly necessary to say, in conclusion, that the formation of character is by far the most important problem in education. Give us learning, give us accomplishments, give us talents if you can; but above all strive to give us men and women fitted for life and its activities, for its joys, its sorrows, and its struggles, fitted to be happy themselves and to make others happy.

TENNYSON.

MUCH as has been written about the great poet who was laid to rest in Westminster Abbey on the 12th of October last, a few words may properly be devoted to him in this place on account of the marked influence which his writings have had upon the intellectual movement of our time. In him there was an admirable balance and harmony of the logical and emotional powers. Through the former he was in sympathy with the most progressive thought of the age; through the latter, coupled with a noble imagination, he was enabled to enrich the English language with lyrics of priceless value and to infuse into the great body of his poetry the warmth and glow of a high moral inspiration. In many respects Tennyson was an ideal poet. While alive to the controversies of the time, he held a place apart, and never did or suffered aught of a nature to impair the great and ever-increasing consideration in which his name was held. He confined himself strictly to his own region of poetry, not seeking to shine as a prose writer, a critic, a theologian, or a man of society. At the same time his poetical throne was well within view of the people. His style was free from the all but hopeless obscurity of Browning, and yet it was marked by a certain distinction and refinement of thought which placed it just beyond the reach of the intellectually vulgar. Though a "gentleman" by birth, he had sincere popular sympathies; and though an upholder of church and state, his theology was of a very broad and liberal pattern. All things considered, he was in an admirable position for interpreting this age to itself; in other words, for making his contemporaries conscious of the spirit and tendencies of the time. His thought was fresh and forward-glancing in the early years of the century, and in the latest it was still in sympathy with all true progress.

No one can read any considerable portion of the poetry of Tennyson without perceiving his interest in scientific thought. He tells us himself, in Locksley Hall, in a touch which may be regarded as autobiographical:

"Here about the beach I wandered, nourishing a youth sublime
With the fairy tales of science and the long results of time."

In certain well-known stanzas of In Memoriam he has given us a vigorous sketch of the evolution theory, even anticipating the views of Darwin on the descent of man. That he studied the stars is evident from many allusions. Take the beautiful verses from Locksley Hall:

"Many a night from yonder ivied casement ere I went to rest,
Did I look on great Orion sloping slowly to the west;
Many a night I saw the Pleiads rising through the mellow shade,
Glitter like a swarm of fire-flies 'tangled in a silver braid."

In The Palace of Art he tells how—

. . . "while Saturn whirls, his steadfast shade
Sleeps on his luminous ring";

and in The Princess how

. . . "the fiery Sirius alters hue,
And bickers into red and emerald."

That he did not sympathize with the attacks of theologians on scientific speculations may perhaps be gathered from the following lines in the Prologue to his Morte d'Arthur:

"Half awake I heard
The parson taking wide and wider sweeps,
Now harping on the church commissioners,
Now hawing at Geology and schism;
Until I woke and found him settled down
Upon the general decay of faith
Right through the world—'at home was little left
And none abroad: there was no anchor, none,
To hold by.'"

That he placed but limited faith in ecclesiastical authority is more than hinted where he says to the Rev. F. D. Maurice:

"Should all the churchmen foam in spite
At you so careful of the right,
Yet one lay-heart will give you welcome
(Take it and come) to the isle of Wight."

In the preceding verse he had intimated that he would not mind in the least if "eighty thousand college councils" had "thundered anathema" at his friend. His references to the clergy, indeed, were not in general flattering; and this, considering that his own father whom he greatly revered was a beneficed clergyman, is a little remarkable. When the old woman in The Goose began to grow rich with her golden eggs, "the parson," we read, "smirked and nodded." In Maud we read of "the snowy-banded, delicate-handed, dilettante priest"; and in the Northern Farmer we do not get a deep impression of the value of the ministrations of the parson whom that worthy, when he went to church, heard "a bummin' away" over his head. At the same time the tone of Tennyson's mind was essentially reverent. Without cramping his thought he bowed his will to a Power that he recognized as divine. No man ever faced intellectual difficulties more fully and fairly than he did. He would sometimes solve his difficulties by what Comte has called "the logic of feeling" in a way which is not given to all of us, but he never laid false pretensions to argumentative victory. In his Two Voices he lets the evil spirit have its say to the fullest extent, and then answers:

"I can not make this matter plain,
But I would shoot, howe'er in vain,
A random arrow from the brain."

So in In Memoriam there is earnest aspiration and even affirmation, but no dogmatism, no appeal to authority or reliance on authority.

To the moral law Tennyson throughout his works is unfailingly loyal. If, as he says, he received his laurel "green from the brows of him who uttered nothing base," he has bequeathed that laurel as fresh and stainless as he received it. We can not think of a better course of moral hygiene than a selection which might be made from the late laureate's poetry. The Palace of Art tells most powerfully of the misery of selfishness; the Idylls of the King are a noble and impassioned plea for truth and fidelity; Maud and Locksley Hall strike all the chords of high and generous feeling; and The Princess sets the relations of the sexes in a light which is familiar enough to us to-day, but which forty-five years ago had almost the character of a gospel. It may be said of Tennyson's Muse that, while the world in which she lives and moves is a noble one, it is not an impossible one: hence the benefit of reading Tennyson; the virtues which he depicts and glorifies are essentially human in their character and make for the perfection of human life. They are within our reach if we will but strenuously grasp at them. If the verse of Tennyson had descended into the grave with him, the world to-day would be a grievous loser; but while we mourn the poet who gladdened and instructed our age, we rejoice to think how much he has left that our children and our children's children will prize not less highly than we, and that will extend its healthful influence through ages to come.

LITERARY NOTICES.

Man and the Glacial Period. By Prof. G. Frederick Wright, author of The Ice Age in North America. With an Appendix on The Tertiary Man, by Prof. Henry W. Haynes. With Three Folded Maps, and 108 Figures, Maps, and Sections in the Text. New York: D. Appleton & Co. (No. 69 of the International Scientific Series.) 12mo. Pp. xvi + 385. Price, $1.75.

The rapid progress of scientific investigations during this latter half of the nineteenth century has been scarcely less surprising than the countless applications of invention in manufactures, in the vast development of railroads, and in the uses of electricity for the telegraph and telephone, and for motive power and light. Within the past hundred years the science of geology has sprung into existence, and only about fifty years ago its division known as glacial geology began with the grand work of Agassiz in his study of the glaciers in the Alps, of their former extension across the wide valley of western Switzerland to Mont Jura, and of the glacial drift in Great Britain which he at once saw to be due to the former presence of sheets of land ice. At nearly the same time, in 1841, Boucher de Perthes made the first collection of stone implements in the gravel terraces of the Somme Valley, by which geologists and archæologists were reluctantly convinced that the human race dates back to a remote prehistoric period, since which time very great changes of climate have taken place and the valleys of many rivers have been eroded far below their old flood plains. Because of the relationship of the earliest traces of man with the Glacial period, this latest part of the geologic record has attracted the interest of many observers and nearly all readers; new and important discoveries are being made every year, and a vast amount of literature in scientific journals and government reports is constantly accumulating; but many difficult problems in this field remain still under discussion, concerning measurements of the antiquity of man, the duration of post-glacial time and of the Ice age, the causes of its climatic changes, and whether it consisted of only one epoch of glaciation or of two or more separated by mild and warm interglacial epochs when the ice-sheets were melted away. Among these observers and writers none during recent years has traveled more extensively to gather information or been more successful in contributing to our knowledge than Prof. Wright, who in this book, as in his previous larger volume, treats this subject in a clear, vigorous, and entertaining style.

Agassiz reasoned, from the action of the Swiss glaciers in their wearing the rock surfaces over which they moved, and in their transportation of drift and formation of terminal moraines, that all countries bearing such marks or striæ on the bed-rocks and similar deposits of till, or intermingled bowlders, gravel, sand, and clay, have been overspread by ice. Prof. Wright similarly devotes fifty pages to descriptions of glaciers now existing, and of the ice-sheets of Greenland and the Antarctic continent, before considering the evidences of past glaciation. On the Sierra Nevada and Mount Shasta living glaciers are found, but are of very small size. Northward they occur in increasing numbers and abundance on the Cascade Range and in the Selkirk Mountains and the Coast Ranges of British Columbia and Alaska. About one hundred and fifty miles north of Sitka the Muir Glacier, which was explored and mapped by Prof. Wright in 1886, has an extent of about three hundred and fifty square miles; and the Malaspina Glacier or ice-sheet, lying between Mount St. Elias and the ocean, mapped by Russell in 1890 and 1891, covers some fifteen hundred square miles. These are very far surpassed, however, by the Greenland ice-sheet, explored by Rink, Nordenskiöld, Nansen, and Peary, which probably has an area of half a million square miles; and the Antarctic ice-sheet is ten times more extensive, occupying, indeed, a somewhat greater area than the northern half of North America, which was enveloped by ice during the Glacial period.

The terminal moraines of the ancient ice-sheet of this continent have been traced by Wright, Chamberlin, Salisbury, Leverett, Upham, and others, from Nantucket and Cape Cod, westward through Long Island, northern New Jersey and Pennsylvania, Ohio, and other States to Minnesota and North Dakota; and farther westward the glacial boundary crosses Montana, Idaho, and Washington to the Pacific south of Vancouver Island. Stone implements proving the presence of man here during the Ice age have been found in plains and terraces of modified drift deposited in valleys by streams flowing from the melting and receding ice-sheet in New Jersey, Ohio, Indiana, and Minnesota. Equal or greater antiquity must be also affirmed for the Calaveras skull, stone mortars, pestles, and spear-heads which have been obtained by Whitney, King, Becker, Wright, and others, from the gold-bearing gravels under the lava of Table Mountain in California.

In the chapter on the ancient glaciers of the Eastern hemisphere a very valuable contribution of more than forty pages is from the pen of Mr. Percy F. Kendall, relating to the glaciation of the British Isles, with a map showing their contour and the areas covered by their ice-sheets. Mr. Kendall fully sustains the conclusions of the late Prof. Henry Carvill Lewis, that the British drift was due to land ice, with no considerable marine submergence of any part of these islands. The marine shells, mostly fragmentary, which are found up to the height of about fourteen hundred feet on Moel Tryfaen, are confidently ascribed to currents of the ice-sheet flowing southward over the bed of the Irish Sea, plowing up its marine deposits and shells and carrying them upward as glacial drift to this elevation.

Norway, Sweden, and Denmark, the North Sea and the Baltic, northern Germany, and a large part of Russia, were enveloped by an ice-sheet which flowed radially outward from the Scandinavian mountains and plateau. Bowlders of Scandinavian rocks were brought across the present area of the North Sea to Yorkshire in England. Moraines of this ice-sheet have been traced across Germany by Prof. R. D. Salisbury, who finds them closely like the moraines that he had previously explored in the northern United States.

Many relics of palæolithic man, contemporaneous with the Glacial period and with numerous extinct species of animals, have been found in river gravels and in caves in Wales, England, France, Belgium, and Germany, which Prof. Wright has well described. He does not proceed, however, to treat of the neolithic and later races of men, who have inhabited Europe since the Ice age. The glacial type of man is represented by portions of skeletons, including skulls, exhumed many years ago in Canstadt and Neanderthal, Germany, and recently by Profs. Lohest and Fraipont in the commune of Spy, Belgium.

The author believes that all the phenomena of the drift can be better explained by a single Glacial epoch than by two or several such epochs divided by long intervals of mild or warm climate. In this opinion he differs from most American glacialists, from Prof. James Geikie and others in Great Britain, Wahnschaffe in Germany, Penck in Austria, and De Geer in Sweden; but is in agreement with Lamplugh in England, Falsan in France, and Holst in Sweden, who attribute the fossiliferous beds inclosed between deposits of till to oscillations of the front of the ice, rather than to its complete departure and return. "So far as we can estimate," says Prof. Wright, "a temporary retreat of the front, lasting a few centuries, would be sufficient to account for the vegetable accumulations that are found buried beneath the glacial deposits in southern Ohio, Indiana, central Illinois, and Iowa, while a temporary re-advance of the ice would be sufficient to bury the vegetable remains beneath a freshly accumulated mass of till." With reference to the argument for two distinct glacial epochs in North America drawn from the greater oxidation of the clays and the more extensive disintegration of certain classes of the bowlders found over the southern part of the glaciated area, attention is directed to the superficial decay of the rocks before the Ice age, like that now observed outside the drift region. "There was an enormous amount of partially oxidized and disintegrated material ready to be scraped off with the first advance of the ice, and this is the material which would naturally be transported farthest to the south; and thus, on the theory of a single Glacial period, we can readily account for the greater apparent age of the glacial *débris* near the margin. The *débris* was old when the Glacial period began."

As to the causes of the Ice age, the author points out strong objections against the astronomic theory which has been so ably advocated by Croll, Geikie, and Ball. Measurements of the rates of erosion of the gorges below the falls of Niagara and of St. Anthony, as shown by Gilbert and Winchell, allow us no more than seven thousand to ten thousand years since the end of the Glacial period, instead of the eighty thousand years required by Croll's theory. Geographic conditions seem more likely to have produced the glacial climate, continental ice-sheets, and formerly more extensive glaciers on mountain ranges. According to Dana, Upham, Le Conte, Jamieson, and others, submarine river channels and fjords, reaching down three thousand to four thousand feet beneath the sea-level, prove that these glaciated areas were greatly uplifted, probably attaining such altitudes that their precipitation of moisture was mostly snow throughout the year; and the snow and ice may have been more rapidly accumulated because of changes in the oceanic circulation by submergence of the Isthmus of Panama.

Prof. Wright concludes that the earliest men, so far as we know of their antiquity by that of the Ice age, lived perhaps thirty thousand to forty thousand years ago. He assumes that the elevation of the northern part of our continent and of northwestern Europe at the close of the Tertiary era may have been at the rate of three feet a century, like the present uplifting of some portions of Scandinavia, so that in one hundred thousand years they would be raised three thousand feet, which is thought probably enough to cause the accumulation of the ice-sheets; and for the reign of the ice or duration of the Glacial period he accepts Prestwich's estimate of about twenty-five thousand years.

The question whether man existed, as has been claimed, in Europe or in California during the later part or even the middle of the Tertiary era, far longer ago than the Ice age, is examined by Prof. Haynes in an appendix of this work, showing that no reliable evidence of Tertiary man has been yet discovered.

The Case against Bimetallism. By Robert Giffen. New York: Macmillan, 1892. Pp. 264. Price, $2.

In the domain of the physical sciences the results of research, when acquiesced in by those competent to judge, take their place as a part of the body of accepted truth, and are no longer open to discussion. In sociology, however, the demonstration of any proposition, and the concurrence of all competent judges in its truth, carries no such weight with the mass of people. This is particularly true in economics. The demonstration that entire freedom of trade is essential to the fullest working out of the economic life of a nation is as old as the science, yet we have the spectacle of the greater number of the advanced nations of the world clinging to the opposite policy. Another of the fallacies to which great numbers adhere, in the face of repeated demonstration that it is a fallacy, is bimetallism. And in this case this most pernicious doctrine finds adherents, not alone among the masses of the people, but among otherwise instructed economists as well. It has been demonstrated over and over again that a dual standard of value is a delusion; in fact, has been so thoroughly demonstrated that adherence to the idea is not a whit more creditable intellectually than is the pursuit of a perpetual motion. Mr. Giffen may, therefore, be forgiven for having but little patience with bimetallism or its adherents. He very properly feels that an economist should not be called upon to continually discuss a question that is already settled; but the continual reappearance of this doctrine and its wide popular support renders it necessary to restate from time to time the economic facts and to examine the alleged practical results. The present book is not a systematic treatise, or even a series of essays grouped in a logical order, but consists of miscellaneous papers contributed to various periodicals, letters to The Times, and addresses. The general scope of this collection of papers is indicated by the titles, which are as follows: The General Case against Bimetallism, On some Bimetallic Fallacies, A Problem in Money, The Inevitable Results of Universal Bimetallism, M. de Laveleye on Mint Price, The Alleged Bimetallism of France, 1803–'73, Unsalable Silver, The American Silver Bubble, and A Chapter on Standard Money. In an appendix there is a further consideration of the case of France, and also a number of extracts from debates in the House of Commons on bimetallism in 1830.

The general tenor of Mr. Giffen's positions is that nothing that a government can do can alter the relations of the two metals, gold and silver, as determined by economic forces; and that if you could tie the metals together at some particular ratio and hold them there, nothing whatever would be gained. You can't, however, do this, so that in all cases of attempted bimetallism what you really have is a shifting standard, first gold, then silver, and so on back and forth, as the market value of the metals varies. The idea that governments, either singly or all together, can give a price to either of the metals different from the bullion price is fitly characterized by Mr. Giffen in the following extract from his paper on Mint Prices: "M. de Laveleye's idea, first of all, is that the impression of a metal with certain stamps by the mint is the fixing of a price for it. If you take an ounce of gold to the mint, he says, it is coined into

£3 17*s.* 10½*d.*, and that is the price of an ounce of gold. This is as much as to say that if you send a cask of beer to the bottler and he fills one hundred bottles with the contents, the one hundred bottles is the price of the cask of beer. Of course, the gold and the beer before and after coining and bottling respectively are the same, and the £3 17*s.* 10½*d.* is an ounce of gold and not the price of it, just as the contents of one hundred bottles are the beer that was in the cask and not the price of it. I need hardly add that this talk of a mint price is the old and time-worn talk of the currency faddists who believe in inconvertible paper."

It is a great pity that books like this of Mr. Giffen can not find their way into the hands and minds of those smitten with the silver mania, and who have been brought to regard the much-abused metal, as they term it, with emotions akin to those excited by contemplation of the forlorn and oppressed.

The Speech of Monkeys. By R. L. Garner. 8vo, pp. 217. New York: Charles L. Webster & Co. Price, $1.

In the title of this book lies the potency which has prompted the acceptance of Mr. Garner's various essays on the subject by the leading reviews. The honest enthusiasm of the author and his positiveness have given a charm and virility to his writings, and made them attractive reading.

The initiatory impulse which has impelled Mr. Garner with unparalleled persistency arose in early childhood, from a superstition, common to all children and savages, that animals talk among themselves. This belief, instead of being outgrown by Mr. Garner, became the dominating impulse of his life—has animated him to the most painstaking efforts, and to the most sanguine utterances. The book abounds in surmises to be answered in only one way; no effort is made to even suggest any other conclusion than the one which supports his thesis. On the very first page, for instance, he wonders how it has occurred to man to whistle to a horse and dog instead of using some sound more like their own. He says, "I am at a loss to know how such a sound has ever become a fixed means of calling these animals." The simple answer should have occurred to Mr. Garner that a whistle is easier to utter, is heard farther, and is not only the universal call for dogs but for boys and men. The whistle of the boatswain, postman, policeman, and car-shifter shows the simple utility of this kind of a sound as a call or a signal note.

His experiments with monkeys are very interesting and amusing; his explanations, however, can often bear a different interpretation; thus, on page 76, he describes an experiment with a glove to which he had attached a string by which he drags the glove slowly toward him across the floor. The monkey, on first seeing it at a distance, gives a low note of warning, and as the glove approaches she makes a louder note. He says, in regard to these subdued notes of warning, "Her purpose was to warn me of the approaching danger without alarming the object against which the warning was intended to prepare me." It may be observed, however, that all emotional sounds made by animals increase in loudness just in proportion to the excitement occasioned by the cause.

Mr. Garner's interpretation of the gesture for negation seems quite reasonable. His experiments with the phonograph inspire him to further efforts "to find out the fountain-head from which flows out the great river of human speech." Mr. Garner should know that if he is to go to the fountain-head he is not to run out to the extreme tip of one of the twigs which branched off in the Tertiaries, but rather to study the half-apes and the lemurs if he is to get the remotest light on the subject.

A preparation for the work Mr. Garner is engaged in should have been prefaced by an exhaustive study of the emotional sounds emitted by man—sounds quite distinct from articulate utterances which form words and sentences. As an illustration of these sounds, let one witness a base-ball game and observe the different cries which go up from the audience at different points of the play. A few years ago there was a gate-keeper at the Brooklyn base-ball grounds who, though far out of sight of the game, could tell by the kinds of sounds emitted by the multitude precisely what was happening on the field. With unerring certainty he could say, "There's a hot ball caught from the bat," or "man put out at first," "home-run," "caught on the fly," "rank decision," etc. And yet these sounds were all emotional and inarticulate. Now, when so many details of a complex game bring out a variety of symphenomenal expressions, why may we not insist that the so-called speech of monkeys as well as of other animals is of the same nature?

We do not doubt Mr. Garner's earnestness, but lament his impetuous tendency to see one side of the question only. His experiments with the phonograph and his studies of the subject should be encouraged, as the collection of facts will be of great value, even if his theory of speech falls to the ground. The book is interesting reading throughout.

Lessons in Elementary Biology. By T. Jeffery Parker, F. R. S., Professor of Biology in the University of Otago, Dunedin, New Zealand. London and New York: Macmillan & Co. Pp. 408. Illustrated. Price, $2.25.

This work differs essentially in purpose and treatment from the standard Practical Biology. Although the author admits the value of Prof. Huxley's "sound canon of instruction," to proceed from the known to the unknown, yet he clings to the earlier method pursued in teaching biology, analogous with the order of evolution, advancing from the simple to the complex, and defends it upon logical grounds. He recognizes the danger of overwhelming the hapless student at once with unfamiliar objects, new means of observation, and a strange tongue, and suggests a compromise. Disregarding the arrangement of the book, practical class-work may begin with a study of a flowering plant and of a vertebrate animal. The pupil will then be sufficiently acquainted with the terminology and microscopical work to take up the lessons in the order given.

The book, however, is designed for the study rather than the laboratory, and the life processes of different types are described and illustrated with such detail that actual handling of the objects is not essential to a fair acquaintance with their changes of structure. Beginning with amœbæ, representative forms are considered in the order of increasing complexity until examples of the higher plants and animals are reached. At intervals, special lessons are devoted to important topics: cell structure and nuclear division; biogenesis, homogenesis; the origin of species; distinctive characters of animals and plants; reproduction and embryology. The various modes of nutrition, digestion, movement, and generation are treated in connection with each individual organism.

The aim of the author, "to give a fairly connected account of the general principles of biology," is very carefully carried out, and those who desire to gain an insight into the science are materially assisted by a glossary. In this the author has given to several botanical terms a zoölogical meaning, striving toward a more consistent nomenclature; but the student will be grateful, without regard to these innovations, to be saved the thankless labor of searching for words that the average dictionary does not define.

Transformers. By Caryl D. Haskins. Bubier Publishing Company, Lynn, Mass., 1892. Pp. 150. Price, $1.25.

It not infrequently happens that an apparatus, machine, or method of work which was discarded in the early stage of a developing industry, becomes later, by the progress of the industry, to be very important. This has been the case in the application of electricity to the production of light. It began with the alternating current, and is now returning to it. The use of this type of current is now becoming so general that it would not be beside the mark to say that future progress in the application of electricity will all be in this direction. An increasing amount of incandescent lighting is being done with it, and it needs only the development of a satisfactory alternating-current motor to render it available for all power purposes for which the continuous current is now employed. The marvelous flexibility of this form of current is what constitutes its great commercial advantage. You can start with a current of any tension and volume you please, and produce at the operating point a current of any other tension and volume that you desire within the limits of the original energy. You can step up to higher tension or down to lower tension, or do both in succession. All this is accomplished by the use of the transformer—a form of induction coil This, which is the vital part of the alternating-current system of distribution, forms the subject of this little volume of Mr. Haskins.

The book is primarily addressed to working electricians who have charge of alternating-current apparatus, but it may be read understandingly by any one who is sufficiently interested in the progress of electricity to have taken the trouble to acquire a rudimentary knowledge of the subject.

The book opens with a brief consideration of the phenomena of induction and its application to the transformer. A chapter is given to a mathematical consideration of it, one to the changes it has undergone to fit it for commercial use, and one each to its construction and its use in practice. The book closes with a description of the chief commercial transformers. Various miscellaneous subjects, which could not well find a place in the body of the book, are noticed in an appendix.

Induction Coils. By G. E. Bonney. New York: Macmillan & Co., 1892. Pp. 231. Price, $1.

The author has essayed in this volume to give such practical knowledge of the methods of constructing and operating induction coils as will be of use to the amateur coil-maker. After considering briefly the theory of induction, he gives directions how to construct spark-coils, devotes a chapter each to Accessories to Coils, and special forms of coils. Some of the other chapters are Batteries for Coils, Repair of Batteries and Coils, and Useful Notes on Coils. He also devotes a chapter to some of the famous coils, such as that constructed for Mr. Spottiswoode by Apps, of London. The book is provided with a general index, and is quite fully illustrated.

The Economy of High Wages. By J. Schoenhof. New York: G. P. Putnam's Sons, 1892. Pp. 414. Price, $1.50.

In a time like the present, when a campaign of education on the tariff question is in progress, and when not only the great mass of the people, but many of the supposed beneficiaries of the tariff, are awakening to the fact that prosperity by taxation is not quite what it is represented to be, a book like the present one is a very welcome addition to the current literature of the subject. The protected classes have succeeded in maintaining themselves in the enjoyment of their present gratuities by their appeals to the workingmen to support protection as the sole guarantor of high wages. Protectionists have never tired of contrasting the day rate of wages in this country and Europe, claiming that they were due to the tariff, and that, if American manufacturing industries were deprived of the benefits of protection, wages must fall. In all their discussions of wages they have assiduously represented that the difference in wages corresponded with the difference in labor cost of the goods made here and abroad. It has been pointed out a good many times by tariff reformers that high wages do not necessarily mean high cost of production, but no one has heretofore taken up the question and dealt with it in such detail as the author of the present work. Mr. Schoenhof is peculiarly well fitted to undertake his task. He was commissioned by the late Secretary Bayard to make a study of the question in the trade and manufacturing centers of Europe while in the diplomatic service under the Cleveland administration, and has himself had an extended experience as an employer of labor. He not only controverts the proposition that a high rate of day wages necessarily means a high labor cost in production, but maintains that a high rate of wages is necessarily associated with a low labor cost of the goods. High wages mean high efficiency of the worker and low wages low efficiency, and the essential condition of the payment of high wages is that the worker is so much more efficient and has the command of so much better tools that he can produce goods more cheaply. Our high-priced American labor, therefore, has nothing to fear from the cheaper labor of England, and the relatively high-priced labor of England nothing to fear from the low-priced labor of the Continent. The real cheapness of high-priced and therefore efficient labor, when measured in commodities produced, which is the only consideration that has any bearing on the question of the competition of producers, can be readily apprehended and arrived at deductively. Mr. Schoenhof does not content himself, however, with an argument, but examines in detail the chief trades and industries of the world, finding that everywhere a high rate of wages and a low labor cost in production go hand in hand. He gives schedules in the pottery, glass, iron, cotton, and woolen industries, abundantly proving his position, and shows very clearly that, so far from the working-man profiting by protection, he is injured at every turn. It is much to be hoped that the essential contention of the book can be properly brought before the farmers and artisans of the country while attention is so keenly alive to the importance of tariff questions. Tariff reformers will find ready to their hand in its pages just the kind of material needed to illustrate and enforce their positions, and should make good use of it in the opportunities afforded by present political discussions.

Fragments of Science. By John Tyndall. In two volumes. New York: D. Appleton & Co., 1892. Pp. 452 each volume.

The original volume under this title issued some twenty years ago has gradually grown in size by the addition of new papers until it finally became so unwieldy as to necessitate dividing it into two volumes. Besides the matter in the previous edition there are some fifteen new papers, mostly relating to researches in molecular physics. The present volume and the volume recently issued under the title of New Fragments contain, the publishers state in an introductory note, all of the occasional papers which Prof. Tyndall cares to preserve in a permanent form. The first of the present volumes contains the papers that relate to the laws and phenomena of matter solely; while the second, with the exception of the address upon the electric light, deals with questions which traverse the domain of mind as well as of matter. This volume contains the celebrated Belfast address delivered before the British Association at its Belfast meeting in 1874, as well as Prof. Tyndall's reply to various critics which he issued under the title of An Apology. The volume contains also the well-known address upon the Scientific Use of the Imagination, and that upon Matter and Force, as well as his excursion into fields considered by theologians especially their own, in which he discusses miracles and prayer in relation to natural laws.

It is not necessary at this late day to say anything in commendation of Prof. Tyndall's exposition of science. He is read wherever the English language is spoken, and comes perhaps in closer intellectual and emotional contact with his readers than any other scientific man of our time. This is due in large measure to that transparent intellectual honesty which makes him scorn to be self-deceived or to take any lower aim than the pursuit of truth, lead whither it will. There is, moreover, an elevation of moral tone pervading all his speculations concerning that unknown world into which we vainly peer, which brings him into sympathetic contact with all earnest seekers after truth, no matter how widely they differ in their conclusions. Of the literary merit of the discourses of Prof. Tyndall it is also needless to speak. The purity and vigor of his diction have always charmed his readers as much as his lucidity of thought, and he has long been recognized as one of the masters of style. Those who prize his writings will be glad to have them in this last form, which in all probability will prove to be a final one.

Life in Motion, or Muscle and Nerve. By John Gray McKendrick. London and Edinburgh: A. & C. Black, 1892. Pp. 200. Price, $1.50.

This little book consists of a course of six lectures delivered before a juvenile audience at the Royal Institution, and is an excellent example of what a popular exposition of a scientific subject should be. Though addressed to juveniles, the lectures can be read with interest and profit by older folk who are not specially informed on physiological subjects and the methods and apparatus used by experimenters in studying the problems to which they address themselves.

The title Prof. McKendrick has given to his course is not a very happy one, as it does not indicate with any clearness the subject-matter of the lectures, which deal with muscular movement. He uses in his demonstrations the muscle of the frog which correponds with that of the calf of the leg in man. This he excites by means of an electric current, and performs a number of the striking and beautiful experiments devised by physiological experimenters for the study of the behavior of living matter. He illustrates by experiment the lifting power of a muscle when contracting; the nature of the movement that occurs when a muscle is contracting; shows graphically by means of curves on smoked glass the times of contracting and relaxing, and the time required for nerve transmission; discusses the chemical changes that take place in a muscle when working and its analogy to a heat engine; and, after showing that a muscle generates an electric current, closes his course with a consideration of the electric organs found in certain fishes.

Elements of Qualitative and Quantitative Analysis. By G. C. Caldwell, Ph. D. Second edition, revised and enlarged. Philadelphia: P. Blakiston, Son & Co. Pp. 175.

The author, who is Professor of Chemistry in Cornell University, has brought together in this book the material that he has published before in handbooks of analysis, together with much new matter. The volume is divided into five parts: in the first of these the processes and manipulations of analytical chemistry are described quite fully; the second sets forth the systematic course of qualitative analysis; the third is devoted to the operations of quantitative analysis; directions for examples in quantitative analysis constitute part four; and lists of apparatus and reagents, various tables, etc., make up part five. This is the first book that we have seen to use the new spellings of chemical terms originated by the American Association for the Advancement of Science.

Life Histories of North American Birds. By Charles Bendire, Captain U. S. Army. Washington: Smithsonian Institution. Pp. 446, quarto.

The Smithsonian Institution has begun a series of Special Bulletins, designed to illustrate the collections in the National Museum, and Captain Bendire's work, covering part of the collection of birds' eggs, appears as the first of the series. The present volume is confined to gallinaceous birds, pigeons, and birds of prey, embracing a total of one hundred and forty-six species and subspecies. Besides describing the eggs and nest, the author gives the breeding habits of each species, its migratory and breeding ranges, so far as these have been determined, and other facts of its life history. The classification given in the Code and Check List of the American Ornithologists' Union has been followed, and the synonymy and nomenclature used in this list have been adopted also. The value of the work is greatly enhanced by twelve elegant colored plates of eggs, embracing a total of one hundred and eighty-five varieties. Captain Bendire is Honorary Curator of the Department of Oölogy in the National Museum.

History of Higher Education in Massachusetts. By George Gary Bush. Washington: Bureau of Education. Pp. 445.

The best friend of Harvard University can not help seeing a great want of proportion in a history of Massachusetts colleges that gives more space to Harvard than to thirteen other institutions combined, yet this Prof. Bush's book does. The author gives a connected history of Harvard in his first three chapters, then describes the various departments of the university, tells how its instruction is given, sets forth the "formative influences" at Harvard which constitute student life, and closes with a sketch of the presidents of the college and university and a Harvard bibliography. Next comes a brief history of Williams College (chartered in 1793), by Eben Burt Parsons, D. D., secretary of the faculty. Then follow similar accounts of Andover Theological Seminary, Amherst College, Tufts College, Massachusetts Institute of Technology, Worcester Polytechnic Institute, and Boston College, by persons connected with the respective institutions. Accounts of Boston University, Massachusetts Agricultural College, and Clark University, compiled from official records, are also included. There are three histories of women's colleges—Mount Holyoke, Wellesley, and Smith—prefaced by a general chapter on Higher Education for Women, by Mrs. Sarah D. (Locke) Stow. The volume is well illustrated with plates, representing the buildings of the various colleges.

Physical Education in the Public Schools. By R. Anna Morris. New York: American Book Co. Pp. 192. Price, $1.

This is a manual of gymnastics that may be performed in a school-room, some without any and some with simple apparatus. It provides for a graded course, extending from the first year of school to the high school. The movements are explained, and many are illustrated. There are directions for marching, which include a set of fancy utions called the Irving School March 1. An illustrated chapter is devoted to artean posturing. Apparatus drills with ds, Indian clubs, rings, dumb-bells, etc., described, and a great many additional utions are suggested. The volume in-les thirty-two pages of music suitable for utions of classes. We are somewhat as-shed to see in the front of the book a ical quotation ascribed to Herbert Spen-!

ERALOGY. By FREDERICK H. HATCH, F. G. S. New York: Macmillan & Co. Pp. 124. Price, $1.

THIS is a brief elementary manual con-ng of two parts, the first devoted to racters of minerals, and the second being riptive. In the first part the crystalline ns of minerals are described quite fully, the chemical composition, specific grav- and other characters are treated briefly. the descriptive part the minerals are uped under these heads: rock-forming erals, ores and veinstones, salts and other ful minerals, gems or precious stones. text is illustrated with many cuts show- the forms of crystals or amorphous min-s and the occurrence of minerals in veins.

'REATISE ON HYGIENE AND PUBLIC HEALTH. Edited by THOMAS STEVENSON, M. D., and SHIRLEY F. MURPHY. Vol. I. Philadel-phia: P. Blakiston, Son & Co. Pp. 1013.

THE extensive work of which the first in-lment is before us is made on the plan of ing the several subjects included in its be treated by authors having special quali-tions for their respective tasks. In the ction of subjects the editors have been led mainly by the needs of the English ials known as Medical Officers of Health, there is much information in the essays ch is applicable to sanitary conditions the ld over. The first volume comprises six- essays dealing separately with air, er, food, clothing, baths, the dwelling, sical education, offensive and noxious nesses, etc. The most space is given to treatise on The Dwelling, by P. Gordon th and Keith D. Young. The authors l with the subjects of site, the arrange-t of laborers' dwellings, prisons, bar-ks, schools, workhouses, and hospitals, both general and special, and the drainage of the dwelling. The Disposal of Refuse is also treated with much fullness in a separate article by W. H. Corfield, M. D., and Louis C. Parkes, M. D. In the essay on Warming and Ventilation, the author, W. N. Shaw, F. R. S., gives formulas and describes methods for calculating the movement of air in various systems of ventilation, and gives a summary of the conditions to be satisfied to secure a proper change of air. He also compares the efficiency of the ordi-nary modes of heating, and gives various numerical data concerning heating in the climate of England. The volume is illus-trated with nearly two hundred cuts and plates, and has a separate index.

ANIMAL COLORATION. By FRANK E. BEDDARD, M. A., F. R. S. E. New York: Macmillan & Co. Pp. 288. Price, $3.50.

MR. BEDDARD has chosen a very attractive topic, and has made a book interesting to both the zoölogist and the general reader. After an introductory chapter giving the principal facts of animal coloration, he cites a number of cases in which the coloration of an animal appears to be in part due di-rectly to the influence of the surroundings, among which are the prevalence of green in the animals of verdant Ceylon, the white fur of polar animals, and the absence of color among cave-dwelling species. Coming to the purposes of color in animals, the author finds much to discuss under the head of pro-tective coloration. While on this subject he raises the question whether as a matter of fact animals are concealed from their foes by their protective resemblances, and shows that there is much evidence on the negative side. He contends, also, that in some cases so-called protective coloration is produced more simply and directly than by the opera-tion of natural selection. Warning colora-tion, first explained by Mr. Wallace, next re-ceives attention. The author is inclined to give much weight to the suggestion of Dr. Eisig that in caterpillars which are distaste-ful to their enemies the usual bright pig-ments cause the inedibility of the species instead of being produced to advertise it. Alluring colors receive attention in the same chapter. Allied to coloration like the sur-roundings is mimetic coloration or resemblance of one species to another that is better endowed with means of defense, or with some other desirable possession. Mr. Beddard frequently cautions investigators against proceeding as if the sight or taste of animals were the same as that of man, for in the questions here discussed the point of view is important. The volume closes with an account of the chief differences in coloration between the sexes of animals, and a statement of the leading theories proposed to explain them. The text is illustrated with four colored plates and thirty-six woodcuts.

Natural History Lessons. Part I, Shelter, Food, and Clothing. By George Ashton Black. Part II, Plants and Animals. By Kathleen Carter. New York: Henry Holt & Co. Pp. 98. Price, 54 cents.

Science is rapidly acquiring the means for teaching its great pedagogical lesson that most knowledge may be obtained better from the study of things than from the study of books. This little manual is such a means. The first part of it is adapted to children of the usual primary-school age, and the second part to those in grammar-school grades. Its method requires constant practice in observation and investigation upon the objects and processes studied or upon pictures of them, thus giving the child at the outset of his education a thorough grounding in the natural way of acquiring knowledge. Prang's Lithographs of the Trades and Mr. Calkins's Manual accompanying them are expected to be used where the actual operations can not be witnessed.

Bulletin of the Philosophical Society of Washington, Vol. XI. Pp. 618.

The presidential addresses delivered before the Philosophical Society in 1888, 1889, and 1890, together with thirteen papers on special scientific topics, form the body of this volume. With these are printed the minutes of the society and of the Mathematical Section for 1888 to 1891, the rules and lists of officers and members of the society. Among the papers is one on The Observation of Sudden Phenomena, by Prof. S. P. Langley, in which is described a mechanism for lessening the error in observation represented by the "personal equation." Prof. F. W. Clarke has a paper on The Relative Abundance of the Chemical Elements; another is by Everett Hayden on Hurricanes in the Bay of North America; and John R. Eastman has a record of The Progress of Meteoric Astronomy in America, containing important catalogues of meteorites and meteoric showers. As the subject of his presidential address in 1891, Major Clarence E. Dutton took the practical matter of Money Fallacies. The Evolution of Serials published by Scientific Societies is traced by W J McGee. The other papers deal with various technical matters.

Florida, South Carolina, and Canadian Phosphates. By C. C. Hoyer Millar. New York: The Scientific Publishing Co. Pp. 223. Price, $2.50.

The practical and commercial side of phosphate mining occupies almost the whole of this volume, although it is supplemented by some notes on the geology of phosphate deposits and numerous tables of chemical analyses. The raising of phosphates from the beds of streams, the mining of pebble-deposits and of rock phosphates are described briefly, and copious information is given in regard to transportation, freights, prices, cost of production, companies engaged in the business, and similar matters connected with the industry. About half the volume is devoted to the Florida operations, South Carolina and Canada dividing the other half between them. An appendix contains analyses of a variety of foreign phosphates.

Under the title *Cardiac Outlines* a manual for physicians has been prepared by *William Ewart*, M. D. (Putnams). It is devoted to the physical examination of the heart and the recording of the results of such examination. The mode of recording the observations advised is by means of diagrams, the various parts of which are arrows to be crossed out if the sounds for which they stand are absent. There are fifty-two figures, and several leaves bearing the diagram referred to are bound into the volume.

A handsome manual of directions for *Leather Work* has been prepared by *Charles G. Leland*, whose manuals on several other minor arts are well known (Macmillan & Co. $1.50). It is eminently practical, beginning with a description of tools and materials and describing one style of work after another, from the simplest to the most elaborate. The text is illustrated with over fifty figures of patterns, many of them representing work executed during the middle ages. There is also a special chapter on patterns and design. Directions for gilding are included in the volume and there is a suggestive list of articles that may be made of leather. The mechanical work of the volume is tasteful and appropriate, the leather cover being stamped with a design by the author.

Rev. *Henry C. Kinney*, an Episcopal missionary at the Chicago stock-yards, has published a pamphlet entitled *Why the Columbian Exposition should be opened on Sunday*. It is a vigorous plea in behalf of the workingmen who could not visit the fair on any other day of the week, and undertakes to prove that Sunday opening would not be irreligious nor in conflict with the Illinois statute, nor lead to any of the consequences that many pious persons dread.

The *Treatise on Diseases of the Nose* prepared for physicians two years ago by *Greville Macdonald*, M. D. (Macmillan, $2.50), has already reached a second edition. It consists of descriptions of the diseases of the nose and its accessory cavities, and the methods of treatment which the author has found advisable. A considerable number of instruments designed for nasal surgery are described and figured. There are also cuts and a colored plate representing morbid growths in the nose. In the second edition a number of important additions and modifications have been made.

Part XXII of the *Proceedings of the Society for Psychical Research*, July, 1892, contains five papers. In the first, On Indications of Continued Terrene Knowledge on the Part of Phantasms of the Dead, F. W. H. Myers gives cases in which an apparition has seemed to the person seeing it to act as if the dead person whom it represented had a remembrance of the events of his life, and other cases in which persons in a trance have gained knowledge that they did not have before. Mr. Myers will perhaps show later how any information as to the knowledge possessed by the dead can be gained from the workings of the minds of the living. The second paper is an account by Richard Hodgson of Mr. Davey's Imitations by Conjuring of Phenomena sometimes attributed to Spirit Agency. The conjuring includes some wonderful slate-writing and materializing tricks, and is valuable material for those who wish to combat the spiritualistic superstition. Miss R. C. Morton contributes a Record of a Haunted House, in which the main narrative is well supported by independent accounts. The third of Mr. Myers's papers on The Subliminal Consciousness follows. Its special topic is The Mechanism of Genius, and it deals largely with mathematical prodigies. The concluding paper is a supplement to Dr. Backman's experiments in clairvoyance previously published.

The society is represented in America by Richard Hodgson, 5 Boylston Place, Boston.

A very full manual of *Directions for Collecting and Preserving Insects* has been prepared for the National Museum by Dr. *C. V. Riley*. In these directions the apparatus is first described, and the student is then told how to collect in the four seasons of the year, how to find insects under stones, in rotten stumps, in living trees, and on sandy places, how to take insects of the several orders, etc. Then follow directions for killing and preserving insects, for preparing and mounting them, for the preservation of alcoholic specimens, for labeling and arranging collections, and for protecting them against museum pests and mold. Other subjects on which information is given are insect boxes and cabinets, the rearing of insects, and packing and transmitting specimens; directions for collecting arachnids and myriapods are given also. The manual is introduced by an account of the classification of the hexapods, in which some forty species are figured, and concludes with a list of the entomological works most useful to the student. The whole number of illustrations is one hundred and thirty-nine.

One of the Bulletins of the United States Geological Survey recently issued, No. 76, is of much popular and practical interest. It is the second edition of a *Dictionary of Altitudes in the United States*, compiled by *Henry Gannett*, the first edition of which was published in 1884. The present work is considerably enlarged, mainly by the addition of determinations of altitudes by railroads, so that the volume now contains 393 pages.

A monograph on *The Humming-Birds*, forming part of the Report of the National Museum, for 1890, has been prepared by *Robert Ridgway*. It comprises a general zoölogical account of this group of birds, followed by descriptions of the several species found in the United States. The text is illustrated by forty-six plates and about fifty cuts.

An ingenious system of writing, signaling, and cryptography, to which he has given the name *Cosmography*, is described in a small pamphlet by *Charles G. Burke* (124 Nassau Street, New York). On a scale of three horizontal lines, using a dot, two slanting and one vertical marks, any language having not more than twenty-eight letters may be written in cosmography. The dot and three marks, if placed below the first line of the scale, stand for *a*, *d*, *c*, and *b* respectively; if on the first line, they stand for *e*, *h*, *g*, and *f*, and so on. In telegraphing, one, two, three, and four dots may take the place of the characters, and one, two, and three dashes may indicate the lines. An instrument consisting of a lettered dial with arms, called the "cosmograph," embodies the system in a mechanical form.

The *First Book of Electricity and Magnetism* (Macmillan & Co.) is designed to precede the usual elementary text-books in this study. The author, *W. Perren Maycock*, has felt the need as a teacher of interesting beginners, who are often discouraged by technical language. The subject of the magnet is entered upon at once; the explanations are clear, simple, and fully illustrated. Other divisions of the work besides magnetism are: electricity in motion, and electricity at rest. An index, list of apparatus, and blank pages for notes are furnished, as well as questions for teachers.

PUBLICATIONS RECEIVED.

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Brannan, J. W., M. D., and Cheeseman, T. M., M. D. A Study of Typhus Fever. New York. Pp. 15.

Brooklyn Ethical Association. Man and the State. Studies in Applied Sociology. New York: D. Appleton & Co. Pp. 558. $2.

Brooklyn Institute of Arts and Sciences. Prospectus for 1892–'93. Pp. 40.

Bryant, William M. A Syllabus of Psychology. Chicago: S. C. Griggs & Co. Pp. 60. 25 cents.

Bubier, E. T., 2d, Editor. Questions and Answers about Electricity. Lynn, Mass.: Bubier Publishing Company. Pp. 100. 50 cents. New York: D. Van Nostrand & Co.

Chadwick, Rev. John W. Education as related to Citizenship. D. Appleton & Co. Pp. 24. 10 cents.

The College Fraternity. E. H. L. Randolph, Editor. New York: Fraternity Publishing Co. Monthly. Pp. 82. 25 cents. $2 a year.

Daudet, Alphonse. L'Évangéliste. Translated by Mary Neal Sherwood. New York and Chicago: F. T. Neely. Pp. 304. 50 cents.

Day, David T. Mineral Resources of the United States. U. S. Geological Survey. Pp. 671.

De Varigny, Henry. Experimental Evolution. Macmillan & Co. Pp. 270. $1.50.

Dobbin, Leonard, and Walker, James. Chemical Theory for Beginners. Macmillan & Co. Pp. 240. 70 cents.

Drake, Jeanie. In Old St. Stephen's. D. Appleton & Co. Pp. 232. 50 cents.

Dumble, E. T., State Geologist. Third Annual Report of the Geological Survey of Texas. Austin. Pp. 410, with Maps.

Emerson, James, Willimantic, Mass. Treatise relative to the Testing of Water-wheels and Machinery. Pp. 480. $1.

Fallon, W. H., and Hobbs, E. C. Report of the North Dakota Weather Service for July, 1892. Bismarck. Pp. 16.

Fay, Joseph Story. The Track of the Norseman. Pp. 7.

Fouillée, Alfred. Education from a National Standpoint. D. Appleton & Co. Pp. 332. $1.50.

Harrington, Mark. Report of the Chief of the Weather Bureau for 1891. Washington. Pp. 190.

Hay, O. P. On the Ejection of Blood from the Eyes of Horned Toads. Pp. 10.—On the Breeding Habits, etc., of Certain Snakes. Pp. 13.

Hilgard, E. W. A Report on the Relations of Soil to Climate. Washington: Weather Bureau. Pp. 59.

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Horr, Hon. Roswell G. The Republican Party. D. Appleton & Co. Pp. 16. 10 cents.

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Humphry, J. E. Amherst Trees: An Aid to their Study. Amherst, Mass.: Carpenter & Morehouse. Pp. 78.—Fungous Diseases and their Remedies. Boston: Rockwell & Churchill. Pp. 16.

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McDonald, Marshall, U. S. Fish Commissioner. Report respecting the Establishment of Fish-cultural Stations in the Rocky Mountain Region and Gulf States. Washington. Pp. 66, with Plates.

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Mahan, Captain E. T. Admiral Farragut. D. Appleton & Co. Pp. 333, with Portrait and Maps. $1.25.

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Parker, William W., M. D., Richmond, Va. Instinct in Animals and Intelligence in Man contrasted. Pp. 19.—The Ancient and Modern Physician. Pp. 18.

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Powers, Edward. Should the Rainfall Experiments be continued? Delavan, Wis. Pp. 16.

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POPULAR MISCELLANY.

Reality of Geological Catastrophes.—In a review of the history of the theories of the development of the earth's crust—that of uniformitarianism and that of catastrophes—in his address at the British Association, Prof. Archibald Geikie spoke of a modification or enlargement of the uniformitarian doctrine which has been brought about by continued investigation of the terrestrial crust and consequent increase of knowledge respecting the history of the earth. "Though Hutton and Playfair believed in periodical catastrophes, and indeed required these to recur in order to renew and preserve the habitable condition of our planet, their successors gradually came to view with repugnance any appeal to abnormal, and especially to violent, manifestations of terrestrial vigor, and even persuaded themselves that such slow and comparatively feeble action as had been witnessed by man could alone be recognized in the evidence from which geological history must be compiled. Well do I remember in my own boyhood what a cardinal article of faith this prepossession had become. We were taught by our great and honored master, Lyell, to believe implicitly in gentle and uniform operations, extended over indefinite periods of time, though possibly some, with the zeal of partisans, carried this belief to an extreme which Lyell himself did not approve. The most stupendous marks of terrestrial disturbance, such as the structure of great mountain chains, were deemed to be more satisfactorily accounted for by slow movements prolonged through indefinite ages than by any sudden convulsion. What the more extreme members of the uniformitarian school failed to perceive was the absence of all evidence that terrestrial catastrophes even on a colossal scale might not be a part of the present economy of this globe. Such occurrences might never seriously affect the whole earth at one time, and might return at such wide intervals that no example of them has yet been chronicled by man. But that they have occurred again and again, and even within comparatively recent geological times, hardly admits of serious doubt. How far at different epochs and in various degrees they may have included the operation of cosmical influences lying wholly outside the planet, and how far they have resulted from movements within the body of the planet itself, must remain for further inquiry. Yet the admission that they have played a part in geological history may be freely made without impairing the real value of the Huttonian doctrine, that in the interpretation of this history our main guide must be a knowledge of the existing processes of terrestrial change."

Physiological Action at a Distance.—Discussing the cause of physiological action at a distance, in the British Association, Prof. Errera, of Brussels, said that most vegetable organs were sensitive to the influences of the environment, and responded to these stimuli, as long as they were capable of growth, by bending in different directions—phenomena familiar to vegetable physiologists. But two years ago other phenomena were observed, which did not appear to belong to any of the known categories. Elfving found that pieces of iron and, to a less degree, of zinc or aluminium, as well as different organic substances, such as sealing-wax, rosin, etc., attracted the growing sporangium-bearing filaments of a mold (*Phycomyces nitens*). All other metals Elfving found inactive, but the filaments of the mold itself showed a mutual repulsion. This movement, however, Prof. Errera considered wholly due to the hygroscopic condition of the stimulatory substance. The sensibility of phycomyces, he observed, was in fact so great that it might be used as a reagent to test the existence of hydroscopic power, which he illustrated in the case of camphor, the hydroscopic condition of which, after one experiment, was proved by careful weighing, although it was unknown to chemists. All the experiments succeeded in a saturated atmosphere, showing that hydrotropism was not due, as generally believed, to difference in the hygrometric state of the air. To sum up, concluded the author, the apparently mysterious action of iron on phycomyces was nothing but a matter of hydrotropism, and hydrotropism itself, negative or positive, was the bending of a vegetable organ toward the points, not where it would find a minimum or maximum of moisture, but where it would transpire most or least.

Disappearance of Wild Plants.—The report of the committee of the British Association on the disappearance of wild plants from their native habitats mentioned fifty of the less common wild plants of the west of Scotland which had been greatly reduced in number in recent years from natural and other causes. The natural causes were due to agriculture, drainage, industry, and the growth of towns and villages, and seemed to be outside of the scope of protective measures. In many cases disappearance is attributable to the removal of specimens by collectors for the formation of herbariums, and of plants with showy flowers and ferns for sale. Herbariums are essential to the study of botany, but the committee thought their multiplication might be made unnecessary by the formation of local collections for reference. Collections for sale might be prevented by the intervention of proprietors. But it was difficult to suggest any course of prohibitive measures. In the discussion the too specific designation of places where choice plants can be found was deprecated as making access to them too easy to unscrupulous searchers. A resolution was passed on the preservation of birds and eggs; and Canon Tristram, speaking to it, put in a plea for the preservation of birds of prey, pointing to the mice-plague in Dumfries and Lanark shires as a result of destroying the balance of Nature by wholesale killing of such birds.

Prize Essays on Alcohol.—The American Medical Temperance Association, through the kindness of J. H. Kellogg, M. D., of Battle Creek, Mich., offers the following prizes:

1. One hundred dollars for the best essay On the Physical Action of Alcohol, based on Original Research and Experiment.

2. One hundred dollars for the best essay On the Non-Alcoholic Treatment of Disease.

These essays must be sent to the secretary of the committee, Dr. Crothers, Hartford, Conn., on or before May 1, 1893. They should be in type-writing, with the author's name in a sealed envelope, with motto to distinguish it. The report of the committee will be announced at the annual meeting at Milwaukee, Wis., in June, 1893, and the successful essays read. These essays will be the property of the Association, and will be published at the discretion of the committee. All essays are to be scientific, and without restrictions as to length, and limited to physicians of this country. Address all inquiries to T. D. Crothers, M. D., secretary of committee, Hartford, Conn.

Devolution of the Little Toe.—The thumb and great toe of man are two-jointed, while the other fingers and toes are three-jointed. But it has been observed, in the examinations of skeletons, that the little toe is occasionally two-jointed; the middle and terminal phalanges having been so united that they can hardly be distinguished. This variation occurs in about thirty-six per cent of the cases, and usually affects both feet alike, but appears rather more frequently in women than in men. Pressure of the shoes has been assigned as a cause of it, but it has been observed in children under seven years old, and even in embryos as often as in adults, and in circles where tightly fitting shoes are not worn. Dr. Pfitzner, who has made a special study of the subject, has come to the conclusion that the little toe is in process of degeneration, and that without its being possible to show that it is suffering an adaptation to any external mechanically operating influence. Corresponding to this, certain processes of reduction are going on in the muscular apparatus. The whole phenomenon is of interest, because we are witnessing its beginning, and can certainly predict its outcome in the final reduction of the little toe to two joints.

The Exact Point of the Pole.—If any of our arctic explorers ever reach the pole, they will be confronted by a very difficult problem in determining the exact point. Geographical determinations increase in difficulty on approaching the pole, on account of the narrowing of the degrees of longitude, and the compass, sextant (if the weather is cloudy), and chronometer are of little use then. A process for taking the point at the pole has been described by M. E. Durand Gréville, which depends on the properties of the gyroscope. The apparatus consists of two gyroscopes and a plumb-line. To determine the latitude a gyroscope which has been oriented by its axis to the pole of the sky —or a gyroscope-compass—is employed. The angle which its axis makes with the vertical of the place is complementary to the latitude. To determine the longitude, a second gyroscope is needed, which has been adjusted so as to turn in a plane parallel to the meridian of the point of departure. The plane of the gyroscope-compass being necessarily parallel to the equator, if we project the vertical of the place upon it, and measure the angle which that projection makes with the line of intersection of the planes of the two gyroscopes, we shall have the difference in longitude of the point of departure and the point of arrival. A practical arrangement for taking this measure has been devised by M. Trouvé. Before starting, the travelers set in motion the gyroscope-compass and the gyroscope whose plane is the meridian of the point of departure. When the position of a point is to be determined, the axes of the two gyroscopes are conveyed parallel to themselves, and the vertical of the point reached is taken with a plumb-line. If the axis of the gyroscope-compass is parallel to the plumb-line, the balloon is immediately above the pole. The result is not affected by height above the earth's surface, for the directions of the three instruments continue the same at all points of the same vertical.

Canadian Names and Places.—Dr. George M. Dawson observes, in his Geography of Canada, that throughout the country many of the original Indian names of places have been adopted and perpetuated by the whites, but in most cases they have suffered abbreviation or other changes in the process. In general the native names are found to be of a descriptive character, and to express some noted feature or product of each locality. Taking instances from different parts of the country and in several dialects, Nictau means "forks of a river"; Shediac, "running far back"; Matapedia, "roughly flowing"; Quebec, "a strait or an obstruction"; Toronto, "a tree in the water"; Winnipeg, "muddy water"; Saskatchewan, "rapid current." It is further noteworthy that in many cases the principal villages or places of resort of the Indians have since become the sites of towns or cities. This depends on the circumstance that the whites first sought such places for purposes of trade, but chiefly on the fact that the Indians selected localities where natural lines of travel, such as rivers, converged, or were interrupted by falls or rapids, necessitating portages; also such places as sheltered havens or harbors on the sea-coast or the shores of the Great Lakes.

Vegetation of New Guinea.—So great a wealth of botanical material has been collected in New Guinea that there are now as many of the higher plants of that country known to science as of German plants, or about two thousand. Inasmuch as the component parts of the forest change in extraordinarily short distances, it may be expected that at least three times as many species will ultimately become known. The island has furnished such an abundance of important and prominent new types, that, as respects plant life, it may be regarded as one of the most interesting and beautiful parts of the earth. The close relationship often supposed to exist between the north Australian flora and that of New Guinea has not been confirmed. It is true that the savannas of the Fly River, covered with eucalyptuses, myrtaceæ, and proteaceæ, correspond not only in their outward habitus, but also in composition, with the formation of York Peninsula; but the typical Australian flora is quite foreign to New Guinea, and there is no ground for the supposition that the island was at one time inhabited by Australian species. The palm flora of the island is one of the richest in the world; almost every district is distinguished by endemic species. The age of the island must be very great; the large number of indigenous genera and species testify to this; of the former, at least fifty are already known.

Geographical Development of Coast-lines.—Summing up the points of his paper in the British Association on the Geographical Development of Coast-lines, Prof. James Geikie arrives at the general conclusion that the coast-lines of the globe are of very unequal age. Those of the Atlantic were determined as far back as Palæozoic times by great mountain uplifts along the margin of the continental plateau. Since the close of that period many crustal oscillations have taken place, but no grand mountain ranges have again been ridged up on the Atlantic seaboard. Meanwhile the Palæozoic mountain-chains, as was shown, have suffered extensive denudation, have been planed down to the sea-level, and even submerged. Subsequently converted into land, wholly or partially as the case may have been, they now present the appearance of plains and plateaus of erosion, often deeply indented by the sea. No true mountains of elevation are met with anywhere in the coast-lands of the Atlantic, while volcanic action has well-nigh ceased. In short, the Atlantic margins have reached a stage of comparative stability. The trough itself, however, is traversed by at least two well-marked banks of upheaval—the great meridional Dolphin Ridge, and the approximately transmeridional Faröe-Icelandic belt—both of them bearing volcanic islands. But while the coast-lands of the Atlantic proper attained relative stability at an early period, those of the Mediterranean and Caribbean depressions have up to recent times been the scenes of great crustal disturbance. Gigantic mountain-chains were uplifted along their margins at so late a period as the Tertiary, and their shores still witness volcanic activity. It is upon the margins and within the troughs of the Pacific Ocean, however, that subterranean action is now most remarkably developed. The coast-lines of that great basin are everywhere formed of grand uplifts and volcanic ranges, which, broadly speaking, are comparable in age to those of the Mediterranean and Caribbean depressions. Along the northeast margin of the Indian Ocean the coast-lines resemble those of the Pacific, being of like recent age, and similarly marked by the presence of numerous volcanoes. The northern and western shores, however (as in Hindostan, Arabia, and East Africa), have been determined rather by regional elevation or by subsidence of the ocean floor than by axial uplifts—the chief crustal disturbances dating back to an earlier period than those of the East Indian Archipelago. It is in keeping with this greater age of the western and northern coast-lands of the Indian Ocean that volcanic action is now less strongly manifested in their vicinity.

The Story which Scenery tells.—"The law of evolution," said Prof. Archibald Geikie at the British Association, "is written as legibly on the landscapes of the earth as on any other page of the book of Nature. Not only do we recognize that the existing topography of the continents, instead of being primeval in origin, has gradually been developed after many precedent mutations, but we are enabled to trace these earlier revolutions in the structure of every hill and glen. Each mountain-chain is thus found to be a memorial of many successive stages in geographical evolution. Within certain limits, land and sea have changed places again and again. Volcanoes have broken out and have become extinct in many countries long before the advent of man. Whole tribes of plants and animals have meanwhile come and gone, and in leaving their remains behind them as monuments at once of the slow development of organic types and of the prolonged vicissitudes of the terrestrial surface, have furnished materials for a chronological arrangement of the earth's topographical features. Nor is it only from the organisms of former epochs that broad generalizations may be drawn regarding revolutions in geography. The living plants and animals of to-day have been discovered to be eloquent of ancient geographical features that have long since vanished. In their distribution they tell us that climates have changed, that islands have been disjoined from continents, that oceans once united have been divided from each other, or once separate have now been joined; that some tracts of land have disappeared, while others for prolonged periods of time have remained in isolation. The present and the past are thus linked together, not merely by dead matter, but by the world of living things, into one vast system of continuous progression."

House "Leader Pipes" as Lightning Rods.—Mr. W. H. Preece called attention in the British Association to a new danger in the destruction of lightning protectors by recent municipal legislation. He said that the immunity of private houses from being struck by lightning is very marked, and this is considered to be due to the fact that the lead on the roofs and the iron stack-pipes that drain these roofs, connected as they are together, form admirable lightning protectors. Any charge of atmospheric electricity which may fall upon a house so protected is conveyed harmlessly away to the earth. British householders are now required to remove these pipes from direct connection with the drains, and to leave an air-space between the end of the pipe and the grating of the drain. The result is that the electric conduction of the pipe is broken, the stack-pipe ceases to be a lightning protector, and houses are left exposed to the danger of atmospheric electricity. The remedy is very simple. The pipe need not be entirely cut away. Three fourths of its circular section may be removed for the distance required, and one fourth may be left to maintain the old electrical connection; or, if the separation has been effected, then the stack-pipe should be connected with the drain by a wire or rod so as to restore a path for the charge to the earth. Householders are also now compelled to put up stack-pipes to ventilate their soil-pipes, erecting above their roofs a metal tube forming a prominent object exposed to the atmospheric charge, and terminating frequently in an earthenware pipe on the first floor. They are thus liable to be struck by lightning without being offered any means of escape. The tubes should be connected electrically with the earth either directly or indirectly through the stack-pipes, which would then make them sources of safety rather than of danger.

A Haida Indian Pole-raising.—The *keeang* poles of the Haida Indians of the Queen Charlotte Islands, according to Mr. Alexander Mackenzie's account of them, were erected to commemorate the event of a chief taking position in the tribe by building a house and making a distribution of all his property. Each pole has also an individual and distinguishing name. Thus, one of the poles at Masset is named Que-tilk-kep-tzoo, meaning "watcher for arrivals" or "looking" or "watching for arrivals." It was erected by a Haida chief named Stultah, on his decision to build a new lodge. The occasion, as usual, was marked by a large distribution of property, hundreds of blankets and other valuables being given away to all who assisted at the making of the pole, or who were invited to the ceremony. When it was decided to erect a *keeang* and build a lodge, invitations were sent to the tribes in the vicinity to attend, and on arrival the people were received by dancers in costume and hospitably treated and feasted. When all the Indians from adjacent places were assembled, at the appointed time they proceeded to the place selected for the erection of the pole. A hole seven, eight, or ten feet deep having been dug, the pole was moved on rollers till the butt was in a proper position to slip into it. Large ropes were fastened to the pole and gangs of men, women, and children took hold of the ends at a considerable distance away. The most able-bodied men advanced to the pole, standing so close all along on each side that they touched each other, and grasping the pole from underneath they raised it up by sheer strength, by a succession of lifts, as high as their heads, while others placed supports under it at each successive lift. Stout poles tied together like shears were then brought into play, while the lifters took sharp-pointed poles, about eight feet long, and standing in their former positions, lifted the pole (which was immediately supported by the men with the shears) by means of these sticks, until it attained an angle of about forty-five degrees. The butt was then gradually slipped into its place and the gangs at the ropes, who had been inactive all this time, got the signal to haul, when, amid the most indescribable bellowing, hallooing, and yelling, the pole was gradually and surely elevated to the perpendicular position. When the setting was completed, the crowd adjourned to the house of the owner, who feasted the people, and afterward took the place of Eitlahgeet, great chief. Next he distributes his property, a task requiring great discrimination. Often he adopts a new name. When he proclaims to the crowd that he is quite impoverished and has distributed all his effects, they appear to be delighted, and regard him as indeed a great chief.

The Races of Peru.—According to Señor F. A. Pezet, the aboriginal or Indian race which populated Peru, 12,000,000 souls strong when the Spaniards conquered the country, still holds its own, although it has to a great extent degenerated through the miseries which, during centuries, it endured at the hands of its conquerors. It represents to-day about fifty-seven per cent of the entire population. In the interior of Peru it has kept in many places quite pure, not having mixed with any of the other races that have been brought into the country. There are tribes existing to-day with the old Inca Indian features quite distinct, and among these people there is a great and natural intellect. The other great race is the European, or white, imported from Spain at the time of the conquest, which has ever been on the increase since then. It represents to-day about twenty per cent of the population, and is spread over the whole country, but particularly on the coast. As the Peruvian Indian was made to slave at the mines for his Spanish master, the Spaniards had to introduce Africans to till the ground and work on the cotton and sugar estates along the coast. No Africans have come to the country since slavery was abolished in 1854, and the race has been confined to some of the agricultural districts, and is now rapidly dying out. In its place are the "mestizo" and "zambo," cross-breeds of blacks with whites and with Indians. The cross-breed of whites with Indians has produced the "cholo" race, which of all castes is to-day the most numerous. These mixed races represent about twenty-three per cent of the whole population. Of some fifty thousand Chinese imported since 1854, to be agricultural laborers, the greater part have settled for good, and not a few have embraced the Christian faith and married with Indians, cholos, zambos, mestizos, blacks, and whites, thereby forming a diversity of castes.

Ventilation at the Top and at the Bottom of Rooms.—The impression, which is very common, and is even held by engineers, that impure air, on account of its superior weight, accumulates to excess in the lower parts of rooms, while the upper parts are free from it, and that ventilation should be applied near the floor rather than near the ceiling, is controverted in the Sanitarian by Dr. W. H. Thayer. The property of gases to diffuse and intermix with one another, irrespective of relative densities, is lost sight of by these authorities. Dr. Thayer finds that the carbonic-acid gas of respiration and illumination will eventually be equally diffused through the atmosphere, although it is retained at the upper part of a room as long as the high temperature continues; and that it never, under any circumstances, is precipitated in excess in the lower part of the room. This conclusion, partly drawn from the philosophy of the matter, has been amply verified by experiments. Dr. H. Cresson Stiles, of the Metropolitan Board of Health, having analyzed the air of many public schools, hospitals, theatres, and churches, found the air taken from near the ceiling always more highly charged with carbonic acid than that in the lower parts of a room, with the difference often very marked. St. Ann's Church, Brooklyn, which was ventilated on the "bottom ventilation" theory, was found to be badly ventilated, with the carbonic acid in the gallery at the close of the service in larger quantity than near the floor. The ventilation of the hall of the old Brooklyn Institute was nearly perfect, and was all through large openings in the ceiling.

Life on Mount Roraima.—Mount Roraima, in British Guiana, which was first ascended in 1884 by Mr. Everard Im Thurm, was again climbed in November, 1891, by Mr. E. Cromer and Mr. Seyler, two collectors of orchids. Exploring the top, the adventurers found toward the south many gigantic and marvelously shaped rocks that seemed to form, as Mr. Cromer described them, "majestic palaces, churches, and fortresses." Other smaller rocks resembled pyramids, umbrellas, and kettles, and one bore a striking likeness to the statue of a man. Between these grotesque masses of rocks were innumerable lochs, some joined together by canals, most of which were shallow, although here and there a depth of six feet was found. Many new species of orchids and other plants were found; but the mountain-top seemed almost destitute of animal life. Mr. Cromer noticed one black butterfly, a few spiders, some small frogs, some small lizards, and a small, dark-colored mammal, which he supposed was a species of kibihee, and on his approach gave a sound like a whistle, and swiftly crept into a hiding-place between the rocks. The lakes on the summit, which cover a considerable area, were swarming with a sort of black beetle. Mr. Cromer and his companion are the first men who have stayed a night on the top of Roraima.

The Mentone Skeletons.—The grottoes of Baussé Roussé, or of Mentone, as they are commonly called, are nine in number, and seven of them were inhabited by Quaternary man. M. E. Rivière, who owns them, explored certain of them in 1872, 1873, and 1875, and recovered several human skeletons and interesting relics from them. A second entry was made into one of them, the Barma Grande, last winter, during the owner's absence and without his knowledge, and several other skeletons and relics were obtained in it. Of the two which have been most fully excavated one is the skeleton of an old man, and the other of a young man of about eighteen years of age. They both appear to be of the Cro Magnon race, and are of fairly large stature. They were adorned with collars of sea-shells, bored for stringing, and of canine teeth of the deer, and vertebræ of fish (salmon and trout). The skeletons, shells, teeth, and vertebræ are all colored a curious red, dotted with bright points, which is derived from the dust of specular iron, with which the bodies of the adults were covered immediately after death. The arms and utensils found immediately in contact with the skeletons consisted of a cut flint seventeen centimetres long by fifty-one millimetres broad, which was situated behind the head of the old man, a scraper, and a curious article of bone or deer horn in the shape of a double ovoid, marked on the surface with numerous irregular and irregularly spaced striæ.

Distribution of Land-shells.—Land-shells, according to Mr. W. H. Dall's Instructions for collecting Mollusks, are found at all elevations, from the beaches moist with sea-spray to the Alpine heights of fourteen thousand feet in the vicinity of perpetual snow. Some are subterranean in their habits, pursuing earth-worms through their burrows, or nestling in the recesses of bones in ancient graveyards. Others are contented with the protection afforded by dead leaves, decaying logs, under the bark starting from rotten stumps, or in the shelter of loose stones and bowlders. Other groups live on the leaves of sedges, grass, and shrubbery, retreating to the soil for winter quarters; some highly colored species live permanently in the tree-tops of tropical forests. In arid regions they seek the shade of stones, attach themselves to the stems of cacti or other desert plants, or even adhere to the sunburned surfaces of rocks so hot as to be uncomfortable to the touch. The color of the shell bears a certain relation to its favorite station. The tree-living forms are brightest and most varied; the moss-lovers and terrestrial species are usually dull, horny, or greenish, but often have a brilliant, polished, or delicately sculptured surface; while subterranean forms are pale or pellucid. The slugs are generally nocturnal, and retreat to holes and crevices. In general, limestone regions are most favorable for land-shells, and those of flinty rock least advantageous. Woods of resinous trees are unsuited to their tastes, while soft woods of deciduous trees are congenial to them. Some pungent herbs are noxious to them; but nettles are a favorite haunt of certain small land-shells. Spring is the most active season for snails; they attain their fullest development toward midsummer; and as winter approaches they penetrate the ground or in warm regions attach themselves to the bark of trees or to stones for a period of hibernation. They close the aperture of the shell with a leathery secretion, sometimes strengthened by more or less limy matter, or, if naked, may surround themselves with it like a cocoon.

Value of Scientific Amateurs.—Is it not true (asked Prof. Arthur Schuster in the British Association) that the one distinctive feature which separates England from all other countries in the world is the prominent part played by the scientific amateur, and is it not also true that our modern system of education tends to destroy the amateur? By amateur I do not necessarily mean a man who has other occupations and only takes up science in his leisure hours, but rather one who has had no academical training, at any rate in that branch of knowledge which he finally selects for study. We may, perhaps, best define an amateur as one who learns his science as he wants it and when he wants it. I should call Faraday an amateur. He would have been impossible in another country; perhaps he would be impossible in the days of the Science and Art Department. Other names will occur to you, the most typical and eminent being that of Joule. We are in danger of losing one great and necessary factor in the origination of scientific ideas. If I am right, there is a distinct advantage in having one section of scientific men beginning their work untrammeled by preconceived notions, which a systematic training in science is bound to instill. If school examinations could be more general, if scientific theories could only be taught at an age when a man is able to form an independent judgment, there might be some hope of retaining that originality of ideas which has been a distinctive feature of this country, and enabled our amateurs to hold a prominent position in the history of science. At present a knowledge of scientific theories seems to me to kill all knowledge of scientific facts. It is by no means true that a complete knowledge of everything that has a bearing on a particular subject is always necessary to success in an original investigation. In many cases such knowledge is essential, in others it is a hindrance. Different types of men incline to different types of research, and it is well to preserve the dual struggle.

What caused the Ice Age?—In their paper in the British Association on The Cause of the Ice Age, Messrs. P. F. Kendall and J. W. Gray maintain that the Glacial period came on with extreme slowness; that it was of long duration; that it passed away very abruptly and very recently, probably about ten thousand years ago; and that the geological record, though yielding evidence of ancient glaciers, yet was without trace of any previous Glacial period. They criticised the existing theories of the cause of the Ice age, and urged that the ingenious theory of Croll was objectionable upon several grounds. It was linked with a chronology which, even with the reservations made by Sir Robert Ball, was not reconcilable with geological facts. It involved the occurrence of repeated Glacial periods, and accounted neither for the very gradual approach nor the very abrupt departure of the cold. The theory of Mr. Upham, of the United States Geological Survey, that a great series of continental uplifts had raised enormous areas of the Northern Hemisphere above the snow-line, was based on evidence valid in itself, but failed to prove that the uplift was synchronous or coincided with the Glacial period. Further, there was irrefragable evidence that the British Isles stood at almost absolutely the same level as at present. Enormous ice-sheets swathed the whole of the northern and western portions of Britain. An explanation which would not apply to the British Isles might safely be rejected. The authors, although they formulate no theory of their own, invite the attention of astronomers to the suggestion that as the sun has undergone a secular cooling such as the president, Sir Archibald Geikie, declared in his address had happened to the earth, the Glacial period was a consequence of this cooling. This would perhaps account for the gradual refrigeration, leaving not the Ice age, but the genial period which suddenly supervened, to be accounted for. Variations in solar radiation by the operation of the same causes that produce sun-spots do beyond doubt occur; and the sudden blazing out of new stars, like that in Auriga, are facts which suggest almost unlimited possibilities of the rejuvenescence of suns. It may well be that the Glacial period is a phenomenon attendant upon the decrepitude of the sun, and the first of a series whose second term may be nearer at hand than geologists or laymen have previously suspected.

Depth of the Atmosphere.—Calculations based on the observation of the refraction of light have caused it to be supposed that the air becomes so rare at the height of about sixty miles that that distance may be regarded as the limit to its sensible extent; but other calculations, made during the present century, of the distance from the earth at which meteors ignite, indicate that the atmosphere extends to upward of a hundred miles. The question is thus presented, says M. Forster, in a paper on the subject, whether the incandescence of these meteors is caused by the resistance of an earthly atmosphere—that is, of oxygen and nitrogen moving with the earth—or is developed in an interstellar atmosphere. The fact that the aurora borealis reaches heights of about four hundred miles tells in favor of the latter hypothesis. The orbits of some comets and the satellites of Jupiter are subject to changes which can be explained only by the action of a resisting medium, and it would be desirable to determine from solar analysis whether the medium in which the aurora exhibits itself is differently composed from our atmosphere, either of gases emanating from the sun or those produced by the explosion of meteoric bodies. The luminous clouds, of which Mr. O. Jesse has made a special study, are objects of great importance in the study of the circulation of the upper atmospheric strata.

Cyrus W. Field.—Mr. Cyrus W. Field, who died at his summer home near this city, July 12th, will be best remembered for his agency in the laying of the Atlantic cables, by which methods of communication and of transacting business between this country and Europe have been revolutionized. Without him they would not have been put in operation for many years later than they were, if at all. Mr. Field was born in Stockbridge, Mass., in 1819, began his business life as a clerk in A. T. Stewart's store at one dollar a week, and at the end of his term of apprenticeship set up in business for himself as a junk-dealer and paper-maker. He became interested in submarine telegraphy in 1853, and induced a few capitalists to join with him in the Atlantic telegraph enterprise. After thirteen years of effort, fifty journeys across the Atlantic, and many failures, the lines were established, and Mr. Field received the honors that were his due. Several years afterward, Mr. Field engaged in the enterprise of building the elevated railroads in New York city, and materially contributed by his energy to their speedy completion.

National Characteristics in Science.—In his address before the Physical Section of the British Association Prof. Arthur Schuster spoke of the peculiarities possessed by each nation which make it better fitted than its neighbors to do some particular part of the work on which the progress of science depends. No country, for instance, has rivaled France in the domain of accurate measurement, with which the names of Regnault and Amagat are associated, and the International Bureau of Weights and Measures has its fitting home in Paris. The best work of the German universities seems to consist in the following up of some theory to its logical conclusions and submitting it to the test of experiment. The speaker doubted whether the efforts to transplant the research work of German universities into England will prove successful. Does it not seem well to let each country take that share of work for which the natural growth of its character and its educational establishment best adapt it? As far as the work of the Physical Section is concerned, the strongest domain of English students has been that of mathematical physics. Look at the work done in Great Britain during the last two centuries—the work not only in physics, but in astronomy, chemistry, and biology.

Cause of the Bursting of Peat-bogs.—The curious phenomena of the swelling and bursting of peat-bogs have been studied by Herr Klinge. They generally occur after heavy rains, and are preceded by detonations and earth vibrations. A muddy stream issues from them, of varying fluidity, rolling along lumps of peat. Then the mud hardens and the bog sinks back, forming a funnel-shaped pool. The bogs studied by the author have been mostly on high ground, not in valleys. He believes that the eruptions are not caused either by excessive absorption of moisture or by gas explosions—the theories most readily suggested—but by land-slips, collapses, etc., of ground under the bog, which permit water or liquid mud to enter. This breaks up the bog mechanically, mixes with it and fluidifies it, and produces the outburst at the surface. The limestone formations in Ireland, with their large caverns and masses of water, are naturally subject to these collapses, which, with the vibrations they induce, are more frequent in wet years. The heavy rains preceding the bog eruptions are thus to be regarded as only an indirect cause of them. Herr Klinge supposes that similar eruptions occurred in past geological periods, the Carboniferous, for example, in some cases where fossil tree-stems are found in upright position.

NOTES.

In a paper in the British Association, on the Periodical Velocity of Bubbles in Vertical Tubes of Liquid, Mr. F. T. Tronton said that as a bubble ascended in a tube its changes of shape caused corresponding changes in its velocity, and consequently any given bubble if watched would be seen to have alternating *maxima* and *minima* of velocity. Further, the rush of water backward from the front to the rear of the bubble in the narrow channel between the latter and the wall of the tube was greatest when the bubble had its *maximum* elongation. By making the liquid more viscous we could arrive at a point where it became uncertain whether the bubble would ascend the tube in the long or flat condition, but having started either way it would continue in its original shape. At this particular viscosity the velocity of ascent was a *maximum*. Lord Kelvin, as Sir William Thomson is now called, suggested an application of this result to certain engineering problems, and particularly spoke of the possibility of nullifying the retarding effects of the viscosity of water upon the sailing of ships.

The Mexican jumping seed, or "devil's bean," is a euphorbiaceous plant of such poisonous properties that it is used by the Indians to envenom their arrow-points. It not having been scientifically identified to satisfaction, Dr. C. V. Riley has made a special study of it. The saltatory property is not intrinsic with it, but is imparted to it by an insect (*Carpocapra saltitans*), which secures lodgment within the bean and does the work. Dr. Riley believes that the insect is developed in the capsules of several species of the genus *Sebastiana*.

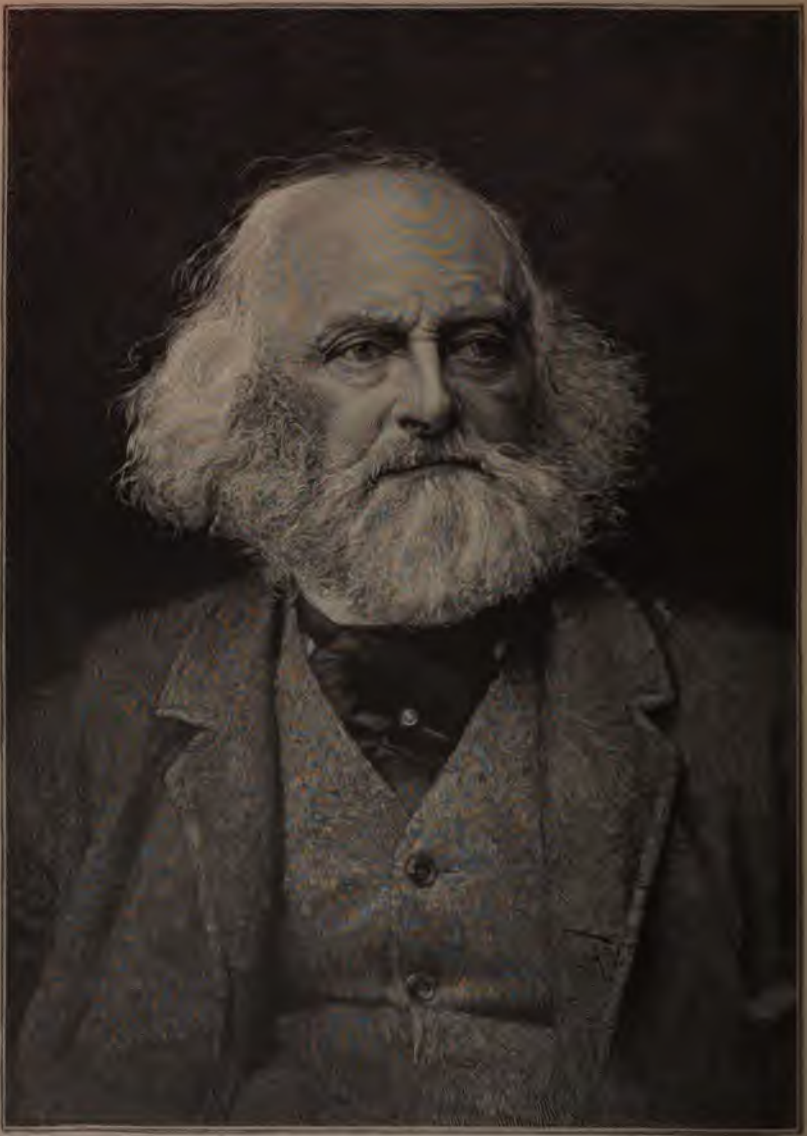
It is said that a larger cave than the Mammoth Cave, situated in the Ozark Mountains, near Galena, Mo., has been explored for a distance of more than thirty miles. In it have been found bones of recent and prehistoric animals, including the hyena and cave bear, and flint arrow-heads, but no bones of man. A few animals of the usual forms found in caves are still living there, including a white newt.

Phosphatic marls, according to the report of Mr. E. A. Smith, State Geologist, have been found in Alabama in the Cretaceous and Tertiary formations. When they were first brought to notice a spirit of speculation was aroused, which subsided when it was found that they did not include in commercial quantity high-grade phosphates suitable for exportation. Dr. Smith, however, regards this as to the advantage of the State, because it will cause the fertilizing material to be used at home, to the enlargement of its crops, as has occurred in New Jersey with its low-grade phosphates, instead of being exported as are the high-grade phosphates of South Carolina, which has, agriculturally, derived no more benefit than other States from its precious stores.

OBITUARY NOTES.

The eminent French philosopher and man of letters, Joseph Ernest Renan, died October 2d. He was the son of a sailor, and was born in Brittany, February 27, 1823. He was educated for the priesthood, and proved to be a remarkable student, but the result of his studies was to make him a theist instead of a Christian priest. His most widely known work is his Life of Jesus, which is one of a series of books on the origins of Christianity. He was also author of a History of the People of Israel, in five volumes, and wrote much on Oriental philology and archæology, in which subjects he was an adept. For many years he was Professor of Hebrew, Syriac, and Chaldaic in the Collége de France.

After some years of ill health, George Croom Robertson died September 20th, at the age of fifty-one. On account of illness he had recently resigned his professorship of Philosophy and Logic in University College, London, and gave up the editorial charge of Mind last year.



LEWIS MORRIS RUTHERFURD.

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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XVIII.—FROM MAGIC TO CHEMISTRY AND PHYSICS.

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PART II.

WE have seen thus far, first, how such men as Eusebius, Lactantius, and their compeers, discouraged scientific investigation as futile; next, how such men as Albert the Great, St. Thomas Aquinas, and the multitude who followed them, turned the main current of mediæval thought from science to theology; and, finally, how such Church authorities as Popes John XXII and Innocent VIII, and the heads of the great religious orders, endeavored to crush what was left of scientific research as dangerous.

Yet, injurious as all this was to the evolution of science, there was developed something far more destructive; and this was the influence of mystic theology, penetrating, permeating, sterilizing nearly every branch of science for hundreds of years. Among the forms taken by this development in the earlier middle ages we find a mixture of physical science with a pseudo-science obtained from texts of Scripture. In compounding this mixture, Jews and Christians vied with each other. In this process the sacred books were used as a fetich; every word, every letter, being considered to have a divine and hidden meaning. By combining various scriptural letters in various abstruse ways, new words of prodigious significance in magic were obtained, and among them the great word embracing the seventy-two mystical names of God—the mighty word "*Schemhamphoras*." Why should men seek knowledge by observation and experiment in the book of Nature, when the book of Revelation opened such treasures to the ingenious believer?

So, too, we have ancient mystical theories of number which the theological spirit had made Christian, usurping an enormous place in mediæval science. The sacred power of the number three was seen in the Trinity; in the three main divisions of the universe—the empyrean, the heavens, and the earth; in the three angelic hierarchies; in the three choirs of seraphim, cherubim, and thrones; in the three of dominions, virtues, and powers; in the three of principalities, archangels, and angels; in the three orders in the Church—bishops, priests, and deacons; in the three classes—the baptized, the communicants, and the monks; in the three degrees of attainment—light, purity, and knowledge; in the three theological virtues—faith, hope, and charity—and in much else. All this was brought into a theologico-scientific relation, then and afterward, with the three dimensions of space; with the three divisions of time—past, present, and future; with the three realms of the visible world—sky, earth, and sea; with the three constituents of man—body, soul, and spirit; with the threefold enemies of man—the flesh, the world, and the devil; with the three kingdoms in Nature—mineral, vegetable, and animal; with "the three colors"—red, yellow, and blue; with "the three eyes of the honey-bee"—and with a multitude of other analogues equally precious. The sacred power of the number seven was seen in the seven golden candlesticks and the seven churches in the Apocalypse; in the seven cardinal virtues and the seven deadly sins; in the seven liberal arts and the seven devilish arts, and, above all, in the seven sacraments. And as this proved in astrology that there could be only seven planets, so it proved in alchemy that there must be exactly seven metals in the *electrum magicum*. The twelve apostles were connected with the twelve signs in the zodiac, and with much in physical science. The seventy-two disciples, the seventy-two interpreters of the Old Testament, the seventy-two mystical names of God, were connected with the supposed fact in anatomy that there were seventy-two joints in the human frame.

Then, too, there were revived such theologic and metaphysical substitutes for scientific thought as the declaration that the perfect line is a circle, and hence that the planets must move in absolute circles—a statement which led astronomy astray even when the great truths of the Copernican theory were well in sight; also, the declaration that Nature abhors a vacuum, a statement which led physics astray until Torricelli made his experiments.

In chemistry we have the same theologic tendency to magic, and as a result a muddle of science and theology, which from one point of view seems blasphemous, and from another idiotic, but which none the less sterilized the field of physical investigation for ages. That debased Platonism which had been such an important factor in the evolution of Christian theology from the earliest days of the Church continued its work. As everything in inorganic Nature was supposed to have spiritual significance, the doctrines of the Trinity and Incarnation were turned into an argument in behalf of the philosopher's stone: arguments for the scheme of redemption and for transubstantiation suggested others of similar construction to prove the transmutation of metals; the doctrine of the resurrection of the human body was by similar mystic jugglery connected with the processes of distillation and sublimation. Even after the middle ages were past strong men seem unable to break away from such reasoning as this;—among them such leaders as Basil Valentine in the fifteenth century, Agricola in the sixteenth, and Van Helmont in the seventeenth.

The greatest theologians aided in developing the fetichism in which much of this pseudo-science was grounded. One question largely discussed was, whether at the redemption it was necessary for God to take the human form. Thomas Aquinas answered that it was necessary, but William Occam and Duns Scotus answered that it was not; that God might have taken the form of a stone, or of a log, or of a beast. The possibilities opened to wild substitutes for science by this sort of reasoning were infinite. Men have often wondered how it was that the Arabians accomplished so much in scientific discovery as compared with Christian investigators: the reason is not far to seek; the Arabians were comparatively free from these mystic allurements, these theologic modes of thought which in Christian Europe flickered in the air on all sides, luring men into paths which led no-whither.

Strong investigators like Arnold de Villanova, Raimond Lully, Basil Valentine, Paracelsus, and their compeers, were thus drawn far out of the only paths which led to fruitful truths. In a work generally ascribed to Arnold of Villanova, the student is told that in mixing his chemicals he must repeat the psalm *Exsurge Domine*, and that on certain chemical vessels must be placed the last words of Jesus on the cross. Vincent de Beauvais insists that as the Bible declares that Noah, when five hundred years old, had children born to him, he must have possessed alchemical means of preserving life; and much later Dickinson insists that the patriarchs generally must have owed their long lives to such means. It was loudly declared that the reality of the philosopher's stone was proved by the words of St. John in the Revelation, "To the victor I will give a white stone." The reasonableness of seeking to develop gold out of the baser metals was for many generations based upon the doctrine of the resurrection of the physical body, which, though explicitly denied by St. Paul, had become a part of the creed of the Church. Martin Luther was especially drawn to believe in the alchemistic doctrine of transmutation by this analogy. The Bible was everywhere used both among Protestants and Catholics, in support of these mystic adulterations of science, and one writer, as late as 1751, based his alchemistic arguments on more than a hundred passages of Scripture. As an example of this sort of reasoning, we have a proof that the elect will preserve the philosopher's stone until the last judgment, drawn from a passage in St. Paul's Epistle to the Corinthians, "This treasure have we in earthen vessels."

The greatest thinkers devoted themselves to adding new ingredients to this strange mixture of scientific and theologic thought; the Catholic philosophy of Thomas Aquinas, the Protestant mysticism of Jacob Boehme, and the alchemistic reveries of Basil Valentine were all cast into this seething mass.

And when alchemy in its old form had been discredited, we find scriptural arguments no less perverse and even comical used on the other side. As an example of this, just before the great discoveries by Stahl, we find the valuable scientific efforts of Becher opposed with the following syllogism: "King Solomon, according to the Scriptures, possessed the united wisdom of heaven and earth; but King Solomon knew nothing about alchemy (or chemistry in the form which then existed), and sent his vessels to Ophir to seek gold, and levied taxes upon his subjects; *ergo* alchemy (or chemistry) has no reality or truth." And we find that Becher is absolutely turned away from his labors, and obliged to devote himself to proving that Solomon used more money than he possibly could have obtained from Ophir or his subjects, and therefore that he must have possessed a knowledge of chemical methods and the philosopher's stone as the result of them.*

* For an extract from Agrippa's Occulta Philosophia giving examples of the way in which mystical names were obtained from the Bible, see Rydberg, Magic of the Middle Ages, pp. 143 *et seq.* For the germs of many mystic beliefs regarding number and the like, which were incorporated into mediæval theology, see Zeller, Plato and the Older Academy, English translation pp. 254 and 572, and elsewhere. As to the connection of spiritual things with inorganic Nature in relation to chemistry, see Eicken, p. 634. On the injury to science wrought by Platonism acting through mediæval theology, see Hoefer, Histoire de la Chimie, vol. i, p. 90. As to the influence of mysticism upon strong men in science, see Hoefer; also Kopp, Geschichte der Alchemie, vol. i, p. 211. For a very curious Catholic treatise on sacred numbers, see the Abbé Auber, Symbolisme Religieux, Paris, 1870; and for an equally important Protestant work, see Samuell, Seven the Sacred Number, London, 1887. It is interesting to note that the latter writer, having been forced to give up the seven planets, consoles himself with the statement that "The earth is the seventh planet, counting from Neptune and calling the asteroids one" (see p. 426). For the *electrum magicum*, the seven metals composing it, and its wonderful qualities, see extracts from Paracelsus's writings in Hartman's Life of Paracelsus, London, 1887, pp. 169 *et seq.* For Basil Valentine's view, see Hoefer, vol. i, pp. 453–465; Schmieder, Geschichte der Alchemie, pp. 197–209; Allgemeine deutsche Biographie, article Basilius. For the discussions referred to on

Of the general reasoning enforced by theology regarding physical science, every age has shown examples; yet out of them all I will select but two, and I present these because they show how this mixture of theological with scientific ideas took hold upon the strongest supporters of better reasoning even after the power of mediæval theology seemed broken.

The first of these examples is Melanchthon. He was the scholar of the Reformation, and justly won the title "Preceptor of Germany"; his mind was singularly open, his sympathies broad, and his freedom from bigotry drew down upon him that wrath of Protestant heresy-hunters which embittered the last years of his life and tortured him upon his death-bed. During his career at the University of Wittenberg he gave a course of lectures on physics. In this he dwells upon scriptural texts as affording scientific proofs, accepts the interference of the devil in physical phenomena as in other directions, and applies the mediæval theological method throughout his whole work.*

Yet far more remarkable was the example, a century later, of the man who more than any other led the modern world out of the path opened by Aquinas, and into that which Roger Bacon had sought to open and which has led modern thought to its greatest conquests. Strange as it may at first seem, Francis Bacon, whose keenness of sight revealed the delusions of the old path and the promises of the new, and whose boldness did so much to turn the world from the old path into the new, presents in his own writings one of the most striking examples of the evil he did so much to destroy.

The Novum Organon, considering the time when it came from his pen, is doubtless one of the greatest exhibitions of genius in the history of human thought. It showed the modern world the way out of the scholastic method and reverence for dogma into the experimental method and reverence for fact. In it occur many passages which show that the great philosopher was fully alive to the danger both to religion and to science arising from their mixture. He declares that the "corruption of philosophy from superstition and theology introduced the greatest amount of

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possibilities of God assuming forms of stone, or log, or beast, see Lippert, Christenthum, Volksglaube, und Volksbrauch, pp. 372, 373, where citations are given, etc. For the syllogism regarding Solomon, see Figuier, L'Alchemie et les Alchemistes, pp. 106, 107. For careful appreciation of Becher's position in the history of chemistry, see Kopp, Ansichten über die Aufgabe der Chemie, etc., von Geber bis Stahl, Braunschweig, 1875, pp. 201 *et seq.* For the text proving the existence of the philosopher's stone from the book of Revelation, see Figuier, p. 22.

* For Melanchthon's ideas on physics, see his Initia Doctrinæ Physicæ, Wittenberg, 1557, especially pp. 243 and 274; also in vol. xiii of Bretschneider's edition of the collected works, and especially pp. 339–343.

evil both into whole systems of philosophy and into their parts." He denounces those who "have endeavored to found a natural philosophy on the books of Genesis and Job and other sacred Scriptures, so 'seeking the dead among the living.'" He speaks of the result as "an unwholesome mixture of things, human and divine; not merely fantastic philosophy, but heretical religion." He refers to the opposition of the fathers to the doctrine of the rotundity of the earth, and says that "thanks to some of them, you may find the approach to any kind of philosophy, however improved, entirely closed up." He charges that some of these divines are "afraid lest perhaps a deeper inquiry into Nature should penetrate beyond the allowed limits of sobriety"; and finally speaks of theologians as sometimes craftily conjecturing that if science be little understood, "each single thing can be referred more easily to the hand and rod of God," and says, "*This is nothing more nor less than wishing to please God by a lie.*"

No man who has reflected much upon the annals of his race can, without a feeling of awe, come into the presence of such clearness of insight and boldness of utterance, and the first thought of the reader is, that of all men Francis Bacon is the most free from the unfortunate bias he condemns; that he, certainly, can not be deluded into the old path. But as we go on through his main work we are surprised to find that the strong arm of Aquinas has been stretched over the intervening ages, and has laid hold upon this master-thinker of the seventeenth century. For only a few chapters beyond those containing the citations already made we find Bacon alluding to the recent voyage of Columbus, and speaking of the prophecy of Daniel regarding the latter days, that "many shall run to and fro and knowledge be increased," as clearly signifying "that . . . the circumnavigation of the world and the increase of science should happen in the same age." *

In his great work on the Advancement of Learning the firm grasp which the methods he condemned held upon him is shown yet more clearly. In the first book of it he asserts "that excellent book of Job, if it be revolved with diligence, will be found pregnant and swelling with natural philosophy," and he endeavors to show that in it the "roundness of the earth," the "fixing of the stars, ever standing at equal distances," the "depression of the southern pole," the "matter of generation," and "matter of minerals" are "with great elegancy noted." But, curiously enough, he uses to support some of these truths the very texts which the fathers of the Church used to destroy them, and those for which

* See the Novum Organon, translated by the Rev. G. W. Kitchin, Oxford, 1855, chaps. lxv and lxxxix.

he finds Scripture warrant most clearly are such as science has since disproved. So, too, he says that Solomon was enabled in his Proverbs, "by donation of God, to compile a natural history of all verdure." *

We have now seen how powerless were the strongest men in physical science, singly, in this struggle against theology and ecclesiasticism, and it may be well to study briefly their efforts after they had learned to combine in societies and academies against the common enemy. In the latter half of the sixteenth century, John Baptist Porta began his investigations, and despite much absurdity they were fruitful. His was not "black magic," claiming the aid of Satan, but "white magic" bringing into service the laws of Nature—the precursor of applied science. His book on Meteorology was the first in which sound ideas were broached on that subject; his researches in optics gave the world the camera obscura, and possibly the telescope; in chemistry he seems to have been the first to show how to reduce the metallic oxides, and thus to have laid the foundation of all those industries based upon the coloring and staining of glass and enamels; he did much to change natural philosophy from a "black art" to a vigorous open science. He encountered the old policy of conscientious men; the society founded by him for physical research, "I Secreti," was broken up, and he was summoned to Rome by Pope Paul III and forbidden to continue his investigations.

In 1624 some young chemists of Paris, having taught the experimental method and cut loose from Aristotle, the Faculty of Theology beset the Parliament of Paris, and the Parliament prohibited this new chemical teaching, under penalty of death.

The same war continued in Italy. In 1657 occurred the first sitting of the Accademia del Cimento at Florence, under the presidency of Prince Leopold dei Medici. This Academy promised great things for science; it was open to all talent; its only fundamental law was "the repudiation of any favorite system or sect of philosophy, and the obligation to investigate Nature by the pure light of experiment"; it entered into scientific investigations with energy. Borelli in mathematics, Redi in natural history, and many others pushed on the boundaries of knowledge. Heat, light, magnetism, electricity, projectiles, digestion, the in-

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* See Bacon, Advancement of Learning, edited by W. Aldis Wright, London, 1873, pp. 47, 48. Certainly no more striking examples of the strength of the evil which he had all along been denouncing could be exhibited than these in his own writings. Nothing better illustrates the sway of the mediæval theology, or better explains his blindness to the discoveries of Copernicus and to the experiments of Gilbert. For a very contemptuous statement of Lord Bacon's claim to his position as a philosopher, see Lange, Geschichte des Materialismus, Leipsic, 1874, vol. i, p. 219. For a more just statement, see Brewster, Life of Sir Isaac Newton. See, also Jevons, Principles of Science, London, 1874, vol. ii, p. 298.

compressibility of water, were studied by the right method and with results that enriched the world.

The Academy was a fortress of science, and siege was soon laid to it. The votaries of scholastic learning denounced it as irreligious; quarrels were fomented; Leopold was bribed with a cardinal's hat and drawn away to Rome; and, after ten years of beleaguering, the fortress fell: Borelli was left a beggar; Oliva killed himself in despair.

So, too, the noted Academy of the Lincei at times incurred the ill-will of the papacy by the very fact that it included thoughtful investigators. It was "patronized" by Pope Urban VIII in such manner as to paralyze it, and it was afterward vexed by Pope Gregory XVI; even in our own time sessions of scientific associations were discouraged and thwarted by Pope Pius IX.*

Such was the struggle of the physical sciences in general. Let us now look briefly at one special example out of many, which reveals, as well as any, the beginning, continuance, and end of theological interference with the evolution of them.

It will doubtless seem amazing to many that for ages the weight of theological thought in Christendom was thrown against the idea of the suffocating properties of certain gases, and especially of carbonic acid. Although in antiquity we see men forming a right theory of gases in mines, we find that, early in the history of the Church, St. Clement of Alexandria put forth the theory that these gases are manifestations of diabolic action, and that, throughout Christendom, suffocation in caverns, wells, and cellars was attributed to the direct action of evil spirits. Evidences of this view abound through the mediæval period, and even as late as the Reformation period a great authority, Agri-

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* For Porta, see the English translation of his main summary, "Natural Magick," London, 1658. The first chapters are especially interesting, as showing what the word "magic" had come to mean in the mind of a man in whom mediæval and modern ideas were curiously mixed; see also Hoefer, Histoire de la Chimie, vol. ii, pp. 102–106; also Kopp; also Sprengel, Histoire de la Médecine, iii, p. 239; also Musset-Pathay. For the Accademia del Cimento, see Napier, Florentine History, vol. v, p. 485; Tiraboschi, Storia della Litteratura; Henri Martin, Histoire de France; Jevons, Principles of Science, vol. ii, pp. 36–40. For value attached to Borelli's investigations by Newton and Huygens, see Brewster's Life of Sir Isaac Newton, London, 1875, pp. 128, 129. Libri, in his Essai sur Galilée, p. 37, says that Oliva was summoned to Rome and so tortured by the Inquisition that, to escape further cruelty, he ended his life by throwing himself from a window. For interference by Pope Gregory XVI with the Academy of the Lincei, and with public instruction generally, see Carutti, Storia della Accademia dei Lincei, p. 126. Pius IX, with all his geniality, seems to have allowed his hostility to voluntary associations to carry him very far at times. For his answer to an application made through Lord Odo Russell regarding a society for the prevention of cruelty to animals and his answer that "such an association could not be sanctioned by the Holy See, being founded on a theological error, to wit, that Christians owed any duties to animals," see Frances Power Cobbe, Hopes of the Human Race, p. 207.

cola, one of the most earnest and truthful of investigators, still adheres to the belief that these gases in mines are manifestations of devils, and specifies two classes—one of malignant imps, who blow out the miners' lamps, and the other of friendly imps, who simply tease the workmen in various ways. He goes so far as to tell us that one of these spirits in the Saxon mine of Annaberg destroyed twelve workmen at once by the power of his breath.

At the end of the sixteenth century we find a writer on mineralogy complaining that the mines in France and Germany had been in large part abandoned on account of the "evil spirits of metals which had taken possession of them."

But at various periods glimpses of the truth had been gained. The ancient view had not been entirely forgotten; and as far back as the first part of the thirteenth century Albert the Great suggested a natural cause in the possibility of exhalations from minerals causing a "corruption of the air"; but he, as we have seen, was driven or dragged off into theological studies, and the world relapsed into the theological view.

Toward the end of the fifteenth century there came a great genius laden with important truths in chemistry, but for whom the world was not ready—Basil Valentine. His discoveries anticipated much that has brought fame and fortune to chemists since, yet so fearful of danger was he that his work was carefully concealed. Not until after his death was his treatise on alchemy found, and even then it was for a long time not known where and when he lived. The papal bull, *Spondent pariter*, and the various prohibitions it bred, forcing other alchemists to conceal their laboratories, led him to let himself be known during his life at Erfurt simply as an apothecary, and to wait until after his death to make a revelation of truth, which during his lifetime might have cost him dear. Among the legacies of this greatest of the alchemists was the doctrine that the air which asphyxiates workers in mines is similar to that which is produced by fermentation of malt, and a recommendation that in order to drive away the evil and to prevent serious accidents, fires be lighted and jets of steam used to ventilate the mines, laying stress especially upon the idea that the danger in the mines is produced by "exhalations of metals."

Thanks to men like Valentine, this idea of the interference of Satan and his minions with the mining industry was gradually weakened, and the working of the deserted mines was resumed; yet, even at a comparatively recent period, we find it still lingering, and among leading divines in the very heart of Protestant Germany. In 1715 a cellar-digger having been stifled at Jena, the medical faculty of the university decided that the cause was not the direct action of the devil, but a deadly gas. Thereupon

Prof. Loescher, of the University of Wittenberg, entered a solemn protest, declaring that the decision of the medical faculty was "only a proof of the lamentable license which has so taken possession of us, and which, if we are not earnestly on our guard, will finally turn away from us the blessing of God." * But denunciations of this kind could not hold back the little army of science. In the last half of the eighteenth century Black, Priestley, and especially Bergmann, rooted out the very foundations of the whole theologic theory, and one more phantom which had long troubled the earth was at last driven forth forever.†

Thus, in spite of adverse influences, the evolution of the physical sciences went on. More and more there rose men bold enough to break away from the theological method, and strong enough to resist the enticements or threats of ecclesiasticism. Alchemy in its first form, seeking for the philosopher's stone and the transmutation of metals, gave way to alchemy in its second form, seeking for the elixir of life and remedies more or less magical for disease; and this in turn yielded to the search for truth as truth. More and more the "solemnly constituted impostors" were resisted in every field. A great line of physicists and chemists began to appear. Though theological modes of reasoning continued to sterilize much effort in chemistry down to our own century, more and more the old influence was thrown off; more and more truth was sought as truth; less and less science was bent to aid in the alleged "saving of souls." "Black magic" with its satanic apparatus vanished, only reappearing occasionally among miraclemongers and belated theologians. "White magic" became legerdemain.‡

In our own time some attempt has been made to renew this war against the physical sciences. Joseph de Maistre, uttering his hatred of them, declaring that mankind has paid too dearly for them, asserting that they must be subjected to theology, likening them to fire—good when confined and dangerous when scattered about—has been one of the main leaders among those who can not relinquish the idea that our body of sacred literature should be kept a controlling text-book of science. The only effect

* For Loescher's protest, see Julian Schmidt, Geschichte des geistigen Lebens, etc., vol. i, p. 319.

† For the general view of noxious gases as imps of Satan, see Hoefer, Histoire de la Chimie, vol. i, p. 350, vol. ii, p. 48. For the work of Black, Priestley, Bergmann, and others, see main authorities already cited, and especially the admirable paper of Dr. R. G. Eccles on The Evolution of Chemistry, New York, D. Appleton & Co., 1891.

‡ For a reappearance of the fundamental doctrine of black magic among theologians, see Rev. Dr. Jewett, Professor of Pastoral Theology in the Prot. Episc. Gen. Theolog. Seminary of New York, Diabolology: The Person and Kingdom of Satan, New York, 1889. For their reappearance among theosophists, see Elephas Levi, Histoire de la Magie, especially the final chapters.

of such teachings has been to weaken the legitimate hold of religion upon men.

In Catholic countries the effort has been of late years mainly confined to excluding science or diluting it in university teachings. Early in the present century a great effort was made by Ferdinand VII of Spain. He simply dismissed the scientific professors from the University of Salamanca, and until a recent period there has been general exclusion from Spanish universities of professors holding to the Newtonian physics. So, too, the contemporary Emperor of Austria attempted indirectly something of the same sort; and at a still later period Popes Gregory XVI and Pius IX discouraged, if they did not forbid, the meetings of scientific associations in Italy. In France, war between theology and science, which had long been smoldering, came in the years 1867 and 1868 to an outbreak. Toward the end of the last century, after the Church had held possession of advanced instruction for more than a thousand years, and had, so far as it was able, kept experimental science in servitude—after it had humiliated Buffon in natural science, thrown its weight against Newton in the physical sciences, and wrecked Turgot's noble plans for a system of public instruction—the French nation decreed the establishment of the most thorough and complete system of higher instruction in science ever known. It was kept under lay control, and became one of the glories of France; but, emboldened by the restoration of the Bourbons in 1815, the Church began to undermine this hated system, and in 1868 had made such progress that all was ready for the final assault.

Foremost among the leaders of the besieging party was the Bishop of Orleans, Dupanloup, a man of many winning characteristics and of great oratorical power. In various ways, and especially in an open letter, he had fought the "materialism" of science at Paris, and especially were his attacks leveled at Profs. Vulpian and Sée, and the Minister of Public Instruction, Duruy, a man of great merit, whose only crime was devotion to the improvement of education, and to the promotion of the highest research in science.*

The main attack was made rather upon biological science than upon physics and chemistry, yet it was clear that all were involved together.

The first onslaught was made in the French Senate, and the storming party in that body was led by a venerable and conscientious prelate, Cardinal de Bonnechose, Archbishop of Rouen. It was charged by him and his party that the tendencies of the higher scientific teaching at Paris were fatal to religion and mo-

* For Dupanloup, Lettre à un Cardinal, see the Revue de Thérapeutique of 1868, p. 221.

rality. Heavy missiles were hurled—such phrases as "sapping the foundations," etc., "breaking down the bulwarks," etc., and, withal, a new missile was used with much effect—the epithet "materialist."

The results can be easily guessed: crowds came to the lecture-rooms of the attacked professors, and the lecture-room of Prof. Sée, the chief offender, was crowded to suffocation.

A siege was begun in due form. A young physician was sent by the cardinal's party into the heterodox camp as a spy. Having heard one lecture of Prof. Sée, he returned with information that seemed to promise easy victory to the besieging party; he brought a terrible statement—one that seemed enough to overwhelm Sée, Vulpian, Duruy, and the whole hated system of public instruction in France—the statement that Sée had denied the existence of the human soul.

Good Cardinal Bonnechose seized the tremendous weapon. Rising in his place in the Senate, he launched a most eloquent invective against the Minister of State who could protect such a fortress of impiety as the College of Medicine; and, as a climax, he asserted, on the evidence of his spy fresh from Prof. Sée's lecture-room, that the professor had declared, in his lecture of the day before, that so long as he had the honor to hold his professorship he would combat the false idea of the existence of the soul. The weapon seemed resistless, and the wound fatal; but M. Duruy rose and asked to be heard.

His statement was simply that he held in his hand documentary proofs that Prof. Sée never made such a declaration. He held the notes used by Prof. Sée in his lecture. Prof. Sée, it appeared, belonged to a school in medical science which combated certain ideas regarding medicine as an *art*. The inflamed imagination of the cardinal's heresy-hunting emissary had, as the lecture notes proved, led him to mistake the word "*art*" for "*âme*" and to exhibit Prof. Sée as treating a theological when he was discussing a purely scientific question. Of the existence of the soul the professor had said nothing.

The forces of the enemy were immediately turned; they retreated in confusion, amid the laughter of all France; and a quiet, dignified statement as to the rights of scientific instructors by Wurtz, Dean of the Faculty, completed their discomfiture. Thus a well-meant attempt to check science simply ended in bringing ridicule on religion, and thrusting still deeper into the minds of thousands of men that most mistaken of all mistaken ideas—the conviction that religion and science are enemies.*

* For a general account of the Vulpian and Sée matter, see Revue des Deux Mondes, 31 mai, 1868; Chronique de la Quinzaine, pp. 763–765. As to the result on popular thought,

But justice forbids raising an outcry against Roman Catholicism alone for this. In 1864 a number of excellent men in England drew up a declaration to be signed by students in the natural sciences, expressing "sincere regret that researches into scientific truth are perverted by some in our time into occasion for casting doubt upon the truth and authenticity of the Holy Scriptures." Nine tenths of the leading scientific men of England refused to sign it; nor was this all: Sir John Herschel, Sir John Bowring, and Sir W. R. Hamilton administered, through the press, castigations which roused general indignation against the proposers of the circular, and Prof. De Morgan, by a parody, covered memorial and memorialists with ridicule. It was the old mistake, and the old result followed in the minds of multitudes of thoughtful young men.*

And in yet another Protestant country this same mistake was made. In 1868 several excellent churchmen in Prussia thought it their duty to meet for the denunciation of "science falsely so called." Two results followed: upon the great majority of these really self-sacrificing men—whose first utterances showed complete ignorance of the theories they attacked—there came quiet and wide-spread contempt; upon Pastor Knak, who stood forth and proclaimed views of the universe which he thought scriptural, but which most school-boys knew to be childish, came a burst of good-natured derision from every quarter of the German nation.†

Warfare of this sort against science seems petty indeed; but it is to be guarded against in Protestant countries not less than in Catholic; it breaks out in America not less than in Europe. Do conscientious Roman bishops in France labor to keep all advanced scientific instruction under their own control—in their own universities and colleges; so do many not less conscientious Protestant clergymen in our own country insist that advanced education in science and literature shall be kept under control in their own sectarian universities and colleges, wretchedly one-sided in their development, and miserably inadequate in their equipment: did a leading Spanish university, until a recent period, exclude professors holding the Newtonian theory; so have many leading American colleges excluded professors holding the Darwinian theory: have Catholic colleges in Italy rejected excellent candidates for professorships on account of "unsafe" views regarding

may be noted the following comment on the affair by the Revue, which is as free as possible from anything like rabid anti-ecclesiastical ideas: "Elle a été vraiment curieuse, instructive, assez triste et même un peu amusante." For Wurtz's statement, see Revue de Thérapeutique for 1868, p. 303.

* De Morgan, Paradoxes, pp. 421–428; also, Daubeny's Essays.

† See the Berlin newspapers for the summer of 1868, especially Kladderadatsch.

the immaculate conception; so have Protestant colleges in America frequently rejected excellent candidates on account of "unsafe" views regarding the apostolic succession, or the incarnation, or baptism, or the perseverance of the saints.

And how has all this system resulted? In the older nations, by natural reaction, these colleges, under strict ecclesiastical control, have sent forth the most bitter enemies the Christian Church has ever known—of whom Voltaire and Renan and Saint-Beuve are types; and there are many signs that the same causes are to produce the same results in our own country.

I might allude to other battle-fields in our own land and time. I might show how, twenty years ago, attempts to meet the want in a great American State of an institution providing higher scientific instruction, were met with loud outcries from many excellent men, who feared injury thereby to religion; and how in various other States, at various times since, the same feeling has been shown. Happily, leading men at the centers of Christian thought in many countries are now taking a larger and better view: but I again point to the recent driving out of the Darwinian professors from the American college at Beirut, under the direction of American Protestants, as an evidence that the old spirit still exists; no longer, indeed, seriously injurious to science, but deeply injurious to religion.*

It was the purpose of Prof. Max Müller's inaugural address as President of the International Oriental Congress to show that the break that now appears in the continuity of thought between the East and West did not exist from the beginning, and that in prehistoric times language really formed a bond of union between the ancestors of many of the Eastern and Western nations; and that more recent discoveries have proved that, in historic times also, language, which seemed to separate the great nations of antiquity, never so completely separated the most important among them as to make intellectual commerce and exchange among them impossible. To have established these two facts, Prof. Müller claims, constitutes one of the greatest achievements and highest glories of Oriental scholarship.

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* It is an interesting fact that one of the men thus driven out of the American college at Beirut, for supposed adhesion to the doctrines of Darwin, has since become one of the most influential editors at Cairo, carrying on a daily journal and two periodicals, and exercising a far greater and wider influence upon thought in the East than ever before. Whatever may be thought of the system of philosophy advocated by President McCosh at Princeton, every thinking man must honor him for the large way in which he, at least, broke away from the traditions of that center of thought; prevented, so far as he was able, persecution of scholars for holding to the Darwinian view; and paved the way for the highest researches in physical science in that university. For a most eloquent statement of the opposition of modern physical science to mediæval theological views, as shown in the case of Sir Isaac Newton, see Dr. Thomas Chalmers, cited in Gore, Art of Scientific Discovery, London, 1878, p. 247.

THE STUDY OF MAN.*

By ALEXANDER MACALISTER, M. D., F. R. S.

ON an irregular and unfenced patch of waste land, situated on the outskirts of a small town in which I spent part of my boyhood, there stood a notice board bearing the inscription, "A Free Coup," which, when translated into the language of the southron, conveyed the intimation, "Rubbish may be shot here." This place, with its ragged mounds of unconsidered trifles, the refuse of the surrounding households, was the favorite playground of the children of the neighborhood, who found a treasury of toys in the broken tiles and oyster-shells, the crockery and cabbage-stalks, which were liberally scattered around. Many a make-believe house and road, and even village, was constructed by these mimic builders out of this varied material, which their busy little feet had trodden down until its undulated surface assumed a fairly coherent consistence.

Passing by this place ten years later I found that its aspect had changed; terraces of small houses had sprung up, mushroom-like, on the unsavory foundation of heterogeneous refuse. Still more recently I notice that these in their turn have been swept away, and now a large factory, wherein some of the most ingenious productions of human skill are constructed, occupies the site of the original waste.

This commonplace history is, in a sense, a parable in which is set forth the past, present, and possible future of that accumulation of lore in reference to humanity to which is given the name Anthropology, and for the study of which this section of our Association is set apart. At first nothing better than a heap of heterogeneous facts and fancies, the leavings of the historian, of the adventurer, of the missionary, it has been for long, and alas is still, the favorite playground of *dilettanti* of various degrees of seriousness. But upon this foundation there is rapidly rising a more comely superstructure, fairer to see than the original chaos, but still bearing marks of transitoriness and imperfection, and I dare hazard the prediction that this is destined in the course of time to give place to the more solid fabric of a real science of anthropology.

We cannot yet claim that our subject is a real science in the sense in which that name is applied to those branches of knowledge, founded upon ascertained laws, which form the subjects of most of our sister sections; but we can justify our separate exist-

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* Vice-presidential address before the Section of Anthropology of the British Association for the Advancement of Science.

ence, in that we are honestly endeavoring to lay a definite and stable foundation, upon which in time to come a scientific anthropology may be based.

The materials with which we have to do are fully as varied as were those in my illustration, for we as anthropologists take for our motto the sentiment of Chremes, so often quoted in this section, *humani nihil a nobis alienum putamus* (we think nothing human foreign to us), and they are too often fully as fragmentary. The bones, weapons, and pottery which form our only sources of knowledge concerning prehistoric races of men, generally come to us as much altered from their original forms as are the rusty polyhedra which once were the receptacles of biscuits or sardines. The traditions, customs, and scraps of folk lore which are treasures to the constructive anthropologist, are usually discovered as empty shells, in form as much altered from their original conditions as are those smooth fragments of hollow white cylinders which once held the delicate products of the factory of Keiller or Cairns.

I have said that anthropology has not yet made good its title to be ranked as an independent science. This is indicated by the difficulty of framing a definition at the same time comprehensive and distinctive. Mr. Galton characterizes it as the study of what men are in body and mind, how they came to be what they are, and whither the race is tending; General Pitt-Rivers, as the science which ascertains the true causes for all the phenomena of human life. I shall not try to improve upon these definitions, although they both are manifestly defective. On the one side our subject is a branch of biology, but we are more than biologists compiling a monograph on the natural history of our species, as M. de Quatrefages would have it. Many of the problems with which we deal are common to us and to psychologists; others are common to us and to students of history, of sociology, of philology, and of religion; and, in addition, we have to treat of a large number of other matters æsthetic, artistic, and technical, which it is difficult to range under any subordinate category.

In view of the encyclopedic range of knowledge necessary for the equipment of an accomplished anthropologist, it is little wonder that we should be, as we indeed are, little better than smatterers. Its many-sided affinities, its want of definite limitation, and the recent date of its admission to the position of an independent branch of knowledge, have hitherto caused anthropology to fare badly in our universities. In this respect, however, we are improving, and now in the two great English universities there are departments for the study of the natural history of man and of his works.

Out of the great assemblage of topics which come within our sphere, I can only select a few which seem at present to demand special consideration. The annual growth of our knowledge is chiefly in matters of detail which are dull to chronicle, and the past year has not been fertile in discoveries bearing on those great questions which are of popular interest.

On the subject of the antiquity of man there are no fresh discoveries of serious importance to record. My esteemed predecessor at the Leeds meeting two years ago, after reviewing the evidence as to the earliest traces of humanity, concluded his survey with the judgment, "On the whole, therefore, it appears to me that the present verdict as to Tertiary man must be in the form of 'Not proven.'" Subsequent research has not contributed any new facts which lead us to modify that finding. The most remarkable of the recent discoveries under this head is that of the rude implements of the Kentish chalk-plateau described by Prof. Prestwich; but while these are evidently of archaic types, it must be admitted that there is even yet room for difference of opinion as to their exact geological age.

Neither has the past year's record shed new light on the darkness which enshrouds the origin of man. What the future may have in store for us in the way of discovery we can not forecast; at present we have nothing but hypothesis, and we must still wait for further knowledge with the calmness of philosophic expectancy.

I may, however, in this connection refer to the singularly interesting observations of Dr. Louis Robinson on the prehensile power of the hands of children at birth, and to the graphic pictures with which he has illustrated his paper. Dr. Robinson has drawn, from the study of the one end of life, the same conclusion which Mr. Robert Louis Stevenson deduced from the study of his grandfather, that there still survive in the human structure and habit traces of our probably arboreal ancestry.

Turning from these unsolved riddles of the past to the survey of mankind as it appears to us in the present, we are confronted in that wide range of outlook with many problems well-nigh as difficult and obscure.

Mankind, whenever and however it may have originated, appears to us at present as an assemblage of tribes, each not necessarily homogeneous, as their component elements may be derived from diverse genealogical lines of descent. It is much to be regretted that there is not in our literature a more definite nomenclature for these divisions of mankind, and that such words as *race*, *people*, *nationality*, *tribe*, and *type* are often used indiscriminately as though they were synonyms.

In the great mass of knowledge with which we deal there are several collateral series of facts, the terminologies of which should be discriminated. In the first place there are those ethnic conditions existing now, or at any other point in time, whereby the individuals of mankind are grouped into categories of different comprehension, as *clans* or families, as *tribes* or groups of allied clans, and as *nations*, the inhabitants of restricted areas under one political organization. This side of our subject constitutes ethnology.

In the second place, the individuals of mankind may be regarded as the descendants of a limited number of original parents, and consequently each person has his place on the genealogical tree of humanity. As the successive branches became in their dispersion subjected to the influences of diverse environments, they have eventually differentiated in characteristics. To each of these subdivisions of the phylum thus differentiated the name *race* may appropriately be restricted, and the sum of the peculiarities of each race may be termed *race-characters*. This is the phylogenetic* side of anthropology, and its nomenclature should be kept clearly separate from that of the ethnological side. The great and growing literature of anthropology consists largely of the records of attempts to discover and formulate these distinctive race-characters. *Race* and *tribe* may be terms of equal extension, but the standpoint from which these categories are viewed is essentially different in the two cases.

There is yet a third series of names in common use in descriptive anthropology. The languages in use among men are unfortunately numerous, and as the component individuals in each community usually speak a common language, the mistake is often made of confounding the tribal name with that of the tribal language. Sometimes these categories are coextensive; but it is not always so, for it is a matter of history that communities have been led to adopt new languages from considerations quite independent of phylogenetic or ethnic conditions. These linguistic terms should not be confounded with the names in either of the other series, for, as my learned predecessor once said in a presidential address, it is as absurd to speak of an Aryan skull as it would be to say that a family spoke a brachycephalic language.

In the one clan there may be, by intermarriage, the representatives of different races; in the one nation there may be dissimilar tribes, each derived by composite lines of ancestry from divergent phyla, yet all speaking the same language.

We have an excellent illustration of the confusion resulting from this disregard of precision in the case of the word *Celtic*, a term which has sometimes been employed as an ethnic, sometimes

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* Pertaining to lines of descent.

as a phylogenetic, and sometimes as a linguistic species. In the last-named sense, that to which I believe the use of the name should be restricted, it is the appropriate designation of a group of cognate languages spoken by peoples whose physical characters show that they are not the descendants of one common phylum in the near past. There are fair-haired, long-headed families in Scotland and Ireland; fair, broad-headed Bretons; dark-haired, round-headed Welshmen; and dark-haired, long-headed people in the outer Hebrides, McLeans, "Sancho Panza type"—men obviously of different races, who differ not only in color, stature, and skull-form, but whose traditions also point to a composite descent, and yet all originally speaking a Celtic tongue. The use of the word *Celtic*, as if it were the name of a phylogenetic species, has naturally led to hopeless confusion in the attempts to formulate race-characters for the Celtic skull—confusions of a kind which tend to bring physical anthropology into discredit. Thus Retzius characterizes the Celtic crania as being dolichocephalic, and compares them with those of the modern Scandinavians. Sir Daniel Wilson considers the true Celtic type of skull as intermediate between the dolichocephalic and the brachycephali; and Topinard figures as the typical Celtic skull that of an Auvergnat, extremely brachycephalic, with an index of 85!

Our traditional history tells that we, the Celtic-speaking races of Britain, are not of one common ancestry, but are the descendants of two distinct series of immigrants, a British and a Gaelic. Whatever may have been the origin of the former, we know that the latter are not homogenous, but are the mixed descendants of the several Fomorian, Nemedian, Firbolg, Tuatha de Danaan, and Milesian immigrations, with which has been combined in later times a strong admixture of Scandinavian blood. It is now scarcely possible to ascertain to which of these component strains in our ancestry we owe the Celtic tongue which overmastered and supplanted the languages of the other tribes, but it is strictly in accordance with what we know of the history of mankind, that this change should have taken place. We have instances in modern times of the adoption by conquered tribes of the language of a dominant invading people. For example, Mr. Hale has lately told us that the speech of the Hupas has superseded the languages of those Californian Indians whom they have subdued. In like manner, nearer home, the English language is slowly but surely supplanting the Celtic tongues themselves.

We may here parenthetically note that what has been observed in the case of language has also taken place in reference to ritual and custom. Observances which have a history and a meaning for one race have, in not a few instances, been adopted by or imposed upon other races to whom they have no such significance, and who in incorporating them give to them a new local color. These pseudomorphs of the earlier cultures are among the most perplexing of the problems which the student of comparative religion or folk lore has to resolve.

But we want more than a perfect nomenclature to bring anthropology into range with the true sciences. We need a broader basis of ascertained fact for inductive reasoning in almost all parts of our subject; we want men trained in exact method who will work patiently at the accumulation, verification, and sorting of facts, and who will not prematurely rush into theory. We have had enough of the untrained writer of papers, the jerry-builder of unfounded hypotheses whose ruins cumber our field of work.

The present position of our subject is critical and peculiar: while on the one hand the facilities for anthropological research are daily growing greater, yet in some directions the material is diminishing in quantity and accessibility. We are accumulating in our museums treasures both of the structure and the works of man, classified according to his distribution in time and space; but at the same time some of the most interesting tribes have vanished, and others are rapidly disappearing or becoming fused with their neighbors. As these pass out of existence we, with them, have lost their thoughts, their tongues, and their traditions; for even when they survive, blended with other races, that which was a religion has become a fragmentary superstition, then a nursery tale or a child's game, and is destined finally to be buried in oblivion. The unifying influences of commerce, aided by steam and electricity, are effectually effacing the landmarks between people and people, so that if we are to preserve in a form fit for future use the shreds which remain of the myths, folk lore, and linguistic usages of many of the tribes of humanity, we must be up and doing without delay. It is on this account that systematic research such as that which Mr. Risley has advocated with regard to the different races of India is of such pressing and urgent importance. It is for this reason, likewise, that we hail with pleasure the gathering of folk lore while yet it survives, and welcome such societies for the purpose as the Folk-lore Congress recently inaugurated.

I have said that in the department of physical anthropology our facilities for research are increasing. The newly founded anthropometric laboratories are beginning to bring forth results in the form of carefully compiled statistical tables, embodying the fruits of accurate observations, which are useful as far as they go. Were these extended in their scope the same machinery might easily gather particulars as to the physical characters of the inhabitants of different districts, which would enable the anthropologist to complete in a systematic manner the work which Dr. Beddoe had so well begun. I would commend this work to the consideration of the provincial university colleges, especially those in outlying districts.

Of all the parts of the human frame, the skull is that upon which anthropologists have in the past expended the most of their time and thought. We have now, in Great Britain alone, at least four collections of skulls, each of which includes more than a thousand specimens, and in the other great national and university museums of Europe there are large collections available for study and comparison.

Despite all the labor that has been bestowed on the subject, craniometric literature is at present as unsatisfactory as it is dull. Hitherto observations have been concentrated on cranial measurements as methods for the discrimination of the skulls of different races. Scores of lines, arcs, chords, and indexes have been devised for this purpose, and the diagnosis of skulls has been attempted by a process as mechanical as that whereby we identify certain issues of postage-stamps by counting the nicks in the margin. But there is underlying all these no unifying hypothesis; so that when we in our sesquipedalian jargon describe an Australian skull as microcephalic, phænozygous, tapeino-dolichocephalic, prognathic, platyrhine, hypselopalatine, leptostaphyline, dolichuranic, chamæprosopic, and microseme, we are no nearer to the formulation of any philosophic concept of the general principles which have led to the assumption of these characters by the cranium in question, and we are forced to echo the apostrophe of Von Török, "Vanity, thy name is Craniology."

It was perhaps needful in the early days of the subject that it should pass through the merely descriptive stage; but the time has come when we should seek for something better, when we should regard the skull not as a whole complete in itself, nor as a crystalline geometrical solid, nor as an invariable structure, but as a marvelously plastic part of the human frame, whose form depends on the co-operation of influences, the respective shares of which in molding the head are capable of qualitative if not of quantitative analysis. Could measurements be devised which would indicate the nature and amounts of these several influences, then, indeed, would craniometry pass from its present empirical condition, and become a genuine scientific method. We are yet far from the prospect of such an ideal system, and all practical men will realize the immense, but not insuperable, difficulties in the way of its formulation.

In illustration of the profound complexity of the problem which the craniologist has to face, I would ask your indulgence while I set out a few details to show the several factors whose influence should be numerically indicated by such a mode of measurement.

The parts composing the skull may be resolved into four sets: there is, first, the brain-case; secondly, the parts which subserve mastication and the preparation of the food for digestion; thirdly, the cavities containing the organs of the senses of hearing, sight, and smell; and, fourthly, those connected with the production of articulate speech. If our measurements are to mean anything, they should give us a series of definite numbers indicating the forms, modifications, and relative size of these parts, and their settings with regard to each other and to the rest of the body.

To take the last point first, it needs but a small consideration to show that the parts of the skull are arranged above and below a certain horizontal plane, which is definite (although not easily ascertained) in every skull, human or animal. This is the plane of vision. The familiar lines of Ovid—

> "Pronaque cum spectent animalia cetera terram,
> Os homini sublime dedit; cœlumque tueri
> Jussit, et erectos ad sidera tollere vultus" *—

are anatomically untrue, for the normal quadruped and man alike, in their most natural position, have their axis of vision directed to the horizon. Systems of measurement based upon any plane other than this are essentially artificial. There are at the outset difficulties in marking the plane accurately on the skull, and it is to be deplored that the anthropologists of different nations should have allowed themselves to be affected by extraneous influences, which have hindered their unanimous agreement upon some one definite horizontal plane in craniometry.

The Frankfort plane, drawn through the upper margins of the auditory foramina and the lowest points of the orbital borders, has the advantage of being easily traced, and differs so little from the plane of vision that we may without substantial error adopt it.

The largest part of the skull is that which is at once the receptacle and the protector of the brain, a part which, when unmodified by external pressure, premature synostosis, or other adventitious conditions, owes its form to that of the cerebral hemispheres which it contains. Speaking in this city of George and Andrew Combe, I need not do more than indicate in this matter that observation and experiment have established on a firm basis certain fundamental points regarding the growth of the brain. The

* While other animals look down upon the earth, he has given an upward face to man; and has ordered him to look at the sky and to raise his eyes to the stars.

study of its development shows that the convolutioning of the cerebral hemisphere is primarily due to the connection, and different rate of growth, of the superficial layer of cells with the underlying layers of white nerve fibers; and that so far from the shape being seriously modified by the constraining influence of the surrounding embryonic skull, the form of the soft membranous brain-case is primarily molded upon the brain within it, whose shape it may however be, to some extent, a secondary agent in modifying in later growth. We have also learned that, although in another sense from that of the crude phrenology of Aristotle, Porta, or Gall, the cerebrum is not a single organ acting as a functional unit, but consists of parts, each of which has its specific province; that the increase in the number of cells in any area is correlated with an increase in the size and complexity of pattern of the convolutions of that area; and that this in turn influences the shape of the inclosing shell of membrane and subsequently of bone.

The anatomist and the physiologist have worked hand in hand in the delimitation of these several functional areas, and pathology and surgery have confirmed what experimental physiology has taught. The topography of each part of the cerebrum, so important to the operating surgeon, should be pressed into the service of the anthropologist, whose measurements of the brain-case should have definite relation to these several areas. In the discussion which is to take place on this subject, I hope that some such relationships will be taken account of. This is not the place to work out in detail how this may be done; I only desire to emphasize the fundamental principle of the method.

The second factor which determines the shape of the individual skull is the size of the teeth. That these differ among different races is a matter of common observation; thus the average area of the crowns of the upper-jaw teeth in the male Australian is 1,536 sq. mm., while in the average Englishman it is only 1,286 sq. mm., less than 84 per cent of that size.*

It is easy to understand how natural selection will tend to increase the size of the teeth among those races whose modes of feeding are not aided by the cook or the cutler; and how, on the other hand, the progress of civilized habits, assisted by the craft of the dentist, interferes with the action of selection in this matter among the more cultured races.

For larger teeth a more extensive alveolar arch of implantation is necessary; and as the two jaws are commensurately developed, the lower jaw of the macrodontal races exceeds that of the

* These and the succeeding averages are from my own measurements, taken from never less than ten individual cases.

meso- or microdontal races in weight. Thus that of a male Australian exceeds that of the average Englishman in the proportion of 100:91.

To work this heavier jaw more powerful muscles are needed. In the average well-developed Englishman with perfect teeth the weight of the fleshy portion of the great jaw-muscles, masseters and temporals, is 60 grammes, while the weight of those as ascertained in two Australians was 74 grammes.

Correlated with this greater musculature a sharper definition of the areas for the attachments of the jaw-muscles is required. The muscular fascicles are approximately of uniform size in both microdonts and macrodonts, as the range of motion of the jaw differs little in different races; but when the skull is smaller on account of the smaller size of the brain which it contains, the temporal crest ascends higher on the side-wall. In the average Englishman the temporal crests at their points of greatest approximation anteriorly across the brows are 112 mm. apart, but in the Australian they are only separated by 103 mm.; the interstephanic distances in these two are respectively 132 and 114 mm.

The more powerful stroke of the mandibular teeth upon the anvil of the upper-jaw teeth in macrodonts renders necessary a proportionally stronger construction of the bases of support for the upper alveolar arch. In any skull this arch requires to be solidly connected to the wall of the brain-case to which the shock of the impact is ultimately transmitted, and in order to protect from pressure the delicate intervening organs of sight and smell, the connection is accomplished by the reversed arches of the infraorbital margins with their piers, malar and maxillary, founded on the frontal angular processes. These foundations are tied together by the strong supraorbital ridge, so that the whole orbital edge is a ring, made up of the hardest and toughest bone in the skeleton.

A twofold modification of this arrangement is required in the macrodont skull. The bony circumorbital ring becomes stronger, especially along its lateral piers, and also as the alveolar arch is longer, and consequently projects farther forward, its basis of support must be extended to meet and bear the malar and maxillary piers. But macrodonts are often microcephalic, and therefore the frontal region of the skull must be adjusted to form a foundation for this arch. In the average English male skull, held with its visual axes horizontal, a perpendicular dropped from the anterior surface of the fronto-nasal suture will cut the plane of the alveolar arch between the premolar teeth or through the first premolar. In an Australian skull the perpendicular cuts the horizontal plane at the anterior border of the first molar teeth.

It is obvious, therefore, that to insure firmness the piers of the arches must be obliquely set, hence the jaw is prognathous; but it is also needful that the supraorbital arcade should be advanced to meet and bear these piers, as the mandibular stroke is always vertical.

But the inner layer of the skull is molded on the small frontal lobes of the brain, so this forward extension must affect only the much thicker and tougher outer table of the skull, which, at the period of the second dentition, here separates from the inner table, the interval becoming lined by an extension of the mucosa of the anterior ethmoidal cell. In this way an air-space, the frontal sinus, is formed, whose development is thus directly correlated to the two factors of brain development and size of the teeth. If the frontal lobes are narrow in a macrodont skull, then the foundations of the outer or malar piers of the orbital arch must be extended outward as well as forward, the external angular process becoming a prominent abutment at the end of a strong, low-browed supraorbital arch, whose overhanging edge gives to the orbital aperture a diminished vertical height.

The crania of the two most macrodont races of mankind, Australian and African, differ in the relation of the jaw to the frontal bone. In the microcephalic Australian the maxillæ are founded upon the under side of the shelf-like projection of the outer table of the frontal, which juts out as a buttress to bear it. On the other hand, the nasal processes of the mesocephalic negro ascend with greater obliquity to abut on the frontal, and have, by their convergence, crushed the nasal bones together and caused their coalescence and diminution.

The crania of the two most microcephalic races present distinctive features of contrast along the same lines. The Bushman's skull is usually orthognathous, with a straight forehead and a shallow fronto-nasal recess; while the Australian skull is prognathous, with heavy overhanging brows. These conditions are correlated to the mesodontism of the Bushman and the macrodontism of the Australian respectively.

In the course of the examination of the relations of brain development to skull growth some interesting collateral points are elicited. The frontal bone grows from lateral symmetrical centers, which medially coalesce, union taking place usually between the second and sixth years of age. It has been noticed by anthropologists that metopism, as the anomalous non-union of the halves of this bone has been termed, is rare among microcephalic races, occurring only in about one per cent among Australian skulls. Increased growth of the frontal lobes as the physical accompaniment of increased intellectual activity interposes an obstacle to the easy closure of this median suture, and so in such races as the ancient Egyptian, with a broader forehead, metopism becomes commoner, rising to seven per cent. In modern civilized races the percentage ranges from five to ten. In following out the details of this enumeration I have spoken as if the microdontal condition had been the primary one, whereas all the available evidence leads to show that the contrary was the case. The characters of all the early crania, Neanderthal, Engis, and Cromagnon, are those of macrodonts. The progress has been from the macrodont to the microdont, as it probably was from the microcephalic to the macrocephalic.

The effects of the variations in size of the teeth are numerous and far-reaching. The fluctuation in the weight of the jaw depending on these variations has an important influence on the center of gravity of the head, and affects the set of the skull on the vertebral column. This leads to a consequent change in the axes of the occipital condyles, and it is one of the factors which determine the size of the neck-muscles, and therefore the degree of prominence of the nuchal crests and mastoid process.

As the teeth and alveolar arches constitute a part of the apparatus for articulate speech, so these varieties in dental development are not without considerable influence on the nature of the sound produced. The necessarily larger alveolar arch of the macrodont is hypseloid or elliptical, more especially when it has to be supported on a narrow frontal region, and this is associated with a more extensive and flatter palatine surface. This, in turn, alters the shape of the mouth cavity, and is associated with a wide flat tongue, whose shape participates in the change of form of the cavity of which it is the floor. The musculature of the tongue varies with its shape, and its motions, upon which articular speech depends, become correspondingly modified. For example, the production of the sharp sibilant S requires the approximation of the raised flexible edge of the tongue to the inner margins of the teeth behind the canines, and to the palatine margin close behind the roots of the canine and lateral incisor teeth. This closes the vocal tube laterally, and leaves a small lacuna about 5 mm. wide anteriorly, through which the vibrating current of air is forced. A narrow strip of the palate behind the medial halves of the median incisors bounds this lacuna above, and the slightly concave raised tongue-tip limits it below.

With the macrodont alveolar arch, and the correspondingly modified tongue, sibilation is a difficult feat to accomplish, and hence the sibilant sounds are practically unknown in all the Australian dialects.

It is worthy of note that the five sets of muscular fibers, whose function it is to close laterally the flask-like air-space between the tongue and the palate, are much less distinct and smaller in gues of the Australians which I have examined than in the s of ordinary Europeans.

re is a wide field open to the anatomical anthropologist in vestigation of the physical basis of dialect. It is one which es minute and careful work, but it will repay any student n obtain the material, and who takes time and opportunity w it out. The anatomical side of phonology is yet an imtly known subject, if one may judge by the crudeness of the tions of the mechanism of the several sounds to be found the most recent text-books. As a preliminary step in this on we are in urgent need of an appropriate nomenclature accurate description of the muscular fibers of the tongue. portance of such a work can be estimated when we rememt there is not one of the 260 possible consonantal sounds to the phonologist which is not capable of expression in of lingual, labial, and palatine musculature.

e acquisition of articulate speech became possible to man hen his alveolar arch and palatine area became shortened idened, and when his tongue, by its accommodation to the ed mouth, became shorter and more horizontally flattened, e higher refinements of pronunciation depend for their pron upon more extensive modifications in the same directions. an only allude now very briefly to the effects of the third factors, the sizes of the sense organs, on the conformation skull. We have already noted that the shape and the size orbital opening depend on the jaw as much as on the eye. eful set of measurements has convinced me that the relative solute capacity of the orbital cavity is of very little signifias a characteristic of race. The microseme Australian orbit e megaseme Kanaka are practically of the same capacity, e eyeballs of the two Australians that I have had the opnity of examining are a little larger than those of the averf mesoseme Englishmen.

e nasal fossæ are more variable in size than the orbits, but perficial area of their lining and their capacity are harder asure, and bear no constant proportion to the size of their ures, because it is impossible without destroying the skull to off the large air sinuses from the nasal fossæ proper for purof measurement. Thus the most leptorhine of races, the no, with an average nasal index of 437, has a nasal capacity c. c., equal to that of the platyrhine Australian, whose aver54·5, and both exceed the capacity of the leptorhine English, average about 50 c. c. There is an intimate and easily d connection between dental size and the extent of the nasal and of the pyriform aperture.

ese are but a few of the points which a scientific craniometry should take into consideration. There are many others to which I can not now refer, but which will naturally occur to the thoughtful anatomist.

In this rapid review of the physical side of our subject the study of these race-characters naturally suggests the vexed question as to the hereditary transmission of acquired peculiarities. This is too large a controversy for us now to engage in, but in the special instances before us there are grounds for the presumption that these characters of microdontism and megacephaly have been acquired at some stage in the ancestral history of humanity, and that they are respectively correlated with diminution of use in the one case and increase of activity in the other. It is a matter of observation that these qualities have become hereditary, and the point at issue is not the fact, but the mechanism of the transmission. We know that use or disuse affects the development of structure in the individual, and it is hard to believe that the persistent disuse of a part through successive generations does not exercise a cumulative influence on its ultimate condition.

There is a statement in reference to one of these characters which has gained an entrance into the text-books, to the effect that the human alveolar arch is shortening, and that the last molar tooth is being crowded out of existence. I have examined 400 crania of men of the long- and round-barrow races, Romano-British and early Saxon, and have not found among all these a single instance of absence of the third molar or of overcrowded teeth. On the other hand, out of 200 ancient Egyptian skulls, nine per cent showed displacement or disease, and 1½ per cent show the want of one molar tooth. Out of 200 modern English skulls there was no third molar tooth in one per cent. So far this seems to confirm the current opinion.

Yet the whole history of the organism bears testimony to the marvelous persistence of parts in spite of contumely and disuse. Take, for example, the present position of the little toe in man. We know not the condition of this digit in prehistoric man, and have but little information as to its state among savage tribes at the present day, but we do know that in civilized peoples, whose feet are from infancy subjected to conditions of restraint, it is an imperfect organ—

> "of every function shorn
> Except to act as basis for a corn."

In one per cent of adults the second and third joints have anchylosed, in three per cent the joint between them is rudimentary, with scarcely a trace of a cavity, in twenty per cent of feet the organ has lost one or more of its normal complement of muscles. But though shorn of some of its elements, and with others as mere shreds, the toe persists, and he would be a bold prophet who would venture to forecast how many generations of booted ancestry would suffice to eliminate it from the organization of the normal man.

Nevertheless, although it is difficult to demonstrate, in the present imperfect state of knowledge, the method whereby race-characters have originated, I think that the most of our anthropologists at least covertly adopt the philosophy of the ancient proverb, "The fathers have eaten sour grapes and the children's teeth are set on edge."

But there are other branches of anthropology of far greater interest than these simple problems upon which we have tarried so long. The study of man's intellectual nature is equally a part of our subject, and the outcomes of that nature are to be traced in the tripartite record of human progress which we call the history of culture. It is ours to trace the progress of man's inventions and their fruits in language and the arts, the direct products of the human mind. It is also ours to follow the history of man's discovery of those secrets of Nature to the unfolding of which we give the name of science. The task is also ours to inquire into that largest and most important of all sections of the history of culture which deals with the relation of human life to the unseen world, and to disentangle out of the complex network of religion, mythology, and ritual those elements which are real truths, either discovered by the exercise of man's reason, or learned by him in ways whereof science takes no account, from those adventitious and invented products of human fear and fancy which obscure the view of the central realities. In this country it matters less that our time forbids us to wander in these fascinating fields wherein the anthropologist loves to linger, as the munificent benefaction of Lord Gifford has insured that there shall be an annual fourfold presentation of the subject before the students of our Scottish universities. There is no fear that interest in these questions will flag for want of diversity in the method of treatment, or of varieties in the standpoints of the successive Gifford lecturers.

From the ground of our present knowledge we can but faintly forecast the future of anthropology, when its range is extended by further research, and when it is purged of fancies, false analogies, and imperfect observations. It may be that there is in store for us a clearer view of the past history of man, of the place and time of his first appearance, of his primitive character, and of his progress. But has this knowledge, interesting as it may be for its own sake, any bearing on the future of mankind? Hitherto growth in knowledge has not been accompanied with a commensurate increase in the sum of human happiness, but this is probably due to the imperfection which characterizes even our most advanced attainments. For example, while the medical and sanitary sciences, by their progress, are diminishing the dangers which beset humanity, they have also been the means of preserving and permitting the perpetuation of the weaklings of the race, which, had natural selection exercised its unhindered sway, would have been crushed out of existence in the struggle for life.

It is, however, of the essence of true scientific knowledge, when perfected, that it enables us to predict, and if we ever rise to the possession of a true appreciation of the influences which have affected mankind in the past, we should endeavor to learn how to direct these influences in the future that they shall work for the progress of the race. With such a knowledge we shall be able to advance in that practical branch of anthropology, the science of education; and so to guide and foster the physical, intellectual, and moral growth of the individual that he will be enabled to exercise all his powers in the best possible directions. And, lastly, we shall make progress in that kindred department, sociology, the study of which does for the community what the science of education does for the individual. Is it a dream that the future has in store for us such an anthropological Utopia ?—*Reprinted from Nature.*

SOME VEGETABLE MALFORMATIONS.

By Prof. BYRON D. HALSTED.

BY malformations are here understood those structures that are so unusual as to attract attention and so curious as to suggest that they are individual freaks to be explained by some peculiarity of surroundings or not at all. They may occur more frequently with some species of plants than with others, but are usually outside of the reign of the rules of inheritance, and therefore not governed by the ordinary laws of vegetative growth.

It is the purpose here first to treat of some of the more common and striking of these monstrosities, and then, if possible, to indicate how these extravagant forms may serve as keys to unlock some otherwise hidden secrets in vegetable morphology.

It is difficult to make any satisfactory classification of these monstrosities, and therefore instances will be given somewhat in the following order—namely, those of stems, of leaves, of flowers, and finally of fruits. One of the most frequent abnormities of the stem is that where, instead of the nearly cylindrical form, it becomes broad and ribbon-shaped. This type of malformation is confined to the less woody stems, as those of the asparagus. Fig. 1 shows such an instance, where the stem broadened out to nearly four inches in some places, while its thickness is less than half an inch. Numerous small side branches arise from the broad surface of this peculiar shoot, while the end is made up of a large number of small buds fused together. As they grow, the individual stems lose their identity in the common belt of blended shoots. The photograph is made from a specimen brought last spring to the writer's laboratory, where the upper foot or more is still to be seen preserved in a large museum jar.

Fig. 1.—Asparagus Fasciation.

The sweet-potato vine perhaps most frequently illustrates this broadening of the stem, but upon a less grand scale than that shown in the asparagus. Only last week a student brought me a plant in which all the several vines were like ribbons, an inch or more in width and several feet in length. It is only a singular instance of a failure of the young formative branches to separate as they are developed from the closely situated buds at the tip; but that this failure should be constant in all the branches of a plant is more difficult to explain.

The reader will call to mind several other kinds of plants that illustrate this same abnormity, to which botanists have given the name of *fasciation*, from the resemblance of the stem to a bandage. Larkspur and dahlia stems sometimes show the same peculiarity, and, should we here include flower-stalks, the dandelion would afford abundant examples, for the long, hollow scapes are frequently doubled or flattened to a ribbon that sometimes has not strength enough to support the abnormal head of flowers. The garden "cockscomb" (*Celosia*) owes its attractiveness largely to the unusual development of the stem at its upper end, together with the high color and the fantastic shapes assumed. This is one of the few exceptions to the rule that a fasciation of the stem is not constant.

Last summer, while looking through the nursery rows of a propagator of hardy perennials, my attention was attracted to the stems of the large-flowered bell-flower (*Campanula grandiflora*). Instead of the cylindrical stem and the loose spray of flowers, these two had developed as shown in the asparagus, and from the broad, flat stalk the flowers were closely arranged. At the enlarged end there were several buds and blossoms more or less blended. In one instance three separate flowers were so closely grown together as to appear as a single monstrous blossom.

Passing now to leaves, the reader will perhaps first of all think of the so-called "four-leaved" clover, in which, instead of the ordinary three leaflets, there is an additional one, or possibly two or more, the abnormity sometimes running as high as seven leaflets. Some years ago, while in Iowa, the writer found a clover plant with fourteen leaves having four leaflets and seventeen with five leaflets, and these outnumbered the ordinary ones. A "six-leaved" leaf found upon another plant had a lobe growing from one side of one leaflet resembling a mouse's ear. There are clover leaves in which the fourth leaflet is shaped like a funnel. The same shape is rarely seen in geranium leaves, and cabbage and lettuce leaves sometimes show strange outgrowths from the middle of the under side. Twin leaves at the most unexpected places are, to say the least, surprising. One such in my possession is of the lilac, which ordinarily has foliage of a well-defined form.

Fig. 2.—Proliferous Roses.

It is when we come to the flower that the greatest absurdities are to be found. Plants may have their stem fasciated and their leaves with strange lobes and incisions, but in the blossom they sometimes go quite "crazy." Gardeners occasionally send or even bring roses that have taken on such peculiar developments that one can scarcely refrain from a smile when the structure is examined. Fig. 2 shows a sample that came to me accompanied by some most difficult questions. Instead of the blossom terminating the branch, as is usually the case, there is a continuation of the cane beyond the flower, where it forms leaves and new buds. This *prolification*, as it is termed, is found at rare intervals and in a less conspicuous manner in perhaps

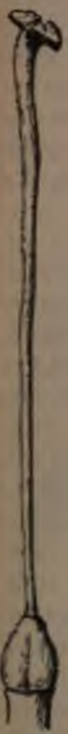


FIG. 3.

FIG. 4.

FIG. 5.

FIG. 6.—ABNORMAL PEPPERS.

FIG. 7.—PEAR WITH BRANCH.

a hundred different genera of plants. The plantains show this prolific manner of producing flowers in a marked degree, as also do the garden pinks.

In the doubling of flowers—that is, the change of stamens or pistils or both into petals—there are many strange combinations produced. All gradations between the perfect stamen with its pollen-bearing tip and the normal petal can be found. In such large flowers as the pæonia the malformations seem like a fruitless struggle between two contending forces, one to keep the flower single and sexual and the other to reduce all parts to a barren neutrality. In the lilies a similar confusion arises in the attempt of the blossoms to hold their essential organs while the surrounding conditions are such as to turn them into the more showy petals. All this multitude of instances, while of exceed ing interest to the student of floral structures, is perhaps more monotonous than amusing from the point of view of this paper, which deals more particularly with the unexplainable and eccentric than with strange shapes that are the natural result of an underlying law. Thus the garden petunia "doubles" easily, and in so doing loses its stamens, or some of them, and much of its former beauty. In a study of this process some three years ago, in which hundreds of specimens were examined, a peculiarity of still greater interest than the simple changing of stamens into petals was brought to light. The unusual size of the petals in some of the doubled flowers led to a dissection of them, when it was found that the contents consisted of stamens partly changed into petals and often highly colored, while in the center of all was a small pistil about one third the normal size. Not infrequently the ovarian stamens had their anthers tipped with a small stigmatic surface, thus indicating the close association of the sexual elements in the floral structures. Fig. 3 shows a normal pistil, the one at Fig. 4 is from a doubled blossom, and Fig. 5 shows the secondary pistil at the center.

Fig. 8.

Last year, while examining some peppers for a fungous disease, a peculiar formation was met with that comes in the same category with the petunia above mentioned. In making a longitudinal section of the fruit, the seed-bearing column was found crowned by a small pepper which in itself was a fruit in miniature. This freak is shown in Fig. 6.

It is an easy step from flower to fruit, for the latter is a part of and a natural result of the former. The prolification seen in the rose and in many other flowers has its counterpart in fruits of various kinds. Thus, strawberries have been known to bear a branch at the free end, and pears sometimes exhibit the same freak. Fig. 7 shows such a fruit with a branch and a number of leaves extending beyond the blossom end.

Instead of a leaf-bearing shoot, the axis is extended by the production of another fruit, or branching may take place in an irregular way, and a structure as monstrous as that shown in Fig. 8 results.

The apple as well as other fruit is not infrequently twinned by the union of two forming buds, as shown in Fig. 9. In others there is less frequently a second row of seed cavities, thus making a "two-storied" fruit, so to speak, as seen in Fig. 10.

Passing below ground, there are more abnormities to be found than most persons are aware of. The peculiar conditions that attend the subterranean habit favor monstrous growths. Not long ago a cluster of sweet potatoes was brought to me. Some were all red upon the surface, others were all yellow, and some were one half red and the other side yellow. The Irish potato is fertile in its freaks. Seemingly not content with the underground situation, potatoes sometimes appear upon the branches among the leaves. Occasionally a potato when planted whole will develop other new and small potatoes beneath the skin and

FIG. 9.—TWIN APPLE.

FIG. 10.—TWO-STORIED APPLE.

out of sight, which only calls to mind how a hollow turnip may have its cavity filled with an after-growth of foliage, only to be discovered when the root is cut in two.

Sometimes the abnormal growths bear a strong resemblance to some other object very far from the one really shown. Thus Fig. 11 shows what might well pass for the human hand, but it is nothing more or less than an ear of corn with the grain removed. Instead of ending in the usual way, it has become branched, thus giving rise to the "fingers," while the lower portion of the cob makes a fair-shaped "wrist." The engraving is made from a photograph recently sent from Missouri.

It would be impossible to mention the instances even of abnormal forms in seeds, or to go further and show how there may be monstrous forms that can only be seen through the compound microscope.

FIG. 11.—HAND-COB.

The molds, mildews, rusts, smuts, and various blights that feed upon higher plants have their freaks that are sometimes puzzling to those who study these minute structures.

A large museum might be filled with the eccentricities of the vegetable world. Some of them would only teach the lesson of a lack of equilibrium among the laws which determine definite lines of growth. Others would serve to open the door to some hidden fact of vegetable morphology. Thus, the interchange of stamens and pistils in some abnormal blossom teaches the lesson of the common origin of the two essential organs, while the gradation of either or both to floral envelopes indicates that pistils are only petals of a special form for a special purpose. In short, the malformations as we speak of them are only forms in less than their usual disguise. The leaf is the unit of structure in the flower, and the flower is a metamorphosed branch, which may terminate in a seed-vessel, as the pear, or in rare instances in a leafy branch beyond the fruit, thereby corroborating the belief that the fruit is a part of a stem.

Some one has said that when under the influence of an intoxicant the victim throws off his disguise and lets his inner self appear; so likewise the plant, when it for some reason not easily seen departs from the normal, lets the thoughtful student of plant nature get glimpses of truth not otherwise vouchsafed to him. Teratology is not chaos, neither are malformations meaningless. The unit of origin of parts is no better demonstrated than through some of the "inebriated" conditions as found from time to time in the kingdom of plants.

MARRIAGE AND KINSHIP AMONG THE ANCIENT ISRAELITES.

By Colonel A. B. ELLIS.

IN the article on Polyandry which appeared in The Popular Science Monthly for October, 1891, we had occasion to refer to the custom of raising up seed to a deceased elder brother as indicating that the Israelites had formerly practiced that form of polyandry in which the associated husbands are brothers; and in the present article we propose to pursue the investigation there hinted at, and to inquire to what extent the Israelites conformed to what appear to have been the normal phases of evolution of marriage and kinship in early times. To clear the ground, it will be convenient to commence by briefly stating what those phases were:

1. There was a primitive condition of which we can ascertain with certainty little or nothing; but, from the analogy of the lower animals, we infer that unions were not for life, and that couples paired for as long as it suited them, or until the child was weaned.

2. This condition was upset by the practice of female infanticide, which caused men to become much more numerous than women.

3. The inevitable result of this disproportion was either that the men of a community held their women in common, or that several men attached themselves to each woman, forming unions of the type of the ruder polyandry.

4. At the same time men strove to add to the number of their women by seizing and carrying off the women of other communities. Marriage by capture commenced.

5. As a result of a community in women, or of polyandry, and also as a result of marriage by capture, the paternity of children would always be uncertain. Hence, fathers being unknown, there could be no kinship in the male line. Kinship and descent would be traced solely through mothers, as we find is the case among nearly all the lower races at the present day.

We need go no further than this, though many other changes ensue; and we will now see what traces may be found in the books of the Old Testament, to indicate that the Israelites passed through these several phases.

First, as to marriage by capture. We read in Genesis, xxxi, 26, that when Jacob had secretly made off with his wives and flocks, Laban upon overtaking him asked, "What hast thou done, that thou hast stolen away unawares to me, and carried away my daughters as captives taken with the sword?" From which it is evident that the practice of carrying off women by force was not unknown. In Numbers, xxxi, we read that the Israelites, having defeated Midian, saved thirty-two thousand virgins as booty. They had at first spared all the women, as spoil, which shows that it was quite usual to do so; but on this occasion Moses induced them to murder all those who were not virgins. In Deuteronomy, xx, 14, women are classed as spoil; and in Deuteronomy, xxi, 11, 14, are the regulations to be observed in taking to wife a woman captured in war. In the song of praise attributed to Deborah and Barak, when exulting over the defeat and death of Sisera, we find (Judges, v, 30): "Have they not sped? have they not divided the prey: to every man a damsel or two?" These are all cases of capture *de facto*, and they show conclusively that the Israelites captured women and took them to wife. That it was also a common practice among the neighboring nations we infer from I Samuel, xxx, 5, where David's two wives are carried off by a raiding party of Amalekites.

But, besides hostile captives, the Israelites had also marriage with the form of capture—an important point, for it shows that marriage by capture had formerly been the normal mode of obtaining a wife, and that the custom of ages had caused a semblance of violence to be considered necessary, even in marriages made by arrangement. The Old Testament phrase is to "take" a wife, as for example Genesis, xxiv, 67: "And Isaac brought her into his mother Sarah's tent, and took Rebekah, and she became his wife"; Genesis, xxxviii, 2: "And Judah saw there a daughter of a certain Canaanite, whose name was Shuah; and he took her"; Numbers, xii, 1: "For he (Moses) had taken an Ethiopian woman"; Judges, xiv, 7, 8: "And he went down and talked with the woman, and she pleased Samson well, and after a time he returned to take her"; Tobit, vii, 12, 13: "Then take her from henceforth according to the manner"; and "Behold, take her after the law of Moses." This "taking" was a form of capture. Dr. Smith, in his Dictionary of the Bible, article "Marriage," remarks that "taking a wife" seems to be literally meant, and that the "taking" was the chief ceremony in the constitution of a marriage. In the case of Samson we read: "They brought thirty companions to be with him"—that is to say, they brought thirty men to represent the party of the bridegroom in the form of capture, the bringing being necessary in Samson's case because he had none of his own people with him. One of these thirty acted as leader, or best man, and Samson's wife was afterward given to him (verse 20)—a proceeding quite in accordance with existing practices among some people who marry with the form of capture.

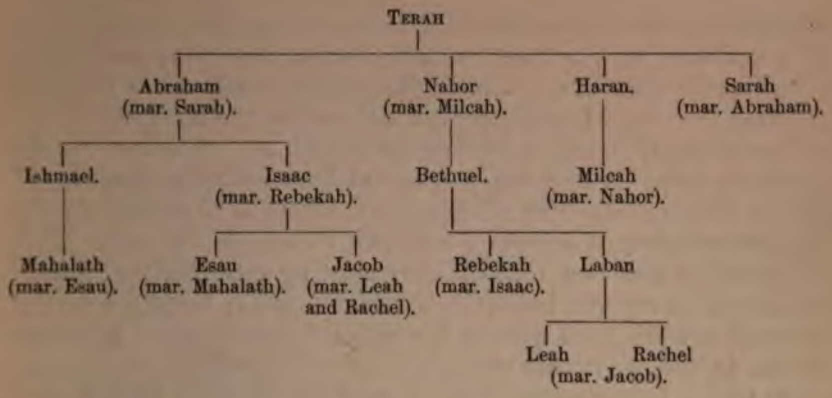
We find a clear case of marriage with the form of capture in connection with the civil war with the tribe of Benjamin. The remnant of Benjamin, six hundred in number, who survived the war, were all men. There were no women left, and as the other tribes had sworn that they would not give their daughters in marriage to the men of Benjamin, there was a prospect of that tribe becoming extinct. In this dilemma the tribes attacked Jabesh-gilead and captured four hundred women, who were handed over to Benjamin; but, as this left two hundred men still unprovided for, they contrived the following plan: A yearly festival was held at Shiloh, at which it was customary for the girls to come out and dance. So they instructed the men of Benjamin to lie hid in the vineyards, and when the girls appeared each man was to seize one and carry her off. So it was done, and in this way the tribes kept the letter of their oath and evaded the spirit. They did not give their daughters to Benjamin, but they connived at their being carried off with the form of capture (Judges, xxi).

The Israelites thus had both marriage by capture *de facto* and marriage with the form of capture, and in the former article we showed that they had once been polyandrous. Now we know that marriage by capture is in its origin due to a scarcity of women, though it is persevered in through custom after that scarcity has ceased to exist. Likewise, polyandry, the marriage of one woman to two or more men, only exists where women are less numerous than men. Consequently, since the Israelites had both these practices, there must have been a period in their history when women were fewer in number than men, and experience and observation all over the world have shown that such a disparity can only be brought about by female infanticide. We conclude, therefore, that the Israelites passed through our second, third, and fourth phases, and will now proceed to see if they also passed through the fifth.

From the fact of their having been polyandrous and having married by capture, we should infer that they must, at the period when these were the normal types of marriage, have had a system of kinship through females. If there were two or more husbands to one wife, the father of a given child could not be determined;

and if women were carried off by force from neighboring tribes and then married, there could be no certainty that the child borne by a captive woman was the offspring of one of the men in whose keeping she happened to be at the time of its birth. Fathers being thus uncertain, if not absolutely unknown, the paternal tie could not be taken into account. Blood-relationship would be traced through the mother, and this system would, through custom, prevail long after the conditions which gave rise to it had come to an end. Independently, then, of any evidence that may be forthcoming, we should conclude that the Israelites must at one time have had a system of kinship through mothers.

We now come to another point. There is no known case of a nation having marriage by capture and marriage with the form of capture without being exogamous; and since the Israelites had both these customs we infer that, unless they were altogether exceptional, they were also exogamous—that is, they prohibited marriage between those who were recognized as being related by blood. When we examine in detail all the marriages mentioned in which it is possible to trace the pedigrees both of husband and wife, we find that there is not one that would violate the principle of exogamy if descent were in the female line, while there are a great number which could not possibly occur if the Israelites were exogamous and traced descent in the male line. For instance, Nahor, Abraham's brother, married the daughter of his brother Haran (Genesis, xi, 29)—his niece, if descent were in the male line, but no relation if in the female. Abraham married his father's daughter (Genesis, xx, 12)—his half-sister if kinship was traced through males, but if through females, no relation. Marriages of this kind, it may be mentioned, are peculiar to the system of female descents and could not occur under any other system of kinship, if marriages between blood-relations were forbidden. We see in this case, too, what a point Abraham made of explaining that his wife was not the daughter of his mother, but only of his father. Isaac married Rebekah, granddaughter of his paternal uncle Nahor, who had himself married his brother's daughter (Genesis, xxiv, 15). Isaac and Rebekah would not be blood-relations if descent were in the female line. Esau married the daughter of Ishmael, his uncle on the father's side (Genesis, xxviii, 9; xxxvi, 3). Jacob married the daughters of his maternal uncle, Laban (Genesis, xxix, 10, 16). With descent in the female line Laban would be Jacob's blood-relation, but his daughters would not, since they would be of the kin of their mother. Laban and Jacob were both great-grandsons of Terah, and the following "tree" will show to what an extent, if kinship was reckoned in the male line, the descendants of Terah knowingly intermarried in the same blood.



That the Israelites married relations on the father's side is thus indisputable, but if they were exogamous, as we must believe them to have been, since they had marriage by capture and marriage with the form of capture, marriages between blood-relations were forbidden; hence we must conclude that relations on the father's side were not accounted blood-relations, and that kinship and descent were traced through mothers exclusively.

All the above cases, and that of Amram, father of Moses, who married his father's sister (Exodus, vi, 20), are anterior to the Levitical law, which forbade marriage with a sister-german, or by the same father, and also with a father's sister; and so, had it been then in force, would have prevented the marriage of Abraham with Sarah, and that of Amram with Jochebed. The Levitical law was therefore an innovation, since it prohibited marriages which had formerly been allowed. It also prohibited marriage with a brother's wife, which is generally taken as meant to include his widow; but as in Deuteronomy, xxv, 5, a man is enjoined to marry his brother's widow, if the brother had died childless, it seems probable that the prohibition in Leviticus, xviii, 16, was directed against that form of polyandry in which the associated husbands are brothers, which, as we have before shown, the Israelites certainly at one time had.

As we have said, the Levitical law changed the existing custom; yet, strangely enough, long after the supposed date of its promulgation, we find Tamar, in the affair with her half-brother Amnon, saying (I Samuel, xiii, 13): "Speak to the king, for he will not withhold me from thee," just as if marriage with a sister-german was quite customary and had not been forbidden. From this we are driven to conclude that the Levitical law is misplaced chronologically—a conclusion which M. Renan seems also to have arrived at.* It seems probable that the Levitical code was really

* History of the People of Israel, vol. i, p. 166; vol. ii, pp. 169, 298.

adopted at a much later period than is commonly supposed, probably not very long before the Babylonian captivity, and was a complete revolution, substituting kinship through males for that through females. It perhaps was included in the book of the law so mysteriously found in the reign of Josiah, and of the provisions of which both he and the people had been entirely ignorant (II Kings, xxii, xxiii). The marriage law seems to have been drawn up for a people just adopting a system of female descents. This is shown by the fact that the only aunt by marriage that a man might not marry was his father's brother's wife; he might marry his mother's brother's wife, or his wife's father's sister. It is also shown in the particular stress laid upon the prohibition of marriage with a father's daughter. This is forbidden in verse 9, and again, with more detail, in verse 11. Such a marriage would be perfectly lawful under a system of female descents, and that of Amnon with Tamar would have been one of this class. From Ezekiel, xxii, 11, it would appear that such marriages continued to be common among the Israelites up to the time of the overthrow of Jerusalem. If the Levitical law is not misplaced, how comes it that, in spite of the particular manner in which such marriages are forbidden, David would not have withheld Tamar from Amnon?

There are, besides, other reasons for supposing that if the books of the Old Testament were arranged in order of publication, Leviticus ought to be placed toward the end of Kings. By the Levitical law only priests and Levites were to offer sacrifices and "inquire of the Lord," yet Samuel, who was neither, did both, as did Saul, and David, and many others, among them Joshua, a Beth-shemite (see I Samuel, vi, 14, 15; xiii, 9; xiv, 37; xxiii, 2, 4; II Samuel, ii, 1; v, 19, 23; vi, 18). The Levitical law also condemned those who sacrificed in "high places," or away from the sanctuary, where the ark was present; yet Samuel (I Samuel, ix, 13) went up to a "high place" to sanctify the sacrifice, and afterward disposed of that portion which, according to Leviticus, vii, 31–34, belonged to the priest; and David is made to say (I Chronicles, xiii, 13), "Let us bring again the ark of our God to us, for we inquired not at it in the days of Saul." All these acts and omissions were violations of stringent laws, yet no one seems to have been aware that they were doing wrong, and the only inference to be drawn is that the laws did not then exist. This gains further support from the fact that we read in I Kings, viii, 9, that when Solomon brought the ark to the temple there was nothing in it but the two tables of stone, though the ark was the place in which the book of the law was to be kept (Deuteronomy, xxxi, 26), and that we hear nothing of any book of the law till Hilkiah, the high priest, alleged that he found one during the reign of Josiah.

Moreover, when we look into the marriages mentioned in Joshua, Judges, Samuel, and Kings, we find that they exhibit the same peculiarity as do those mentioned in Genesis. They could all take place if the Israelites were exogamous, and had descent in the female line, while many could not possibly take place if they were exogamous, and had descent in the male line. It is needless to multiply examples, and the two following will be sufficient. (Joshua, xv, 17:) Othniel, son of Kenaz, the brother of Caleb, married Caleb's daughter. (II Chronicles, xi, 18:) Rehoboam, son of Solomon, (1) Mahalath, his first cousin on the father's side; (2) Abihail, his father's first cousin; and (3) Maachah, his first cousin on the father's side. There may be some doubt about the last wife. In II Chronicles, xi, 20, and I Kings, xv, 2, she is called the daughter of Absalom; but in II Chronicles, xiii, 2, she is called the daughter of Uriel of Gibeah.

It may be objected that the Israelites could not have been exogamous because they were endogamous; but the fact is that they were not endogamous till after the Babylonian captivity, and were not endogamous in the true sense even then. Endogamy is that law which allows marriage only between persons who are recognized as being of the same blood; and though, after the captivity, the Israelites made a law against marrying foreigners (Ezra, x; Nehemiah, x, xiii; I Esdras, ix), yet at the same time they observed the Levitical law forbidding marriage within certain degrees of consanguinity. They had thus an endogamy of nationality, coupled with exogamy within the nation.

But even this external endogamy, so to speak, did not exist before the captivity, for the evidence that the Israelites did marry foreigners is overwhelming. There was marriage with foreign women taken in war, and rules governing the procedure in such cases. Then of individual examples we have the following: Abraham took Hagar, an Egyptian, and Keturah, an Arab (Genesis, xvi, 3, and xxx, 1). Esau married a Hittite and a Hivite (Genesis, xxxvi, 2). Judah married Shuah, a Canaanitish woman (Genesis, xxxviii, 2). Joseph married Asenath, an Egyptian (Genesis, xli, 45); and Moses, Zipporah, an Ethiopian (Exodus, ii, 21, and Numbers, xii, 1). Simeon married a Canaanitish woman (Exodus, vi, 15).

The first limitation of marriage with foreigners is found in Deuteronomy, vii, 1–3, where the Israelites are forbidden to intermarry with seven nations—the Hittites, Girgashites, Amorites, Canaanites, Perizzites, Hivites, and Jebusites. But the Israelites did not obey this prohibition * (Judges, iii, 6, and I Kings, xi, 2), and

* We suppose here, for the sake of argument, that the prohibition existed at this time, though there are good reasons for believing that Deuteronomy was really written by Jeremiah.

marriages with the women of other nations naturally continued. Thus, Boaz married Ruth, a Moabitess; David, the daughter of the King of Geshur (II Samuel, iii, 4), and Solomon married a number of foreign women (I Kings, xi, 1). We equally find cases of Israelite women having married foreign men. In Leviticus, xxiv, 10, we read of a woman of Israel who had a son by an Egyptian. Abigail, David's sister, married an Ishmaelite (I Chronicles, ii, 17); and the daughter of Sheshan married an Egyptian (I Chronicles, ii, 34, 35). In Judges, xii, 8, 9, we read that Ibzan had thirty sons and thirty daughters. He sent the latter abroad, and took in thirty women from abroad for his sons. All these examples show conclusively that the Israelites married foreigners, and that therefore they were not endogamous.

When a nation adopts an endogamy of nationality, it may invariably be ascribed to one of two causes: either the nation is, or considers itself to be, superior to its neighbors, and, having become dominant in war, refuses to intermarry with those it considers inferior; or the surrounding nations consider themselves superior, and refuse to intermarry with a people whom they regard as inferior. In the one case the endogamy is voluntary, in the other it is involuntary. Now the first could not have been the case with the Israelites; they were not dominant in war, and if they considered themselves superior to their neighbors, they did not carry their exclusiveness so far as to decline to marry their women. But during the captivity it is exceedingly probable that, as a conquered people, they were despised by their conquerors, and compelled, to a great extent, to marry among themselves. In Tobit, iv, 12, 13, we find a father saying to his son, "Despise not in thy heart thy brethren, the sons and daughters of thy people, in not taking a wife of them"—a speech which seems to acknowledge that the Israelites were despised. The number of those who married foreign women, as given in Ezra, x, is exceedingly small out of a body of 42,360 males (Ezra, i, 2, 64); and it is most probable that a national endogamy was forced upon the Israelites during the captivity. Then, it seems that the priests took advantage of the opportunity, and endeavored to make it a national characteristic, alleging for this purpose that it was an old law, and that all the misfortunes of the nation were to be attributed to its violation in times past.

From this necessary digression we return now to the consideration of the evidence of female descents. Another indication of that system is the strong affection between brothers and sisters uterine, as compared with that between brothers and sisters german; for, if descent were in the male line, the blood-tie derived from the common father ought to have had the greater weight.

It is Simeon and Levi, uterine brothers of Dinah, who revenge the affront offered her, and when reproved by Jacob they say, "Should he deal with our sister as with a harlot?" The other sons of Jacob took no part in the act of treachery (Genesis, xxix, 33, 34; xxx, 21; xxxiv, 25, 31). Notice, too, the love which Joseph has for Benjamin, "his mother's son" (Genesis, xliii, 29, 30), and how cold by comparison is his regard for his brothers-german. The rape of Tamar is revenged by her uterine brother Absalom, who causes Amnon to be murdered (II Samuel, xiii, 28). It is interesting to note the language used in this case (II Samuel, xiii, 1): "And it came to pass after this that Absalom, the son of David, had a fair sister, whose name was Tamar; and Amnon, the son of David, loved her"; and (verse 4), "And Amnon said unto him, I love Tamar, my brother Absalom's sister." The relationship between Tamar and Absalom is evidently regarded as something very different from that between her and Amnon. Indeed, in our view, Tamar and Amnon were not regarded as related at all. In verses 2, 5, 6, etc., Tamar is spoken of as Amnon's sister; but then it must be remembered that the term sister was used in a very comprehensive sense, and included female cousin, and in fact women generally of about the same age as the speaker. In Tobit, v, 20; vii, 16; and xviii, 14, are examples of a husband addressing his wife as sister.

Another indication is found in the numerous cases in which men are described as the sons of their mothers, as if the maternal descent were of more moment than the paternal. Bethuel is described as "son of Melcah, the wife of Nahor, Abraham's brother" (Genesis, xxiv, 15). Joab is generally styled "the son of Zeruiah" —that is, after his mother (II Samuel, xxiii, 18; I Kings, i, 7; I Chronicles, xxvi, 28). Abishai, Joab's brother, is also called the son of Zeruiah (II Samuel, xiv, 21; xviii, 2). David calls them both "ye sons of Zeruiah" (II Samuel, xix, 22).

Much more important, however, than these, are the cases in which the son is clearly regarded as being of the kin and nation of the mother rather than of the father. Abimelech was son of Gideon by a Shechemite woman, and, if descent were in the male line, he could not have been considered a Shechemite; but the story, as narrated in Judges, ix, shows clearly that he was considered one. His mother's brethren say, "He is our brother," and support his cause. Amasa was the son of Abigail, David's sister, by Jether the Ishmaelite (I Chronicles, ii, 17). If descent were in the male line, Amasa would have been reckoned an Ishmaelite, and not one of the Beni-Israel at all. But what are the facts? David sends to him, saying, "Art thou not of my bone, and my flesh?" and makes him captain over the host of Judah, his mother's tribe. Again, Sheshan gave his daughter in marriage to his servant Jarha, an Egyptian, and the offspring of this union were regarded as Israelites (I Chronicles, ii, 34, 35)—that is to say, they traced descent and nationality through the mother. Here, then, we have three cases, one in which the male parent is an Israelite, and two in which the female parent is. In the former case the son is not considered an Israelite, and in the two latter he is—that is, in each case he is regarded as belonging to the nation of his mother. In this connection it is curious to note that in the list of the kings of Edom given in Genesis, xxxvi, 31–39, no king is the son of his predecessor; and in verse 39 we have a clear case of descent being traced through females: "His wife's name was Mehetabel, the daughter of Matred, the daughter of Mezahab."

All these examples are found prior to the Babylonian captivity, after which the custom was changed. In Ezra, ii, 61, and Nehemiah, vii, 63, we read that the children of a daughter of Barzillai, the Gileadite, were called after her family name, and were reckoned as not of Israel, because "they could not show their father's house, and their seed, whether they were of Israel" (Ezra, ii, 59).* Before the captivity Amasa, the son of an Israelitish woman by an Ishmaelite, and Attai, the son of an Israelitish woman by an Egyptian (I Chronicles, ii, 35), were reckoned as of Israel, the maternal descent was sufficient; but after the captivity it was considered necessary to show "the father's house." This seems to indicate that the change from a system of descents through females to one through males, which had no doubt been gradually taking place for some generations, was fully accomplished by the time that the two tribes returned from Babylon.

A point not to be overlooked is the inferior position held by women in post-captivity times. When kinship is traced through females, the position of women is necessarily high, for they are the heads of families; but when they lose the latter position through a change in the system of descents, they are commonly reduced to a condition more or less servile. Now we have some cases of women holding high positions before the captivity, notably Miriam, Deborah, and Huldah. The first is mentioned in Micah, vi, 4, as the equal of Moses and Aaron: "For I brought thee out of the land of Egypt, . . . and I sent before thee Moses, Aaron, and Miriam." In Exodus, xv, 20, she is styled a prophetess, and in Numbers, xii, 2, she and Aaron rebel against the leadership of Moses. She was evidently a person of authority, and so was Deborah the prophetess, for she judged Israel (Judges, iv, 4).

* In I Esdras, v, 38, this family is called "the sons of Addus, who married Augia, one of the daughters of Berzelus, and was named after his name."

Huldah, a prophetess, is mentioned in II Kings, xxii, 14, and II Chronicles, xxxiv, 12, as being consulted by the high priest and others. After the captivity we do not find women holding any such positions.

We may now claim to have shown that the Israelites passed through our fifth phase, and had a system of descent through mothers before they had one through fathers. We have shown that they had marriage by capture, and marriage in the form of capture, from which we must believe them to have been exogamous. They were certainly not endogamous, for they married foreigners. If they were exogamous, they could not have married in the recognized blood-stock, and we can not find that they married into the maternal blood, though there is abundant evidence that they married into the paternal blood. We find a much stronger tie between brothers and sisters uterine than between brothers and sisters german; some cases in which men are styled the sons of their mothers, and others in which kinship and nationality are distinctly traced through the mother exclusively. It is only after the captivity that it is necessary to show the paternal descent. The system of kinship through females being the simplest, is naturally the first that is established; for kinship depends upon a perception of the unity of blood, and the most obvious and unmistakable case is that between mother and child. Once established, it lingers on, through custom, even after the tie between father and child has been recognized; and in the case of the Israelites it appears to have lasted till about the days of David, at which time they appear to have been in a state of transition,* as the Polynesians are now; and, finally, after contact with the Babylonians and Greeks, they effected a change to descent in the male line.

The Hebrew books are stated to have been restored by Esdras, when they had been destroyed by the Chaldeans (II Esdras, xiv, 21, 47), and, according to Eusebius, it is solely to his recollection that we are indebted for the books of the Old Testament. Now, at that time it was necessary for a man who claimed to be of Israel to show his father's house; Esdras was one of those who made this a *sine qua non*. The change to this system had, as we

* The normal course seems to be that the female system of descents is changed for one under which relationships are traced on both sides of the house, and this in turn is replaced by one through males. In the reign of David, relationship was certainly traced on both sides, for we read in II Samuel, xxi, that when it was considered necessary to sacrifice a number of members of Saul's family in order to stay a famine, the persons selected were two sons of Saul and five grandsons. The latter were the sons of Merab, daughter of Saul, by her husband Adriel the Meholathite. The sacrifice of the sons of Saul shows that descent was traced from father to son, and that of Merab's children, that it was also traced from mother to son.

have said, been probably gradually taking place for some generations, and what is certain is that the system of female descents had been left so far behind, that the compiler or compilers of the books had not the least suspicion that it had ever existed. That they had no knowledge of it is shown by the trouble they took to connect themselves in the male line with the traditional patriarchs by long lists of names of men. They filled up the gaps between persons mentioned in the traditions by lists of names of fathers and sons, as in Genesis, xi, between Shem and Terah; and that the indications of female descents we have noted were preserved, was doubtless due to the superstitious regard they had for the actual words of the oral traditions, and to the fact that the compilers had not the slightest conception of the inferences to be drawn from them. It is inconceivable that, after having invented pedigrees to connect themselves in the male line with the traditional patriarchs, they should knowingly have left evidence that affords a *prima facie* proof that descent was formerly in the female line, and the pedigrees consequently fictitious.

These pedigrees were no doubt introduced in support of the endogamy of nationality, which the priests enforced after the captivity. They were designed to prove that the Israelites were a chosen people, descended from Abraham, Isaac, and Jacob, and so all of one blood; but they were drawn up with so little care, that it is easy to prove from the books themselves that they are inventions of a later date. For example, we read in Exodus, vi, 3, that the national god, Jahveh, or Jah, only revealed his name shortly before the exodus, and expressly stated that his name was not known to the patriarchs; yet in Genesis, xlvi, among a number of names compounded of the names of "heathen" gods, we find some compounded of Jah. Reuben (verse 9) has a son named Carmi (Jah makes fruitful). Gad (verse 16), himself named after the Phœnician goddess of good fortune, has a son Areli (Jah is powerful). Asher (verse 17), named after the Assyrian god, has a son Beriah (Jah is vigorous, or Jah is my maker). Now, either these names must have been put into the text subsequent to the revelation of the name to Moses, or else the story of that revelation is apocryphal.

In regard to these pedigrees, the ancient Greeks furnish an exactly parallel example. They, like the Israelites, had arrived at a system of kinship through males, and had connected themselves by long lists of names of fathers with the traditional heroes and gods. They had so completely forgotten that they had ever had any other system of descents, that Herodotus, speaking of the Lycians, said that they differed from every other nation in the world in tracing descent through mothers. Yet the traditions of the Greeks, like those of the Israelites, contained indications of the earlier system, which those who reduced the traditions to writing suffered to remain in ignorance of their real meaning; and, as Mr. McLennan, who collected those indications, has shown,* there can be no reasonable doubt but that the Greeks had a system of descents through mothers before they had one through fathers.

THE EARLY EXTIRPATION OF TUMORS.†

(*ABSTRACT.*)

By JOHN W. S. GOULEY, M. D.,
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IN a paper, bearing the title of A Plea for the Early Extirpation of Tumors, Dr. Gouley makes a succinct argument, based upon long experience, in favor of removing morbid growths from the human economy in a very early stage of their development. What follows is therefrom abstracted, with the object of presenting to the general reader the main points discussed, and of calling his attention to the importance of the subject, in consideration of the fact that more than two thousand persons die annually from the effects of cancerous tumors in the State of New York, and in about the same proportion in other States and countries. How this percentage of mortality may be lessened is suggested in the course of the discussion.

The paper begins with the question, At what period of the development of a tumor is its extirpation justifiable? The answers to this question, for a long time, have been divided between early and late surgical intervention and non-intervention. Some surgeons, at home and abroad, have favored and do now favor early extirpation even in the case of benign tumors, but many advise non-interference so long as tumors are small, painless, stationary, or of slow growth.

If it were generally known among intelligent people that great numbers of innocent tumors sooner or later become malignant, and that malignant tumors often simulate benign tumors and remain quiescent for a great while, the sufferers would unhesitatingly consent to the removal of these morbid growths in their inception, long before the possible advent of serious mischiefs, or when the cure might be effected by minor operations which would leave the smallest scars, especially in such parts as the face, neck, arms, or hands.

In the discussion of the initial question the following points

* Studies in Ancient History.

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are considered: 1, The relative frequency of malignant and benign tumors; 2, the liability of the transformation of benign into malignant tumors; 3, the impropriety of delaying operative interference; and 4, the advantages of early operations.

1. The testimony of careful observors tends to show that the malignant tumors exceed the benign in frequency, and also that many malignant tumors remain stationary and seemingly harmless for one, two, six, eight years, and even for longer periods, then increase rapidly, and soon contaminate the system. (Then follow technical and statistical considerations in substantiation of these propositions.) Twenty-four per cent of all cancerous tumors affect the breast. Benign tumors of the breast are most frequent before the age of forty, and cancerous tumors of the breast are most frequent after the age of forty. Cancerous tumors are very much more frequent in the female than in the male sex. The discrimination of malignant and benign tumors at the bedside is often so difficult that surgeons are justified in advising immediate extirpation and in relying upon the microscope to insure the diagnosis and establish the prognosis.

2. The liability to the transformation of benign into malignant tumors has long been recognized, but the histological demonstration of the phenomenon is modern. It has happened that some tumors have been excised during their transition from the benign to the malignant type, and that this metamorphic process has been verified by careful microscopical examination of different parts of the growths. But so far it has not been possible to determine the precise time of the beginning of the transformation. Warts, moles, and other benign growths upon the face or body have been observed to undergo cancerous metamorphosis many years after their appearance. Fibrous and fatty tumors are often transformed into malignant tumors. So long as a tumor retains a comparatively high degree of organization it remains benign; but when its constituent tissues are disturbed, there is apt to be an accession of tissues of a low grade of organization and the tumor becomes malignant; the lower the organization the greater the malignity.

3. In stating the reasons why he believes it improper and unwise to delay operative measures for the cure of tumors, the author discusses the methods of general and local treatment employed. He considers some of them delusive, and others directly harmful, particularly the escharotics, which he thinks should be condemned. The anciently promulgated precept, that so long as a tumor is causing no apparent mischief and shows no disposition to increase in size it should not be disturbed, is still regarded by many as conservative, and commonly followed to the letter in the management of tumors. In accordance with the light thrown on

late upon the natural history of tumors, it is proper to inquire if this precept can be regarded as truly conservative. The well-known fact that any solid benign growth is liable to become malignant should be sufficient to induce surgeons to condemn the arbitrary expectancy which is so generally counseled and which so surely leads to disaster. Even if a particular tumor increases without showing signs of malignity, there can be no advantage in waiting until it shall have attained a great size, as the larger the tumor the more formidable the operation for its removal. The advice that a morbid growth should not be removed because it is stationary and causes no inconvenience does not seem to be founded on sound principles. Because it does not produce present inconvenience gives no surety that it will not sooner or later cause the greatest distress, if only from its increase in size or its interference with a vital function; but the liability to malignant transformation is what is most to be dreaded. Therefore, as a general rule, it may be considered unwise to allow any accessible tumor to so increase in size as to be damaging to the individual, or, if it be stationary, to wait until it is metamorphosed before proposing an operation for its cure. The true spirit of conservatism is manifested by advising the removal of a morbid growth when it is benign, when it is stationary, when it is small, when the operation for its eradication is trifling in comparison with what it must be when the tumor has attained a great size, or when the neighboring lymph-glands are implicated. The modern improvements in inducing anæsthesia, simplifying surgical processes, and insuring asepticism of wounds render operations safe as compared to those of former times, so that no serious harm need now be apprehended from the extirpation of most tumors. Morbid excrescences of all kinds, being worse than useless to the human economy, should be treated like foreign invaders, and removed before they become too mischievous.

4. There can be no reasonable doubt of the advantage of excising a small tumor believed to be malignant, even if this be owing only to the ease with which the operation can be executed, or to the slight degree of violence inflicted upon the parts as contrasted with the magnitude of the procedure needed for the ablation of a growth which has attained great dimensions or which has infected the adjacent lymph-glands.

For a long time there has been a prevailing belief that extirpation of a quiescent malignant tumor only serves to stimulate the extension of the disease. But this belief does not appear to have been founded upon trustworthy clinical observations or pathological data. It is undoubtedly true that any incomplete cutting operation upon a malignant tumor, or its partial cauterization with silver nitrate or arsenic, only serves to stimulate its extension; but complete extirpation with the knife, including the adjacent connective tissue and lymphatics, leaves behind no disease to be extended. Recurrence of the disease in this case would take place after cicatrization of the wound, and would be by new cell proliferation and not by extension. External cancerous tumors have been excised, and in the course of a few weeks the patients have died of internal cancer; but in such cases, if the internal had not antedated the external disease, the metastatic process had surely begun before the operation, and would scarcely have occurred had the tumor been excised five or six months before.

Since it appears from analysis of the observations of surgeons of long and vast experience that a large proportion of benign tumors in time become malignant, and that most malignant tumors have a stage of benignity, there should be no hesitation in advising the extirpation of these tumors as soon as discovered, and this advice may be regarded as the very essence of conservatism and of prophylaxis. From a purely æsthetic point of view it is of no little consequence to minimize scars resulting from the excision of tumors of the face, neck, arms, or hands, particularly those occurring in the gentler sex, and this can be best accomplished by the timely removal of such morbid growths as are likely to increase to the extent of greatly disfiguring the patients. It should, however, be noted that almost any scar is better than an ugly tumor.

The nævi that appear upon the faces of infants, though benign, often grow so rapidly as to constitute serious disfigurement, and to require operations which leave extensive scars. If before these little vascular tumors cover a space of more than two or three millimetres they are promptly destroyed with the thermocautery, the ensuing scar is likely to be almost imperceptible. The operation is completed in a few seconds, and the pain is very slight.

The greatest mischief arises from temporization in the case of small epithelial growths upon the lip. Any tumor of the lip of doubtful character should unhesitatingly be removed. As a general rule, the subsequent dissection and microscopical examination of the tumor shows the operation to have been justifiable. Early excision is the surest means of obtaining a long period of immunity from recurrence. The period of immunity from recurrence after operations is very variable even in the same species of tumors. Thus, in cancer the average is stated by some observers to be three years and a half, and by others seven years; the extremes are three months and forty years. The writer has reported cases in which the periods of immunity varied from seven to forty years. As soon as a tumor recurs, when it is still small, painless, and apparently harmless, it should be extirpated. The moral effect of this timely operation is generally good, bodily comfort is thereby promoted, and life is prolonged. It is therefore wise to operate as often as the tumor recurs.

According to the observations of many experienced surgeons, the average duration of life is a little less than three years from the first appearance of the tumor in cases of breast cancers that have not been subjected to any treatment. Does this not indicate the wisdom of prompt action in the great majority of cases, since the shortest average duration of life after operations which were not performed during the stage of benignity of the tumors is three years and a half, and since it has been shown that early operations afford the best chance for many years of immunity from recurrence?

Very large tumors are now rarely seen in comparison with the great numbers recorded before the introduction of ether, nitrous oxide, and chloroform as anæsthetic agents. The dread of surgical operations was formerly so great that patients were ready for the use of any means proposed rather than the knife, although many of the modes of treatment employed were cruel in the extreme, far exceeding any torture that could have been inflicted with cutting instruments. Thanks to the several modern modes of inducing anæsthesia, the patients of to-day need have little fear of the knife, for they are assured that they will be rendered insensible to pain during and for a time after operation. The surgeon, conscious that he is inflicting no pain, is then able to give his whole attention to the work in hand, and performs the operation in accordance with the recent improvements in surgical procedures and with the best modes of insuring asepticism of the wound.

The categorical answer to the initial question is, that at the earliest period of the development of any accessible tumor its complete extirpation is not only justifiable, but should be regarded as an eminently conservative and equally humane act.

As described by Mr. C. Willard Hayes, of the Schwatka Exploring Expedition, the southern Alaskan coast mountains form a broad elevated belt with many scattered peaks, of which none perhaps have an altitude of more than eight or nine thousand feet, while there is no dominant chain. The southwestern front of the range rises abruptly from the waters of the inland passage, forming a rugged barrier to the interior. A few rivers have cut their channels through the range, and it is penetrated at varying distances by numerous deep fiords. From the head of Lynn Canal northwestward the range decreases in altitude and probably spreads out and merges in the broken plateau which occupies the eastern part of White River basin. This region is practically unknown, however, and the precise relation of the Coast Range to the St. Elias Range has not yet been determined.

THE EVOLUTION OF CIVILIZATION AND THE ARTS.

By M. GUSTAVE LE BON.

WE sought to show, in an address on the Influence of European Civilization on Colonies (1889), that civilized nations can not impose their civilization on the lower races, and to demonstrate the insufficiency of education, institutions, or creeds to change the social condition of inferior peoples. We maintained that all the elements of a civilization correspond with certain modes of feeling and thinking, or with a mental constitution representing the past of a whole race, the hereditary motives of conduct resulting from the experience and acts of a long series of ancestors. Only centuries, not conquerors, can essentially transform these. We held, further, that a people can rise in civilization only by a series of steps; and that, if we try by educating them to evade those steps, we only confuse their morals, and leave them at a lower level than the one they had themselves reached. And we assumed that the Arabs are the only modern people capable of civilizing inferior peoples, because they alone still have extremely simple institutions and creeds. I intend now to make the question general, and to show that the higher races have never been influenced by a foreign civilization more rapidly than the lower races; and that if they have sometimes adopted creeds, institutions, languages, and arts different from those of their ancestors, it was not till they had slowly and profoundly transformed them and brought them into relation with their mental constitution.

History appears to contradict this proposition on every page, and to show us peoples who have changed the elements of their civilization and adopted new religions, languages, and institutions; but a closer examination of these supposed changes shows us that, while the names of these things may have been changed with great ease, the realities concealed behind the names have continued to live, and have been transformed only with extreme slowness. The theory is likely to appear most paradoxical in the case of religious creeds; but, in fact, we find some of the most striking verifications of it in them. Everybody knows that all the great religions—Brahmanism, Buddhism, Christianity, and Islam—have provoked conversions of entire races, which have come over to them all at once. But a close study will convince us that in these cases it has been the name of the religion and not the religion itself that has been changed; and that the newly adopted creeds have suffered modifications that would bring them into conformity with the old creeds they replaced, and of which they were simply the continuation, and this sometimes to such an extent that they no longer have any visible relationship with the creeds of which they keep the name. Thus, the Buddhism of China is so different from the Buddhisms of other countries that it is hardly recognizable as the same religion; and the Buddhism of India is different from that of Nepaul, and that is far removed from the Buddhism of Ceylon.

Brahmanism, too, exhibits various aspects among the different races of India, of which it is the nominal religion. All these peoples doubtless regard Vishnu and Siva as their chief divinities, and the Vedas as their sacred books; but the chief divinities have impressed only their names, and the sacred books only their texts, on the religion. By their sides are innumerable forms of worship in which we find, among the several races, the most various beliefs—monotheism, polytheism, fetichism, pantheism, ancestor-worship, devil-worship, animal-worship, etc. The titles of the sacred books are venerated by all Brahmans, but of the religion they teach there is none.

Islam has not escaped this law, even though its monotheism be so simple. It is a long distance from the Mohammedanism of Persia to that of Arabia and that of India. Polytheistic India has found a way to make the most monotheistic of creeds polytheistic. To the fifty million Mussulmans of India, Mohammed and the saints of Islam are only new gods added to thousands of other gods. Islam has not succeeded in establishing in India that equality of all men that has made its success everywhere else. The Mussulmans of India have their castes, like the Hindus. In Algeria, the Arabs and the Berbers are both Mussulman; but the Arabs are polygamous, while the Berbers are monogamous, and their religion is simply a fusion of Islam with their ancient paganism. The religions of Europe are not exempt from this law. As in India, the dogmas established by Scripture remain inviolate, but they are merely vain formulas which each race interprets in its own way. Under the general denomination of Christians we find real pagans, like the Bas Breton, praying to idols; fetich-worshipers, like the Spaniard, adoring amulets; and polytheists, like the Italian, worshiping the Madonnas of each village as different divinities. Pursuing the subject further, it would be easy to show that the great religious schism of the Reformation was the necessary consequence of different interpretations of the same religious book by quite different races—the peoples of the north of Europe desiring to discuss their creed and regulate their lives for themselves, and those of the south being more backward than they in independence and philosophical spirit.

The same rule as with religions prevails with institutions and languages. They can not be transmitted without becoming modified. Consider how often in modern times the same institutions, imposed by force or persuasion, have been transformed according to races while keeping identical names. The Spanish-American republics adopted the democratic Constitution of the United States; but with those races that form of organization, which had made the United States so great, was quickly transformed into a rule of bloody dictatorships and frightful anarchy. A people may, in an extreme case, forcibly impose its institutions on a different race, as England has done in Ireland, but decadence is the result to the subjected people.

So language, even though it be fixed by writing, is necessarily changed in passing from one people to another; and this is what renders absurd the idea of a universal language. It is true that the Gauls, notwithstanding the superiority of their numbers, adopted the Latin language within two centuries of the conquest; but they soon changed it to suit their wants and their special mental moods, and the French resulted at last—an idiom very different from the Spanish and Italian, though having a common origin with them. In India, with its numerous and various races, there are said to be two hundred and forty languages, some of them differing from others as much as French from Greek, and three hundred dialects. The most generally prevalent of them is modern, being only three hundred years old—Hindustani, formed by the combination of the Persian and Arabic of the Mussulman conquerors with the native Hindi. Conquerors and conquered quickly forgot their own language to take up a new one adapted to the conditions of a mixed people.

These brief illustrations, which could be extended indefinitely, show how deep are the transformations to which peoples subject the elements of a civilization which they borrow. The loan often seems considerable because the names change abruptly; but it is always, in its beginnings, really very small. In the course of centuries, by the slow labors of generations, the borrowed element, with the successive additions made to it, at last differs much from that for which it was substituted. History, which regards words most, takes hardly any account of these successive variations; and when it tells us, for instance, that a people adopted a new religion, we conceive at once, not the creed that was really adopted, but the religion as we know it now. A close study of these slow adaptations is necessary for the proper comprehension of their genesis and of the differences in the case between words and realities.

The history of civilization is thus composed of slow adaptations, of successive minute transformations. If they seem sudden and considerable to us, it is because, as in geology, we suppress the intermediate phases, and regard only the extremes.

However intelligent and well endowed we may suppose a people to be, its faculty for absorbing a new element of civilization is always very restricted. Even the Greeks, the most intelligent people of antiquity, in the evolution of their arts needed centuries to advance beyond gross copies of Assyrian and Egyptian models and arrive by successive stages at the achievement of the masterpieces that have immortalized their name.

Yet the peoples which have succeeded one another in history—excepting a few primitive nations like the Egyptians and the Chaldeans—have had little else to do than to assimilate, by transforming them according to their mental peculiarities, the elements of civilization that constituted the heritage of their past. The development of civilization would have been infinitely slower, and the history of nations would have been only an eternal new beginning, if they had not been able to profit by previously elaborated materials. The civilizations created by the inhabitants of Egypt and Chaldea seven or eight thousand years ago have constituted a source whence all peoples have drawn in their turn. Greek arts were derived from the arts created on the banks of the Tigris and the Nile; the Roman style from the Greek; and the Roman style, admixed with Oriental influences, gave birth in succession to the Byzantine, Romanesque, and Gothic styles, according to the genius and the age of the peoples among whom they were developed. What we have said of the arts is applicable to all the elements of a civilization—institutions, languages, and creeds. The languages of Europe are derived from a mother-language formerly spoken on the central plateau of Asia; its laws from the Roman law, which was in its turn derived from anterior laws; its religion from the Jewish religion, associated with Aryan creeds; and its sciences would not be what they are but for the slow labor of ages. We can discern, despite the great gaps of which there are many in the history of civilization, a slow evolution of our knowledge that leads us across ages and empires to the dawn of those ancient civilizations which the modern science of the day is trying to connect with the primitive times when mankind had no history. But, while the source is common, the transformations—whether progressive or retrogressive—which each people, according to its mental constitution, has imposed on the borrowed elements, are very diverse; and the history of these transformations constitutes the history of civilization.

Before considering the transformations which arts, like other elements of a civilization, have suffered in passing from one people to another, let us ask to what extent they are the expression of a civilization. Writers on art are accustomed to say that they faithfully reflect the thought of the people, and are the best expression of their civilization. This is doubtless often the case, but the rule is far from being general, and the development of the arts does not always correspond with the mental and social development of nations. While there are peoples to which works of art are the most important manifestation of their genius, there are others high in the scale of civilization with which art has only played a secondary part. If we were obliged to write the history of the civilization of each people, and could take one element, that element would vary from one people to another. It would be arts for one, political or military institutions, or industries, by which others would be known best. This fact will account for the arts having suffered very unequal transformations in passing from some peoples to others.

The Egyptians and the Romans, among ancient nations, present characteristic examples of inequality in the development of the different elements of their civilization, and even of the different branches of which each of these elements is composed.

The Egyptians were weak in their literary efforts, and their paintings were mediocre, but in sculpture and architecture they produced masterpieces which the Greeks were able to excel during only a short period of their history.

The Romans were not in want of teachers or of models, for they had the Egyptians and the Greeks, but they never succeeded in creating an art characteristic of themselves; no people perhaps ever betrayed less originality in their productions in this field. But they raised the other elements of civilization to the highest point. Their military organization assured them the domination of the world; their political and judicial institutions are still patterns for us; and their literature inspired the centuries that followed them.

The Greeks, who manifested the highest superiority in the most diverse branches, may likewise be cited to prove the want of parallelism between the development of the various elements of civilization. Their literature was already brilliant in the Homeric epoch; but modern discoveries in archæology show that in the same period their sculptures were grossly barbaric, and were simply crude imitations of Egyptian and Assyrian work.

The Hindus most pointedly illustrate this inequality of develment. Few peoples have equaled them in architecture; in philosophy their speculations go to a depth to which European thought has only recently arrived; in literature they produced admirable works, even though they fell short of those of the Greeks and Latins. But they were mediocre and far below the Greeks in statuary, and were nullities in the domain of scientific and historical knowledge, while they betray an absence of precision which we meet in equal degree among no other people.

There are, further, races which, without ever having occupied a position in any way superior, have been able to create an individual art free from apparent relationship with anterior models. In less than a century after they conquered the Greco-Roman world, the Moslems had transformed the Byzantine architecture which they adopted, so greatly that it would be impossible to discover by what types they were inspired, if we had not the series of intermediate monuments under our eyes.

Even a people possessing no artistic or literary aptitude may create a high civilization. Such were the Phœnicians, who had no superior gift except their commercial skill. They promoted civilization by bringing different parts of the world into relations, while they produced nothing themselves, and the history of their civilization is nothing but the history of their trade.

There are, finally, people that stand low in all the elements of civilization except art, as the Moguls, whose monuments in India, with hardly anything of the Hindu about them, are so splendid that competent critics have declared them the finest works that have been raised by human hands; but nobody would class the Moguls among the higher races.

It is further to be remarked that, even with the most civilized peoples, the period when art attains its highest degree of development is not usually at the culminating epoch of their civilization. The most perfect works of the Hindus and Egyptians are generally the most ancient; and that remarkable Gothic art, the admirable works of which have never been paralleled, flourished in Europe in the semi-barbarous middle ages. It is, therefore, impossible to judge of the degree of a people's advancement solely by the development of its arts, which constitute only one of the elements of its culture, and that one which has not been shown, any more than has literature, to be the highest. It is, on the contrary, sometimes the case that peoples at the head of civilization —as the Romans in ancient times and the Americans in modern— are weakest in works of art, while other peoples have produced their highest literary and artistic masterpieces in their half-barbarous ages.

The period of individuality in the art of a people appears, therefore, to be a blossoming of its infancy or its youth, and not of its mature age. There are many other evidences that the progress of the arts is not parallel with the advance in the other elements of civilization, but that they have an independent and special evolution. It is a general law that when art has reached a certain level, marked by the creation of high masterpieces, a period of imitation sets in, followed by a period of decadence, both of which are independent of the course of the other elements of civilization. This lasts till some revolution or innovation, the adoption of a new creed, or some like factor intervenes to introduce new elements, as did the Crusades in the middle ages, the revival of Greek and Latin studies in the Renascence, and the Mussulman conquest in India.

It is also to be remarked that as art in a general way reflects certain wants and corresponds with certain sentiments, it is destined to share their fate, and therefore to vanish when they cease to be vital; but that condition is no sign of a decay of civilization. At no period has civilization been as high as now, and at none has art been more commonplace. From a spontaneous outgrowth of the devotion of the past it has become an accessory, a thing of luxury and convention, imitative rather than original. No people of the present has a national art, but all are contented with copies of the models of past ages.

If we study the shapes in which architecture, for instance, has been transmitted from one people to another since its historical beginning with the Egyptians, we shall find that in the hands of an inferior race—the Ethiopians, who, although they had centuries to work in, were deficient in cerebral capacity—it tended to inferior forms; while with the Greeks, a higher race, whose development also occupied several hundred years, it was improved upon and raised to a much higher level. The Persians, an inferior people to the Greeks, and whose independent career was much shorter, displayed considerable talent for adaptation, and were beginning to work a transformation in their art, when they were overthrown. A thousand years later they rose again, and devised an architecture having the stamp of originality, but combined with it marks of the influence of the ancient art and of the more recent Arabian art.

Another more modern school of architecture, of which specimens are yet standing, strikingly illustrates the extent to which a race modifies the arts which it adopts. The example is all the more typical because it is drawn from a group of peoples professing the same religion but having different origins. I mean the Mussulmans, whose structures in Spain, Africa, Syria, Persia, and India present so considerable differences that it is impossible to arrange them in one class as we do the different styles of the Gothic. The correctness of this illustration is enforced by a reference to India, where, although the same religions and the same rule prevail throughout the land, the temple in the north and the pagoda in the south, consecrated to the same divinity, are as different from each other as a Grecian temple and a Gothic cathedral. This great peninsula furnishes the most suggestive and the most philosophical of historical books. It is now, in fact, the single country in which we can, by simple changes of place, transfer ourselves at will into different periods of time and observe still in life the series of successive stages which mankind has had to pass through to reach the higher levels of civilization. All the forms of evolution can be found there, from those representative of the stone age to those of the age of steam and electricity.

In this essay I have endeavored to set forth the principles: that the various elements, the aggregation of which constitutes a civilization—especially institutions, creeds, and arts—are the expression of certain modes of thinking and feeling special to each race, and inevitably suffer transformation in passing from one race to another; that they rarely undergo a parallel development among different races. With some, institutions—with others, literature, industry, or art—prevail. One or several of these elements may remain at an inferior level in the midst of a brilliant civilization, or it may stand high in a low civilization. Of all the factors having an influence on the adoption and evolution of the fundamental elements of a civilization, the most important is race. It holds a position much above that of the influence of political institutions, conquest, or religious belief, which is powerful everywhere else. When a people of a much higher race is in contact with a people of a much lower race—as the whites with the negroes—the latter can not immediately acquire anything useful from it. Two superior races confronting one another exert no action upon each other when, in consequence of differences in mental structure, they have incompatible civilizations. This condition exists when a highly civilized people finds itself in contact with a people having a very ancient and very different civilization, as when modern Europeans are brought into contact with the Hindus or the Chinese. When civilizations possessing compatible elements, like those of the Mussulmans and the Hindus, meet, they first overlay one another and then fuse as to their compatible elements. The civilizing action which some peoples can exercise upon others has been more profound the further we go back in history, because the elements of civilization were less complicated in ancient times than now. This power of action has been reduced from age to age.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

M. Perrotin, a French astronomer, records several observations of luminous protuberances escaping from the disk of Mars, near the fiftieth degree of southern latitude, resembling what would result from the escape of a flow of matter from the planet. The author held the publication of his discovery in reserve for some time, apprehending that there might be some mistake about the matter, but, convinced at last of the reality of the appearance, communicated the fact to the French Academy of Sciences on the 5th of September. No adequate explanation has been offered for the phenomenon, but the discoverer suggests that it may be connected with the luminous points that may be distinguished on the disk of the planet.

A CAPTIVE COMET.

By CHARLES LANE POOR.

ON the night of June 14, 1770, the great French astronomer Messier first saw the captive comet. It then appeared as a small patch of haze against the cloudless sky, but it rapidly grew larger and more brilliant, until, on July 2d, when it passed nearer to the earth than any other known comet, it was as bright as the North Star, and its diameter was twice that of the full moon. From that moment its brilliancy faded, it grew fainter and fainter, and was seen for the last time on October 2d.

While this comet of 1770 is one of the most famous in the annals of astronomy, it owes its celebrity not to the spectacular effects it produced, for it was not one of those magnificent objects that stretch across the heavens, exciting the wonder and admiration of the intelligent, the fear and dread of the ignorant. Its fame is due to its mathematical history, to the path it was then traveling, and to the path it has since traveled. Only twenty years had elapsed since Halley had made his great discovery of the existence of periodic comets, and this comet of 1770 was shown by Lexell to belong to this interesting class of bodies, to be then revolving around the sun in an ellipse of five and a half years. To the conclusions of Lexell it was at once objected by other mathematicians that if this comet revolved about the sun in an ellipse, like the planets, it should have been seen six years before, and again, six years before that; at least, some record of its former appearances ought certainly to be found. As there were no such records, as it could be shown that there was no comet that had appeared regularly every five and a half or six years, Lexell's opinions were for the moment discredited. However, he soon conclusively proved that he was right, that the comet was moving at the moment in an ellipse such as he had described, but that it had not always traveled in that same path. He showed that in 1767, or only three years previously, the comet had passed very close to the giant planet Jupiter, and that then its path had been greatly altered, so completely changed, indeed, that never before had it passed near enough to the earth to be seen. He also predicted a second close approach of these two bodies in 1779, and said that this circumstance might prevent the reappearance of the comet after that date. This prediction of Lexell's was fulfilled, for the comet was never again seen, unless it prove that the comet discovered by Brooks on July 6, 1889, is the lost body.

On that summer evening, at Geneva, N. Y., Brooks discovered a faint telescopic comet, since known as comet *d and V*, 1889. As this body never became visible to the naked eye, it received but passing notice from the daily newspapers; even astronomers, at first, thought very little of it, as the discovery of a new comet is now a matter of almost monthly occurrence. It was not long, however, before this body began to attract the attention of the scientific world, and it was soon recognized as a permanent member of the solar system; and now, through the researches of Dr. Chandler and others, it has become the most famous comet of this century. It has been identified with the lost comet of Lexell, which disappeared one hundred and twenty years ago.

Upon what grounds do we base this conclusion? A comet was seen for but a few months during the summer of 1770, another one is observed during the summer and fall of 1889, and it is asserted that these two bodies are identical. There are no physical means by which they can be identified, for comets have no permanent characteristics which, when once seen, can always be recognized. Indeed, to all appearances, these two bodies were utterly unlike: the comet of 1770 was large and bright, with a well-marked tail; while the comet of 1889 was hardly visible even with powerful telescopes, and then appeared but as a small patch of haze against the dark sky. If, then, we rely on similarity of appearance to establish the identity of these two comets, we should fail to do so, and would be forced to conclude that they are not the same. But by a study of the movements of the two, especially of the latter, it can be shown that they must have occupied, at one time, the same position in space—their identity is then self-evident.

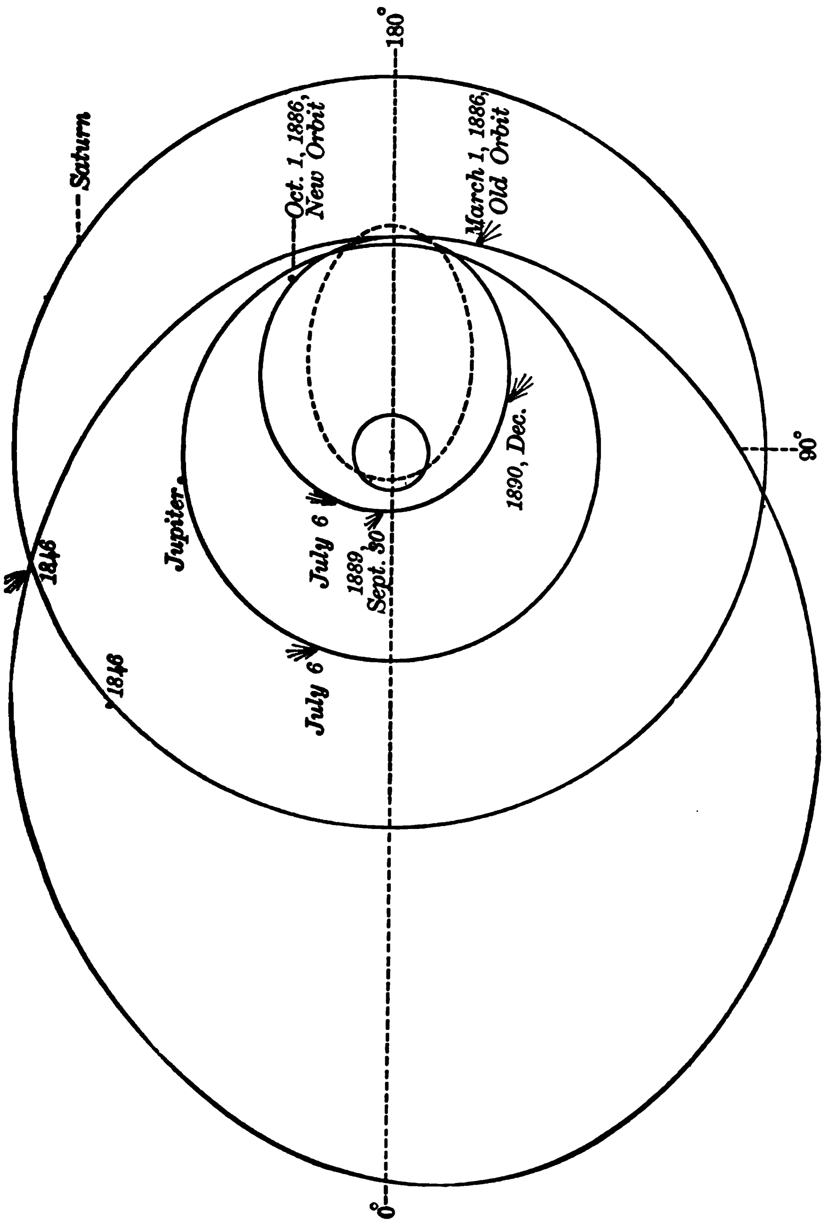
At present the comet is moving in a small ellipse of about seven years' period. This path is shown in the diagram. The smallest circle represents the annual orbit of the earth around the sun. Just outside of this circle is a heavily drawn ellipse with one of its foci at the sun. This is the present orbit of comet V, and on it are marked three positions of this interesting body. The first, July 6, 1889, marks its position on the night of discovery; the second, September 30th, at its perihelion passage, or nearest approach to the sun; the third, that of December, 1890, the position it occupied when last seen. For months before this last date, however, the comet could only be seen by means of the great thirty-six-inch Lick telescope. Between the two extreme positions above mentioned, there are scattered along the curve some two hundred and fifty other observations; and on this small part of the comet's path rest all the conclusions as to its movements for over a hundred years.

The first step in the problem was to deduce from these observed positions the orbit of the comet, or the ellipse shown in the diagram. This curve should be clearly understood—it is *not* the *actual path* of the comet through the heavens, but that path which it would describe if the comet and sun were the only two bodies in existence. The earth, Jupiter, all the planets are, in fact, pulling and hauling at the unfortunate body: first one drags it a little one way, then another pulls it in a different direction. The real path of the comet about the sun is, then, a very complicated, wavy sort of a curve, which, as a rule, does not depart very much from the ellipse above figured.

Now, while mathematicians have succeeded in completely solving the problem of two bodies, yet, up to the present day, that of three or more bodies is still unsolved. If the sun and comet were the only two bodies in the universe, then could a mathematician, after a few moments' calculation, predict exactly where each would be a thousand years hence; could tell where they were ten thousand years ago. But as soon as there is introduced into such a simple system the earth, Jupiter, and the other planets, our mathematics fails to give a complete solution. All that can be done is to trace the course of the comet step by step, day by day, almost. We know its position to-day, and we can accurately calculate the direction and the amount of the pull of each planet; hence, we can find where it will be to-morrow, and, by repeating the process, where it will be the next day, and the next. Of course, this is a very laborious process; the calculation of the pull of a single planet requires the writing and the combination of one hundred and fifty numbers of six figures each. But, fortunately, the sun is over a thousand times as strong as the great planet Jupiter, and over three hundred thousand times as strong as the earth; so that, unless the comet approach very near to one of the larger planets, it will never deviate much from its simple orbit around the sun. The steps in our computation may be, therefore, lengthened. The ordinary length of step in such work is forty days; and, in a first computation, the pulls of the smaller politicians—as the earth, Venus, and Mars—can be neglected beside the very strong ones of Jupiter and Saturn.

As we wished to trace the history of comet V, we started with the earliest observed position, that of July 6, 1889, and we began by taking steps of forty days each. Thus the path the comet had traveled was slowly traced backward, and it was found to approach nearer and nearer to Jupiter. Proceeding backward thus over a period of two years, we find that in March, 1887, the pull of Jupiter was so strong that, in order to keep the work at all accurate, we were obliged to shorten the steps to ten days. Continuing thus, the pull of Jupiter grew stronger and stronger, until, in October, 1886, it was actually greater than that of the sun, and a change of method had to be used in order to trace the path beyond that point, and with this change in methods appears the interesting mathematical part of the problem.

It is now perfectly well known to every schoolboy that the sun is the center and ruler of the solar system; that the earth and other planets revolve about it in great ellipses. This simple fact



New and Old Orbits of Comet V, 1889.

was not recognized, however, until nearly the middle of the sixteenth century. For thousands of years previously, astronomers as well as priests, the educated and the ignorant, had thought that the earth was the center of the universe; that the sun, the planets, and the countless stars revolved around and were accessory to this little abode of man.

Ptolemy, the greatest astronomer of the ancients, put this false theory on a strict mathematical basis. By means of his cumbersome system of epicycles he could roughly compute the positions of the planets at any time, could foretell the time of rising and setting of the moon, and predict eclipses. But, while the Ptolemaic system is false, while it does not agree with what we now know to be the true system of the heavens, yet it is mathematically possible. In discussing the various positions and motions of the planets, it would be perfectly possible to consider the earth as the fixed point around which they move; we could thus arrive at correct results, but the processes would be infinitely long and complicated. And yet a modification of this antiquated method was the only means of tracing further the path of this interesting comet, for the pull of Jupiter became now so strong that, in our backward path, we would have had to take steps, not of a few days, not of a few hours, but of twenty or thirty minutes at a time. The task would have been endless.

Jupiter was now the ruler of the comet's destiny, the sun a mere disturbing element, so that it became simpler to give Jupiter its just position as ruler at the center of the comet's motion.

Jupiter was made the momentary center of the universe: comet, sun, earth, and planets were all considered as revolving around this monster planet. The change of the center of motion from the sun to Jupiter was easily effected, and the resulting orbit of the comet about Jupiter was found to be a hyperbola, an open curve. And now, just as before, this curve is merely the path the comet would have described about Jupiter if it and the planet were the only two bodies in existence; the long-suffering comet is still pulled and hauled at by various bodies, notably the sun, and step by step its path had to be traced out. At first, steps of ten days each were found to be sufficiently accurate, but as the comet approached closer and closer to Jupiter it began to move faster and faster, and consequently the length of the steps had to be shortened to four days each. After the comet had passed Jupiter the length of the steps was gradually lengthened again.

The remarkable character of this appulse should be clearly understood. The comet passed the center of Jupiter in 1886, July 19th, at no greater distance than two and one third radii of that planet. It must then have passed the surface of Jupiter at a distance of only one and one third radii—that is, the center of the comet was only about sixty thousand miles from the surface of the planet. It is not at all improbable that parts of the diffused mass of the comet swept over the surface of Jupiter itself, and that we had here a true collision between the two bodies. The comet struck the planet a glancing blow, as it were. As is usual in all collisions, the weaker body suffered: the comet was broken into three parts, while Jupiter was unharmed.

When the comet had passed far enough away from Jupiter, so that the sun had regained its supremacy, the motion was again referred to the sun as fixed point, and the tedious process of tracing the comet's history continued, step by step. Tracing thus backward the path of this minute body, we find that it leads to the spot where Lexell's comet disappeared in 1779. Either two comets can occupy the same space at the same time, or the comets of 1770 and 1889 are one and the same.

We have thus seen something of the laborious process by which, starting with a few observed positions of a body in 1889, we can trace the path it has traveled for one hundred and seven years; how we can show its identity with a comet seen in 1770. Of the path itself but little has yet been said. It is interesting. And as it is always easier to trace a succession of events in the order in which they occur than it is to reverse the order of time, we will start with the first recorded public appearance of the comet, in 1770, and give a brief sketch of its erratic course through the heavens since that moment—though, remember, this path was discovered by tracing the body backward along its course.

Look again at the diagram. In the summer of 1770 the comet was seen moving along the small dotted curve in the region very close to the smallest circle in the diagram, which represents the orbit of the earth. It disappeared from view and passed outward along this dotted curve, making one complete revolution, returning in 1775 to the point where it was first seen. During these few years the earth had also been traveling its yearly path around the sun, and it so happened that in this latter year (1775) the earth had moved into a different position in its orbit, so that the sun was directly between it and the comet. The comet was therefore not then seen. Onward went the comet along this dotted path, until, in 1779, it had reached the outermost point, when it encountered Jupiter. The effects of this appulse were very marked as regards the comet: it was pushed completely out of its path and set moving in an immense ellipse, the one that extends far out to the left in the diagram. From five and a half years its period had been changed to about thirty-four years. In this large path this captive body moved without any extraordinary incident for sixty-seven years, or until 1846. During this time it had traveled twice around the curve, and it was fairly started on its third trip, when Saturn took a hand in the game and altered its path considerably, extending the ellipse to one of forty-seven years period. On it went, but it was never allowed to complete even one revolution in this last ellipse, for in 1886 it collided with Jupiter, as has been already described, and its path was changed to the small ellipse in which the justly famous comet is now moving, and in which it will continue to move for a number of years to come.

THE INVENTOR OF THE LIGHTNING-ROD.

By JOSEPH J. KRÁL.

WHEN the newspapers lately announced the names of eminent electricians which are to adorn the Electrical Building at the Columbian World's Fair in Chicago in 1893, we were surprised, nay, disappointed, to find that the respective officials left out the name of a man of science whose merits would fully entitle him to that honor. We mean Prokop Divis, the man who, before Franklin, discovered the identity of lightning and electricity, and the issuing of electricity from metallic points, two important truths which led him to construct a lightning conductor. But his modesty (he was a Catholic priest and a thorough scholar), and the ignorance of others combined, caused his name nearly to be forgotten. The Encyclopædia Britannica knows nothing of him, while the German Conversations Lexicon of Brockhaus (Volume V, page 406) disposes of his two great discoveries exactly in two sentences. The only mention of him we find in English literature is a short sketch in the Historical Magazine for February, 1868 (page 93, article xii), which is a translation from a French periodical. As the life of Divis is of itself sufficiently interesting, we hope to be justified in presenting a few more details of his life to the readers of this magazine. Our article is based chiefly upon a sketch in the Bohemian Encyclopædia of Rieger and Maly (Volume I, pages 209, 210, and Volume III, page 941).

Prokop Divis (Dyiv'ish) was born on the 1st of August, 1696, in the town of Zamberk (its German name is Senftenberg), in northeastern Bohemia, of Bohemian parents. At the gymnasium of Znojmo he received the rudiments of higher education, and afterward entered the Premonstratensian order at Luka. On November 30, 1720, he bound himself with the three monastic vows, and six years later took the holy orders. On account of his high scholarship, he was soon after appointed Professor of Philosophy in the Lyceum of Luka. A special feature of his lectures were various experiments in physics, with which, contrary to all precedents, he liked to illustrate the subjects discussed. It will be remembered that the Church has never looked with favor upon natural sciences. After a year had passed, Divis was obliged to change his subject and lecture on theology. He distinguished himself also in this new field, and accordingly, on the 5th of August, 1733, the University of Salzburg conferred upon him the degree of Doctor of Divinity.

He had been longing for an opportunity to devote himself to scientific research. His wishes seemed to be fulfilled when he was ordained parson of the parish of Prendice (Pren'dyitsch), a small village in southern Moravia, near the city of Znojmo (Znaim on English maps). Here all his leisure was given to physical experiments; with especial care he studied the properties of water and fire (oxidation). In 1741 he became prior of the Lukan Convent, and consequently had to discontinue his scientific labors for a few years, as the duties of the new office required all his time. Besides, the Austro-Prussian War had just broken out,* and a double care devolved upon the shoulders of the new prior. Throughout the war Divis faithfully performed his duties, but as soon as peace was restored to Moravia he resigned his dignity and returned to Prendice to resume his favorite work. His parish was a small one, and thus Divis was enabled to spare time enough for scientific inquiries. He now entered upon an examination of electricity. Pursuing the safe empiric method, Divis based all his conclusions and estimates upon careful experiments. His observations of thunderstorms led him soon to a discovery that lightning was but an electrical spark—that in his laboratory he could imitate thunder and lightning on a small scale—and he resolved to try if it were possible to make thunderbolts harmless. How thorough his studies were, may be gathered from the fact that he worked out a complete theory of atmospheric electricity, a treatise on which was published from his papers after his death.

Another important discovery followed soon after. Divis found out that metallic points would both attract and discharge electricity more speedily than anything else, and proceeded to make a practical application of the newly discovered truth. About the same time Franklin, on this side of the Atlantic, was receiving his first lessons in electricity from Dr. Spence.

The fame of the electrical experiments of Divis soon reached the imperial court of Vienna, and the Emperor Francis Stephen, who was somewhat of an amateur naturalist himself, invited Divis to Vienna, to repeat his experiments in the halls of the

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* Charles VI, King of Bohemia and Hungary and Emperor of Germany, died in 1740, leaving his dominions to his daughter Maria Theresa. Frederick the Prussian thought this a good opportunity to rob the queen of some of her territories, and he immediately, without any right, and without even a declaration of war, invaded Silesia.

imperial castle. These performances were also honored by the presence of the Empress Maria Theresa. The imperial couple were highly pleased with the experiments, and, to show their esteem for Divis, they presented him with two heavy golden medals with their busts engraved upon them.

In 1750 Divis demonstrated his superior knowledge of electricity in an amusing way. Father Francis, a learned Jesuit, was about to make some experiments with his electrical machine at the Vienna court. While he was making some preliminary remarks, the Bohemian scholar, who had concealed a number of small iron nails in his periwig, approached the machine and viewed it closely from all sides, as though he were going to make a critical examination of it. His true intention was, however, to take away all electricity stored on the metallic balls, in which he succeeded without touching the machine. Imagine the horror of Father Francis when he finally came to perform his experiment, and found that, although his accumulators were well insulated, all his electricity was gone!


Fig. 1.—The Top of the Lightning-rod of Divis.

In 1753 Prof. Richmann, of St. Petersburg, while observing a storm from a hut, was killed by lightning descending an insulated iron bar specially erected for the purposes of the study. Upon learning of the fate of that martyr of science, Divis drew up a memoir on that unhappy occurrence, in which he demonstrated that the iron bars, as used by Richmann, were both unsafe and dangerous, and clearly showed how, in case of a storm, the danger of a lightning-stroke could be averted by means of a conductor, the idea of which had already matured in his mind. This treatise he sent to the famous mathematician and naturalist, Euler, then President of the Berlin Academy of Sciences, asking for his judgment. But his application was in vain; the Academy failed to understand his reasoning. This is one of the numerous instances which go to show that it is always the individual workers to whom we have to look for any advance in science rather than learned societies. When Franklin's account of his discovery was read in the British Royal Society, it was laughed at by the connoisseurs.

Divis was not discouraged by the cold reception with which ork had met in Berlin, but went on to construct his light-od. After all that was necessary had been prepared, the ctor was erected on the 15th of June, 1754, near the resi- of the parson, for Divis, in order to avoid all risks, gave idea of placing the lightning- on the building, but built it tely in the free field near the ng. The lightning-rod of Divis nstructed as follows:

FIG. 2.—A HORIZONTAL VIEW OF THE CROSS-BARS.

ointed, slender iron bar formed ain part of the machine. Fas- to it were two cross-bars, thus g four arms, across each of in turn, a shorter bar was laid. ach of the twelve extremities so d bore a box filled with shav- f iron in which twenty-seven eedles were stuck, making three ed and twenty-four needles in all. The main bar was sup- by a wooden column sufficiently high (forty-eight feet at fterward one hundred and thirty-two feet) to secure protec- or the building and its immediate surroundings. Several ains connected the main bar with the earth. The effect of chine was to divide the lightning into as many sparks as were needles (three hundred and twenty-four), and thus to its force. It might, therefore, more properly be called a ing-divisor.

rcely had the rod been erected when a storm came rushing m the north. Thunder-clouds hung over Prendice, and nally white shafts of lightning were seen darting from the and flying toward the conductor. In a few minutes a cloud enveloped the machine, and the storm soon passed without doing any damage. For two years Divis continued menting with his lightning-rod; the results were published Scrinci in the Prague News (1754). Having satisfied him- regard to the utility of his new machine, Divis offered to peror a plan for erecting a number of conductors in vari- rts of his empire. The emperor submitted the plan to ese mathematicians, who were, unfortunately, a little be- he times, and reported unfavorably upon the Bohemian's ition. The plan was consequently never carried out. Ab- arci, speaking about the report of the Viennese "connois- ' says, in a letter to Divis, "Blasphemant, quae ignorant" blaspheme that which they do not understand). And at 1756, Divis was compelled to remove his lightning-rod. had been a very dry summer that year, which the farmers of Prendice and the neighboring places ascribed to Divis's machine! One day an angry crowd came to the parsonage and tore down the iron bars. The authorities then ordered Divis to take away his machine, and he accordingly removed it and deposited it at Bruck, where it has been kept to this day.

There is a marked similarity between the treatment which the invention of Divis suffered at the hands of his neighbors and that accorded to Franklin's conductor in America. When, in 1755, Massachusetts had experienced a sharp shock of an earthquake, the judgment of the public opinion was pronounced upon Franklin's rods as the direct cause of the earthquake. As late as 1770 a Boston clergyman preached against the lightning-rods as "impious contrivances to prevent the execution of the wrath of Heaven." The difference between the relative positions of the two inventors was that in America a divine denounced a layman, whereas in Moravia laymen denounced a divine. We unwillingly recall the words of Mädler: "In all times and in all countries the enemies of truth and light pretend to be fighting for the honor and glory of God."

Thus Divis was prevented from perfecting his machine, which would have doubtless been wrought by him into a different, more advantageous, shape but for the official order. Divis felt himself obliged to give up his studies and experiments in electricity, and his versatile genius turned to a new field—music. He was well acquainted with acoustics, and as a Bohemian he possessed likewise a personal liking for music; and before long his creative genius enriched the musical world with a new instrument which he named "denis d'or." * This instrument is played by both hands and feet, like an organ, and it can give the sound of almost any stringed or wind instrument, from the *pianissimo* to the *fortissimo*, as it has as many as one hundred and thirty registers. In its effect this instrument is equal to a full orchestra.

This was the last great work of Divis, and on the 25th of December, 1765, the untiring worker quietly departed his life.

Personally, Divis had the true appearance of a thinker. In his early youth his health was rather delicate, but it improved steadily after he began his electrical experiments and never failed him again, although he was constantly at work. Oftentimes he was so deeply absorbed in his experiments or observations that he would not notice his friends coming to see him, until a servant reminded him of their presence by pulling his sleeve. The steady mental work gave his face a serious, unfriendly mien, which disappeared, however, whenever he happened to be in a circle of his friends. His guests, among whom there were many distinguished

* Denis is a French translation of the Bohemian name Divis. D'or means "of gold."

persons, he always entertained courteously. Besides his mother-tongue, the Bohemian, he also knew Latin, German, and French. From the papers he left there was printed, after his death, a treatise entitled Längst verlangte Theorie der meteorologischen Electricität (The Long-sought Theory of Atmospheric Electricity), Tübingen, 1768.

Prokop Divis is an interesting example of an ideal scholar. Originally he studied science merely for the sake of finding out the truth; but when he saw that the truths discovered by him could be utilized for the benefit of mankind, he utilized them. Undoubtedly he knew nothing of Franklin, and there is no evidence that Franklin ever heard of Divis; their discoveries in electricity were wholly independent of each other. But Franklin was the happier of the two because he found a people who understood him—the French; while Divis, by his social position, was prevented from perfecting his instrument. We must remember that Benjamin Franklin was a public man, who stood conspicuously before three countries, while Prokop Divis was merely a parish priest of a small Bohemian village, with few or no connections. Yet we admire his genius evinced by inventions so vastly different—a lightning-rod and a musical instrument. These are wittily characterized in his epitaph, written by one of his contemporaries:

> "Ne laudate Iovem, gentes! quid vester Apollo?
> Iste magis deus est fulminis atque soni." *

GENIUS AND SUICIDE.

By CHARLES W. PILGRIM, M. D.

WINSLOW, in his Anatomy of Suicide, says, "A person who accustoms himself to live in a world created by his own fancy, who surrounds himself with flimsy idealities, will, in the course of time, cease to sympathize with the gross realities of life," and any one who will take the trouble to read the biographies of men of genius will see that this statement is borne out to a remarkable degree. Probably the most striking example of this doctrine, as well as the most pathetic instance of suicide in the annals of literature, is found in the records of Chatterton's short life. From the beginning shadows hovered over him. He was the posthumous child of a poor widow, whose dead husband had been a rough, drunken fellow, and a singer and subchanter in the cathedral choir of Bristol. The mother supported herself

* "Do not praise Jove, nations! What is your Apollo?
This man, rather, is a god of both the lightning and the sound."

by dressmaking in one of the back streets of the old town, and the boy was only able to gain the rudiments of an education in a charity school. His biographer tells us that he was of a peculiar temper, sullen and silent, and given to sudden fits of weeping or violent rage. When only ten years of age he began to write verses, and although he was too shy and diffident to make a confidant of any one, his secret soon became known among the little blue-coats of Colston's Charity School. His uncle, Richard Phillips, was the sexton of the church of St. Mary Redcliffe, in Bristol, one of the most beautiful specimens of parochial church architecture in all England, and many of this strange boy's days were passed studying the inscriptions on the altar tombs and in poring over the forgotten parchment deeds which had lain for years unheeded in the oaken chests in the old muniment-room above the porch. So much of his time was spent in solitude, and he seemed to have so few of the characteristics of children, that many regarded him as weak in intellect. But even then he was thirsting for fame, and while only a child was wont to say that a man might do anything he chose. It was the accidental discovery of the old parchment deeds in the parish church that led this child of genius to perpetrate the Rowley forgeries, and to claim that these products of his own imagination had lain in the old chest for more than three centuries. Failing to obtain the patronage of Sir Horace Walpole, he determined to seek his fortune in London, and in order to obtain his release from Lambert, an attorney into whose employ he had been bound, he sat down on Easter eve, April 17, 1770, and penned his Last Will and Testament, in which he intimated his intention of committing suicide. Among his satirical bequests he leaves his "humility" to the Rev. Mr. Camplin, his "religion" to Dean Barton, and his "spirit and disinterestedness" to Bristol. This strange document had the desired effect, and Lambert canceled his indentures. So, with a light heart, a lighter purse, and a bundle of valuable manuscript under his arm, he set out, at the age of seventeen, to gain fortune and fame as a man of letters in the great metropolis. His after-life is well known. Nothing but disaster followed. He lacked the simplest necessities of life, but even when starving wrote cheerful words and sent small gifts to the mother and sister left behind. Failure met him at every hand, and by degrees he sank lower and lower into the depths of despair, until finally, with his last penny, he purchased sufficient arsenic to end his unhappy life. He was found on his cot of straw with torn manuscript all about him. Thus ended the brief, strange life of the "fate-marked babe who perished in his pride."

Another example of Winslow's doctrine is Hugh Miller, the self-taught genius, who was born at Cromarty, in the north of

Scotland, on the 10th of October, 1802. Like Chatterton, he had little patience with the schools. He would play truant in order to enjoy a book in freedom on the hill or by the sea, and his old schoolmaster feared that he would become a dunce. Curious to state, when it became necessary for him to decide upon a trade, he chose that of stone-mason so that he might be unemployed in the winter frosts, and thus have opportunity to read and write.

For fifteen years he worked in the quarry during the pleasant days of summer, and spent the hours of winter prosecuting the object of his ambition—the writing of good English. His clear, choice diction caused the Edinburgh Review to ask, "Where could this man have acquired his style?" little thinking that the greater part of his life had been spent in the quarry and hewing-shed.

His work attracted so much attention that in 1840 he was called to the editorial chair of The Witness, a semi-weekly paper published in Edinburgh for the purpose of securing spiritual independence. Unremitting labor resulted, and the night following the completion of his greatest work, The Testimony of the Rocks, he yielded to the strain to which his overworked brain had been subjected and sent a bullet through his heart.

Another similar case is that of Robert Tannahill, a Paisley weaver, who was one of the most popular successors of Burns in song-writing. He was born in 1774, apprenticed to his father's trade when twelve years of age, and composed his songs as his shuttle went to and fro. He apparently had a single love affair, which occasioned the composition of the popular song, "Jessie, the Flower of Dunblane." He was shy, sensitive, and awkward, and therefore uncomfortable except in the presence of his humble friends. His monotonous existence was broken only by occasional trips to Glasgow, and the one memorable day in all his life was when James Hogg, the Ettrick Shepherd, paid him a visit. The meeting was prolonged into the night, and the parting was painful and pathetic. Tannahill, grasping the hand of his poet-brother, said, while tears suffused his eyes: "Farewell! We shall never meet again." His words were prophetic, for shortly afterward his body was found stark and stiff in a pool near his house.

To come down to more recent times, we have but to recall the melancholy end of Richard Realf, an English peasant, born in Framfield, Sussex County, June 14, 1834. I can not better give the story of his life than by quoting freely from a letter written to Rossiter Johnson in 1875, who was at work upon a short biography of the poet for the Little Classic Series. In this letter he says: "I never received any education in my boyhood, except for a year or two at the little village school. We were a large family and very poor, and I went to work in the fields at a very tender age." At fifteen, or thereabouts, he states that he began to write verse, "lisping in numbers, for the numbers came." When sixteen he went to visit his sister, who was a servant in the family of a physician at Brighton, and the wife of the doctor, who was a lady of literary tastes, manifested an interest in him and made him her amanuensis. A physician, who lectured on phrenology, shortly afterward became a guest of his benefactress, and learning of the young poet's ventures made use of some of them in one of his lectures to illustrate the organ of ideality. Among the listeners was Lady Byron. She with Rogers, Mrs. Jameson, and Lady Jane Pell, determined upon publishing a collection of his verses, and did so in 1852, under the title of Guesses at the Beautiful. He soon realized that he was in danger of being spoiled by condescending patronage and praise, and therefore wrote to Lady Byron, who was then at her country residence in Surrey, begging her to get him away from surroundings which might make him forget the honest peasant parentage from which he sprang. She at once made arrangements for him to go down to Leicestershire to her nephew, Mr. Noel, manager of one of her estates, where he would have opportunity to study the science of agriculture as well as to prosecute his literary purposes. Like all men of poetic temperament, he had the fatal faculty of falling in love, and an attachment soon sprang up between himself and the eldest daughter of Mr. Noel. Realizing that there was a gulf between them which could never be bridged, he determined to come to America. Reaching New York in 1854, he began to explore the slums for the purpose of writing sketches, but instead became a sort of Five Points missionary. He kept at this work for two years, and then in 1856 conducted a large number of Free State emigrants to Kansas. He became intimate with John Brown, was with him at Harper's Ferry, and narrowly escaped lynching. He enlisted in 1862 and served through the war with credit, rising by promotions to the rank of captain. The next step in his history has a local interest for us who live in the western part of New York, for in the autumn of 1867 we hear of him in Rochester writing a series of remarkable poems for the Rochester Union. It was there that Rossiter Johnson, who was then assistant editor of the Democrat and Chronicle, became interested in him, and it was also there that he contracted the unfortunate marriage which darkened his life and ultimately brought it to an end. Johnson, who has written fully of this episode, tries to excuse him by saying that the woman had nursed him through a critical illness, and that his gratitude made him believe that he could find peace and contentment where an ordinary man would have known that nothing but disappointment and unhappiness would follow.

Realf himself said that he thought his mind was obscured at the time. After some years of misery he procured a divorce and remarried. Happiness seemed to be near again, but after two years, upon some technical grounds, the Superior Court reversed the decision of the lower court and declared his divorce illegal. Misfortunes then began to fall thick and fast. His second wife and children, for he had become the father of triplets, grew ill. Additional heavy drains were made upon his purse by a widowed sister and a paralytic brother, and to add to his cup of bitterness his first wife followed him to California and insisted upon claiming support. At last, bowed down and broken by misfortune, worry, and overwork, he ended with laudanum his eventful and unhappy life in the autumn of 1878. He made two attempts before success resulted, and between them composed the poem beginning "De mortuis nil nisi bonum," thus reminding us of Marcus Lucanus, "the eminent Roman poet of the silver age," who repeated lines from his poems descriptive of death as his life-blood ebbed away.

If we were to look carefully into the histories of the lives of men of genius, we should find many names to add to the number already mentioned, and still more to swell the list of those who had attempted the deed without meeting with success.

Haydon, the celebrated historical painter and writer, overcome by debt, disappointment, and ingratitude, laid down the brush with which he was at work upon his last great effort, Alfred and the Trial by Jury, wrote with a steady hand "Stretch me no longer upon this rough world," and then with a pistol-shot put an end to his unhappy existence.

Richard Payne Knight, the poet, Greek scholar, and antiquary, was a victim of melancholia, and finally destroyed himself with poison.

Burton, the vivacious author of The Anatomy of Melancholy, who had the reputation of being able to raise laughter in any company, however "mute and mopish," was in reality constitutionally depressed, and it is believed that he was at last so overcome by his malady that he ended his life in a fit of melancholy.

Kleist, poet and dramatist, brooded over suicide, attempted it once unsuccessfully, and finally, by agreement with Henriette Vogel, who believed herself affected with an incurable disease, repaired to a small inn near Potsdam, where they ended their lives together.

Lessmann, the humorous writer, like Burton, put an end to himself in a fit of melancholy.

Sir Samuel Romilly, a man of brilliant genius, by whose efforts the criminal laws of England were remodeled—a man loved for his sweet nature and upright manliness—while overcome by grief at the death of his wife, with his own hand sought rest beyond.

Michael Angelo, after receiving a painful injury to his leg by falling from a scaffold while at work upon The Last Judgment, became so melancholy that he shut himself in his room, refused to see any one, and "resolved to let himself die." Fortunately, his intentions were frustrated by the celebrated physician Bacio Rontini, who learned by accident of his condition.

Vittoria Alfieri, of whom it has been said that every event in his life is either a factor of disease or a symptom of mental alienation, attempted suicide in Holland, while making one of his restless trips through Europe in search of change.

Kotzebue, who at last met a tragic death at the hand of an assassin, was at one time so melancholy that he meditated self-destruction. Happily, however, as he tells us, his habit of composition was so firmly fixed that he went on with his work and produced one of his finest dramas, Misanthropy and Repentance.

Cowper, as is well known, when bowed down by religious melancholy, made two unsuccessful attempts upon his life.

Chateaubriand, the brilliant representative of French literature, became so thoroughly discontented with himself and the world that he attempted to take his life.

Dupuytren, the distinguished anatomist and surgeon, whose kindly nature induced him to leave a large share of his fortune for the establishment of a benevolent institution for the relief of distressed medical men, contemplated suicide even when at the acme of his fame.

Cavour, "the regenerator of Italy," and one of the greatest of modern statesmen, twice attempted to kill himself.

Lincoln, as Herndon tells us in The True Story of a Great Life, was subject to fits of extreme melancholy. Nicolay also says that beneath his apparently cheerful and sunny nature there was an undercurrent of deep sadness. At one time, according to Herndon, his melancholy reached such proportions that his friends, "fearing a tragic termination, watched him closely day and night." At this time Lincoln himself wrote: "I am now the most miserable man living. To remain as I am is impossible. I must die, or be better, as it appears to me." While thus suffering he wrote and published a paper on suicide. But, to the glory of civilization, the shadows lifted, and he lived to place his name in perpetual honor by freeing the nation from "the incubus of slavery."

Lamartine, poet, statesman, and orator, when overcome by reverses which were as sudden as his successes had been, looked longingly toward the tomb.

George Sand declared that, whether it was that bile made her melancholy or that melancholy made her bilious, she had been frequently seized by a desire for eternal repose.

Goethe, who thought the suicide of the Emperor Otho worthy of praise, slept for several nights with a dagger under his pillow, trying to get up sufficient courage to imitate the act.

Comte, in a fit of depression, threw himself into the Seine; and there is abundant evidence that Shelley, whose unhappy life was clouded by the suicide of two women, himself contemplated the deed. Fanny Imlay's death by laudanum in the Swansea inn was followed in a few weeks by the recovery of Harriet Westerbrook's lifeless body from the Serpentine. The tragic death of Harriet was a frightful blow to Shelley, and there is no doubt that his character was altered by it. Thornton Hunt says, "I am well aware he had suffered sorely, and that he continued to be haunted by certain recollections which pursued him like an Orestes"; and Woodbury adds, "From that time a shadow fell upon him which never was removed." Whether it was the recollection of the watery grave of the woman he had wronged, or whether it was only the desire to rend the veil which hides the mysteries of the Great Beyond, it is certain that Shelley on more than one occasion contemplated self-destruction.

In Trelawney's interesting records of Shelley and Byron two striking instances are given. The first is a letter from Lerice, dated June 18, 1822, in which the poet writes: "You, of course, enter into society at Leghorn. Should you meet with any scientific person capable of preparing prussic acid, or essential oil of bitter almonds, I should regard it as a great kindness if you could procure me a small quantity. It requires the greatest caution in preparation and ought to be highly concentrated; I would give any price for this medicine. You remember we talked of it the other night, and we both expressed a wish to possess it. My wish was serious, and sprang from the desire of avoiding needless suffering. . . . I need not tell you," he adds, "that I have no intention of suicide at present, but I confess it would be a comfort to me to hold in my possession that golden key to the chamber of perpetual rest." Notwithstanding the denial that he contemplated suicide, an incident which happened soon afterward, and which is related by Trelawney in the same interesting chapter, leaves no doubt that Shelley more than once felt the suicidal impulse to an almost irresistible degree. To make free use of Trelawney's graphic words: "On a calm, sultry evening, while Jane (the wife of Shelley's friend Williams) was sitting on the sands before the villa on the margin of the sea with her two infants watching for her husband, Shelley came from the house dragging his skiff. After launching her, he said to Jane: 'The sand and the air are hot; let us float on the cool, calm sea; there is room with careful stowage for us all in my barge.' She accepted the invitation, and, with the children, got into the boat. They soon drifted from the shore, and the poet, unconscious of her fears or of their danger, fell into a deep reverie, probably, as Trelawney suggests, reviewing all that he had gone through of suffering and wrong, with no present and no future. Jane spoke to him several times, but her remarks met with no response. "She saw death in his eyes." Suddenly he raised his head, his brow cleared, and his face brightened as with a bright thought, and he exclaimed joyfully, "Now let us together solve the great mystery." With a woman's instinct Jane knew that her only chance was to distract his thoughts, and, suppressing her terror and assuming her usual cheerful voice, she answered promptly: "No, thank you, not now. I should like my dinner first, and so would the children." This gross material answer to his sublime proposition so shocked the poet that he was brought back to himself, and paddled his cockle-shell boat into shallow water.

A deep melancholy pervades all of the poet's letters from Pisa and Leghorn, and it was at this time that he was engaged upon The Triumph of Life, which was left unfinished by his untimely end. The poem closes abruptly with these words: "Then what is life? I cried." A sentence of profound significance, as Mr. Symonds says, when we remember that the questioner was now about to seek its answer in the halls of death. With all this evidence before us that death was not unwelcome when it came on that fatal Monday in the winds and waves, is it not fair to assume that had it not come as it did a record of suicide would have been added to one of the most interesting as well as one of the most melancholy histories in the annals of English song?

The examples mentioned have been taken at random, and I am well aware that an exhaustive search would have made this paper many times as long. My only aim has been to cite a few prominent examples in illustration of a subject which to my mind is one of fascinating interest, and to draw, if possible, some deductions from them.

Evidence is not lacking to warrant the assumption that genius is a special morbid condition, and the anthropological school of which Lombroso is the brilliant master is daily gaining converts. Although the doctrines which he advocates have recently received a remarkable impetus, they are not essentially new. Centuries ago Seneca taught that there was no great genius without a tincture of madness, and Cicero spoke of the *furor poeticus*. It is also more than a hundred years since Diderot exclaimed: "Oh, how close the insane and men of genius touch! They are chained, or statues are raised to them." Lamartine speaks of the mental disease called genius; Pascal says that extreme mind is akin to extreme madness; and everybody is familiar with Dryden's couplet:

> "Great wits are sure to madness near allied,
> And thin partitions do their bounds divide."

This is not a pleasant theory I will admit, but, as Lombroso says, does not the botanist find the same thing; and "has not Nature caused to grow from the same germs and on the same clod of earth the nettle and the jasmine, the aconite and the rose"?

But even though this view be not fully accepted, if we take into consideration the fact that the poet lives in an ideal world surrounded by creatures of his own imagination, to whom he attributes the most exaggerated sentiments, it seems to me reasonable to believe that sooner or later unhealthy introspection must be awakened and followed, not infrequently, by the development of morbid tendencies.

But, above all else, it is my belief that a lack of proper training in the early years of life was at the bottom of the unhappiness and mistakes in nearly all the cases mentioned. In the lives of Chatterton, Miller, Tannahill, and Realf, the ones which we have the most closely analyzed, we find a similarity of conditions truly remarkable. Each was born to poverty of the direst kind, each had but little systematic training, and each drifted about upon the sea of knowledge until stranded upon its shoals. If these unhappy lives teach us anything, they certainly show the necessity of guiding with the utmost care the physical, the moral, and the intellectual course of the erratic child of genius. The precocious child especially should receive our most careful attention, for there is more than a grain of truth in the old adage that "genius at five is madness at fifteen." I am myself convinced that precocity is quite as often an indication of morbidity as it is of genius. In rare instances it fulfills its promises, but it only does so when the overactive and unequally developed brain receives proper nourishment and judicious exercise. If the early training be wrong, disappointment is sure to result, and "the huddled knowledge," as Disraeli says, "like corn neglected in a well-stored granary, perishes in its own masses."

According to Prof. W. M. Ramsay, a religious veneration, persistently attached to particular localities, has continued in Asia Minor through all changes in the dominant religion of the country. Modern Turkish survivals of old religious ideas constantly impress the traveler. They are apparent chiefly in the sanctity of particular spots. The sanctity is usually transferred from its original bearer to some Mohammedan or Turkish personage; or else there is a *dede*, or nameless heroic ancestor.

WILL THE COMING WOMAN LOSE HER

By [illegible]

I BELIEVE biologists are pretty well agreed that i... ent course of human evolution continues unchecke... ing man is in serious danger of evolving into a bald... ned. What is to be the fate of the coming woman in t... no one, as yet, has been bold enough to prophesy. Since... it may be safely assumed, for reasons presently to be g... unless the æsthetic instincts of man should underg... change, she will not only retain her "crowning" bea... paired, but in augmented abundance and splendor.

Notwithstanding the gloomy predictions as to the "ba... and toothless future" (see Popular Science Monthly, Oct... in store for the human race, I have been more and more i... as the result of my own observations, with the almost... immunity of my own sex from the results of those i... which are said to be operating so disastrously upon the... attractiveness of the other. I have never seen a case of... baldness among women of any age; partial baldness is r... among sexagenarians, while the large proportion of l... suite of hair to be found among young women and gi... seem to indicate pretty clearly that, if baldness is to be a... teristic of the coming man, it will be one of those sex... ited variations, like hairy chins and guttural voices, that... apply to the other sex.

It may be argued that the superior advantages posse... women for concealing defects of this kind will prevent reli... servations being made in their case; but there are few wo... do not know false hair from genuine when they see it, no... how artistically arranged, and if any woman under sixty i... ed with baldness it is pretty safe to assume that the other... of her acquaintance will know it. At all events, there a... of us, probably, who do not know the truth so far as o... mothers and grandmothers are concerned, and a simple co... son of their soft and often abundant gray tresses with the... pates of their spouses will be sufficient to convince most... that men, as a rule, have a practical monopoly of baldness.

And yet, most of the causes commonly assigned as con... to this defect are as active among women as among men. ... torture their hair with curling-irons and papers and hairpi... degree that no man would tolerate for an instant; they ... and discolor it with all kinds of injurious washes; they rea... the top of their heads structures as heating and uncomfort... a stovepipe hat, or hang upon the back of them appendages ...

nd weight as to strain every hair at the root, and produce nuous headaches; and while their headgear may not be of so preposterous a shape as man's, they wear it much more antly, since they sit with their heads covered in all public s, while he as a rule wears his hat only out of doors. Then, women, as a general thing, enjoy much less vigorous health men, eat less nourishing food—pickles and candy often con-ing a large part of their diet—are more frequently sufferers headaches, deficient circulation, general debility, and Heaven knows what not; and yet, with all this, the sorriest speci- of the sex, physically, often luxuriate in the most abundant of hair.

ow, why should one sex enjoy such comparative immunity the results of practices that are producing such disastrous ts upon the personal appearance of the other? The answer, ke it, is to be found in a cause which Mr. Darwin claims to e been the chief factor in all cases where the purely ornamental lities of a species are concerned—sexual selection. While wom-under the pressure of public sentiment against "old maids," the more urgent pressure of material necessities, will, as a eral thing, marry anybody they think likely to give them a port, regardless of personal defects or attractions, men are e fastidious, and it goes without saying that a bald-headed nan would stand little chance, to use Mr. Darwin's argument, eaving offspring to inherit her deficiencies. I have never wn a woman who would make a bald head an invincible objec- to a man who was eligible in other respects. Most of them indifferent to that peculiarity, while some even like it; they k it looks intellectual, as more than one young woman, un-icious of the grave scientific motive underlying my frivolous aff," has assured me.

After occupying myself for some time with observations upon and middle-aged people, it occurred to me that the influence of subtle factor, sexual selection, could best be determined by rvations upon boys and girls under twenty, in whom, it is to resumed, the influences of heredity have not yet been supple-ted, to any great extent, by other causes. Accordingly, I had ted, and sent out to teachers and school superintendents, five dred blanks, calling for statistics on the subject, with the re-t that they be filled and returned to me within the year. Of five hundred, eighty-six were returned, and some of these con- discrepancies that render them practically worthless—a re-, be it remarked in passing, which betrays a curious indiffer- on the part of teachers to matters of biological interest. The ntic City schools are the only ones from which I succeeded btaining anything like a full report, my efforts being ably seconded by their energetic and wide-awake superintendent, Major W. F. Slaton.

Now, while the statistics at my disposal are too meager to warrant any definite conclusion, it is nevertheless a significant fact that out of a total of 1,196 males between the ages of ten and twenty, ten cases were reported as showing signs of baldness—that is, ·0084, or over eight tenths of one per cent—while in a total of 1,374 females of the same age, but one single case is reported, or about ·00073, a little over $\frac{7}{100}$ of one per cent. In other words, if the unsatisfactory statistics that I have been able to collect can be relied on, the proportion of baldness in boys and girls under twenty is about 80 to 7. As the majority of girls at the age under consideration wear their hair loose, or in simple "Marguerite" braids, so that there is little likelihood of deception, while unwholesome headgear or other individual practices can hardly, as yet, have had time to produce any material effect upon either sex, we may regard the differences indicated by the figures as practically due to the working of heredity alone. Now, there is no apparent reason why girls should not inherit a tendency to baldness as well as boys, unless that tendency is checked by some other factor. Such a factor is sexual selection; for I presume it is hardly necessary to argue here that a bald-headed woman would not stand much chance of "survival" in the struggle for matrimonial honors. As men have always practically done the "selecting," and will probably continue to do so more and more as the conditions of modern life render the competition for husbands more severe, the woman's voice in the matter, when she has any, being limited to a simple negative, it is not likely that the state of baldness to which the human race is said to be tending will ever affect the feminine half of it. There are compensations in all things; and while the individual woman may sometimes murmur at the hard law of dependence which forces her too often to find in some measly little specimen of masculine humanity her only refuge from starvation, the sex in general has to thank the fastidiousness which their superior position cultivates in men for its exemption from a defect as destructive of beauty as of comfort. The time is, perhaps, not very far distant when, in the course of human evolution, a man with hair on his head will be as great an anomaly as a bearded woman, but as long as men love beauty and are won by personal charms, so long will women continue to rejoice in those abundant tresses of brown and gold that are one of the chief ornaments of their sex.

THE PROBLEMS OF ANTHROPOLOGY.*

By RUDOLPH VIRCHOW.

INTERNATIONAL prehistoric congresses have for a whole generation exercised a great influence upon the researches and the ideas of our contemporaries. This institution was founded at the time when the discoveries of Boucher de Perthes of the existence of man in the Drift period; the observations of Ferdinand Keller on pile constructions; those of Cristi and Lartet on the troglodytes of the Dordogne, and of Vorso on the kitchen-middens; and the theory of Darwin and his disciples, were producing a revolution in scientific traditions. As a result of that revolution, the Congress found itself confronting a great problem. It was incumbent on it to study all the countries of Europe in order to collect prehistorical traces of man, to attract general attention to the origin and course of human civilization; and it proposed to itself to remove the veil of mystery from before the primitive cradle of man.

Many of the questions which were raised at this time have now been definitively resolved. We know that man existed in the Quaternary epoch, that he lived through long ages miserable and depressed, while stone, wood, horn, and bone constituted the material of his arms and of his only instruments; we are convinced that a long interval separated the age of stone from the age of metals, and that only in particular places was the use of stone immediately replaced by that of metals. These are the data which now make part of the general knowledge acquired by civilized nations since the foundation of the Congress. But further studies respecting the origin and the regions whence the different branches of civilization have sprung have advanced relatively but very little.

First, the question of Tertiary man especially occupied the Congress, and reached its culminating point at the meeting in Lisbon. We were taken there to the plain of Otta to look in the strata for his remains. We found there flint chips that might in an extreme case be regarded as having been cut by man; but we discovered no human bones or potteries or worked objects; and the majority of the Congress, on leaving the place, were far from being convinced that these flint chips were distinguished, in any respect, from the *débris* which is found in the ground everywhere, and which results from the disintegration of a siliceous soil. Nobody has ever found in virgin Tertiary strata any piece of flint that has been recognized by the learned world as an unquestionable relic of the ex-

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* Address at the opening of the International Congress of Prehistoric Archæology and Anthropology, at Moscow.

istence of man. We have likewise reached the same result in our search for human skulls and bones. We have to recognize that students can not assume that man existed in the Tertiary, or that there is any probability that the human race had its beginning in that epoch; on the contrary, we find a great void which we try to fill with fantastic imaginings, but which furnishes us with no real specimen.

After the Congress of Lisbon, students were more moderate and confined themselves to the search for known objects. Among these objects, archæological finds predominated, and it is easy to understand why archæology has more and more taken the place of anthropology. Palæanthropological objects are so rare, and for the most part so liable to suspicion, that even till the present time the attempt to describe the most ancient race of Quaternary men is beyond the power of science. We have had two examples in Europe that afforded little encouragement: the attempts based on the Canstadt and on the Neanderthal skulls, which, as two eminent students once supposed, belonged to the extinct aborigines of the primitive European race. We discussed the question raised over these two skulls fifteen years ago, at the Congress of German Anthropologists in Ulm, and found that the Canstadt skull did not belong to the Quaternary, while the Neanderthal skull was at least very far from having a typical form.

I shall not examine the whole series of similar discoveries, most of which have only furnished us single exceptional skulls. But I must declare that even if these skulls had been what they were described as being and their geological position had been exactly defined, they could not have constituted proof of the existence of an inferior primitive race that could be regarded as a step between animals and existing man. Many of these skulls appear to be very ancient; but they resemble in all respects the skulls of modern races, and some of them even those of civilized races. We seek in vain for the "missing link" connecting man with the monkey or any other animal species.

We must, however, understand ourselves on a preliminary question. There exists a tradition common to all peoples, or we might say a dogma common to all religions, recognized by all students, ancient and modern, that the human body has an animal organization; that the same physiological and pathological laws rule human and animal life alike. Notwithstanding this uniformity, there exists a definite barrier separating man from the animal, which has not yet been effaced—heredity, which transmits to children the faculties of their parents. We have never seen a monkey bring a man into the world, nor a man produce a monkey. All men having a simian appearance are simply pathological variants. The opinion of Carl Vogt that microcephalous men, resembling simian animals, are produced by atavism, has been wholly abandoned since students have reached the conviction that the skulls of microcephals have indexes of pathological formation, with deficiencies arising from degeneracy.

The human organism, especially in the embryonic stage, is distinguished by many features that have been borrowed, not from the monkey only, but also from other animals. The living elements, the cells, present us the same types in man as in the mammals; sometimes these resemblances in the embryo continue to exist, and are even developed after birth. But this persistence or hyperplasy can not be made to serve as proof of the animal origin of man. Let us take this example of a hyperplasy of this kind: there is in the higher anthropoid apes a bony ramification that connects the jugular of the temporal with the frontal bone. It is sometimes developed in man, and is wanting in some individuals among the higher monkeys. I have shown, and M. Anoutchine has confirmed it, that this ramification occurs very frequently in the Australians, and we both regard the peculiarity as of simian origin. But we can not conclude from that that the Australians are simian-like, for the same peculiarity has been remarked, in some infrequent cases, in the skulls of Europeans; while there is not an example of men having such heads having furnished any other indication of simian organization or development. The bony ramification of the temporal jugular is nothing else than a special peculiarity, sometimes individual, sometimes racial, like curly hair, for example. When we look at a negro's head we might say that it resembles a sheep or a poodle; but, so far as we know, nobody has yet expressed the opinion that negroes are descended from sheep or from dogs. Still, the negroes are like sheep and poodle dogs in the hereditary transmission of a special peculiarity in their hair. In spite of that, their heads in no way resemble those of the animals we have mentioned. Bearing in mind these observations, we have become more circumspect now in our reasonings upon individual or racial analogies between man and animals; we certainly shall not forget that the human organization is in its essentials an animal organism, and that the monstrosities which occasionally appear may be regarded as results of atavism; but we shall require more convincing arguments before we assume a near relationship of man with any definite animal.

It was generally believed a few years ago that there yet existed a few human races which still remained in the primitive inferior condition of their organization. But all these races have been objects of minute investigation, and we know that they have an organization like ours, often indeed superior to that of supposed higher races; thus, the Eskimo head and the head of the Tierra del Fuegians belong to the perfected types. Some races have the same skulls very small, of about the same volume as the microcephalous skulls; for example, the inhabitants of the Andaman Islands and the Veddahs of Ceylon have been regarded as microcephalic. A more exact study has, however, shown a difference between them and the real microcephalic races. The head of an Andaman-islander or of a Veddah is very regular, only all its parts are a little smaller than among men of the ordinary races. Nanicephalic heads (dwarf), as I call them, have none of those characteristic anomalies that distinguish really microcephalic heads.

A single race, that of the Orang-Simaings and the Orang-Cekai of the peninsula of Malacca, still remains unstudied. The single traveler who has penetrated into the mountainous countries inhabited by them, the bold Russian, Miklukho Maklai, has ascertained that certain isolated individuals among Simaings are small and have curled hair. A new expedition has been sent into that country to study the anthropology of the Orang-Cekai, from which I have recently received a skull and a few locks of hair; the stock is really a black race with curly hair, the brachycephalous head of which is distinguished by very moderate interior volume, but it does not offer the most trifling sign of bestial development.

Thus we are repulsed at every line of the assault upon the human question. All the researches undertaken with the aim of finding continuity in progressive development have been without result. There exists no *proanthropos*, no man-monkey, and the "connecting link" remains a phantom.

Scientific anthropology begins with living races; and the first step in the construction of the doctrine of transformism will be the explanation of the way the human races have been formed, and of the means by which they have acquired their specific peculiarities while still preserving hereditary transmission. That is the future field of anthropological debate and investigation. But this field is outside of the limitations of our Congress. It is easy at first sight to suppose a dolichocephalous skull to be transformed into a brachycephalous skull, but still nobody has ever observed the transformation of a dolichocephalous race into a brachycephalous one, or *vice versa*, or of a negro race into an Aryan race.

Prehistoric anthropology should find methods of facilitating acquaintance with the types of ancient races and peoples, and of making possible the discovery of them among living men. It might add to that, if the occasion should present itself, data respecting strange individual cases, by the aid of which it is impossible to form a continuous line or constitute a genealogical tree, but which should be kept in the scientific lumber-room till the time when we can find the intermediate links that may unite them into a series.

And now let us continue faithful to the glorious traditions which our great masters have bequeathed to us. The majority of the students whose names are inscribed in the preceding congresses were archæologists. Lartet and Dessort, Vorso and Liche, Hozedine and Clericci, Ouvarov and Romer, who remain the protecting genius of our congress, have shown us how we must work. To select an example, questions like that of the discovery of copper, and of its value as a medium of exchange, ought to be problems of the greatest interest to us.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

THE ROTATION OF THE FARM.

By APPLETON MORGAN.

IT was an English maxim, as old as Harold, and it is probably a safe one to-day, that "horses feel a famine first." The meaning, of course, is that, in the commencement of a dearth of cereals, the stables would be pillaged of the grains fed to the horses by a hungry populace before it clamored to the authorities for bread.

They seem to have changed all that in Massachusetts. There lies before me a pamphlet, issued by the authority of the Commonwealth of Massachusetts, entitled A Descriptive Catalogue of Farms in Massachusetts, Abandoned or partially Abandoned (issued under the provisions of chapter 280 of the Acts of 1891), by William R. Sessions, Secretary of the State Board of Agriculture, November, 1891. Certainly this is a startling head-line, and those of us who had begun to have faith in modern methods, in agricultural colleges, in the chemistry of crop rotation, by which the element exhausted by the yield of one year should be supplied by the next, confronted by it might begin to weaken as to the compensations, and what had been supposed to be the eternal laws of reciprocal affinities! Is it possible, we would perhaps find ourselves asking, that the Massachusetts farmer, the nearest in the Union in point of mileage to the two or three greatest of its markets, should "abandon" the fields of his ancestors? That, after generations of tillage, any tracts of agricultural land anywhere are diverted to other utilities in the course of their prime function of supporting life is a familiar contingency. Lands once agricultural may be covered by residences or factories as neighboring towns spread out to include them. But absolute abandonment would seem the rarest of possibilities, so long, at least, as the United States is relied upon, as it is to-day, for its over-proportion of the food of this planet of ours. Almost three fifths of the grains, fully half of the meat supply—not to mention the cotton yield—of the civilized world, are expected to be forthcoming from this direction, and yet the New England farmer proposes to "abandon" his share in this great field—a field wherein the farmer, as a farmer, has practically no competition to meet at all! A great deal is being said about the surrender of the farmer class to the appetite for other pursuits. But really it is not, or ought not to be, as bad as that. If other things are equal, as they should be, and if all the adjustments are true, as they should be, there should always be a farmer class and always farms. And while the New England farmer suffers from the American failing of making farms too large, equally with his far Western brother, yet his offset is that, unlike the Western farmer, he does not suffer from immoderate or too numerous middlemen (handlers or brokers), but has, or can have, his market at his door.

The horses in Massachusetts have never yet raised the alarm of famine—not even in the days of the Embargo, or in the cruel times of 1812–'16, when the noble old Bay State was forced by her patriotism not only to send soldiers into a war of which she did not approve, but to see her own peculiar industries ruined, and the only ones ruined, while the war for which she was supplying bone and sinew stimulated every rival industry in her sister States: a pelican situation, which, bad as it was, did not dishearten her or make her falter in her duty. But even then the Massachusetts farmer, who paid a dollar for his hoe, sixty cents a yard for his calico, and thirteen cents for a nutmeg (not a wooden one from a sister State), did not "abandon" his farm. The horses then or since have not been heard from. Why, then, should the State in its paternal capacity step in, announce that her farmers had abandoned her farms, and offer them for sale to strangers? And, so far as the stranger is concerned, he might well ask why he should be expected to buy that which is advertised as useless. One can not exactly break up a farm, as one breaks up a ship, and sell it for junk. At what point, one might ask, does the interest of the stranger directly accrue? Again, there are so many ways of utilizing one's farm. It can be a stock farm, a grazing farm, a dairy, a fruit, a market garden, a poultry, a seeding, a nursery farm. Salt hay is cut from marshes. Cranberries grow in bogs; and if one could not raise cranberries, how about frogs? There is always a demand for the esculent hind legs of those interesting amphibians in some seaboard city; and, indeed, our political economy will not listen to any such thing as a failure in demand or supply of luxuries, however bizarre, any more than of necessities in their due proportions. It is related that even in the midst of the Reign of Terror many of the gentle born, who could not escape from the bloody French cities, hid in garrets or other penetralia, and kept body and soul together by making lace or decorating fans or tapestry; for there was always, it seemed, somebody to buy the yield of fripperies. As long as anything can be produced upon them there should be no abandonment of farms in the vicinity of markets.

We might note, too, that this curious phenomenon of "abandoned" farms in Massachusetts is seen to be further complicated by the fact that it occurs—if it occurs at all—in the face of the extraordinary efforts of that noble State for the educational, the agricultural-educational, betterment of her sons in her agricultural colleges. And, still more suggestively, it appears to the reader of this pamphlet that the Massachusetts farms now "abandoned," or sought to be abandoned, are actually nearer to natural markets or to adequate markets for their produce than any better lands, however served by competing railroads, can possibly be. Nor do I think that the cheap "long haul" which might be supposed to bring the Western prairie into competition with the New England farm will be found to have that effect. The haul is too long and not cheap enough to make the large difference necessary to any such theory. Statistics need not be quoted, surely, to show that the great cities of the Atlantic debouch some thousands untold of their population for at least a third—for certainly a quarter—of the year, into the vicinity of these very markets; or that the great transoceanic facilities—the huge steamships with their abridged transits which have made Europe into a sort of American watering place—have worked no appreciable difference in the mass of Eastern city life which, for that third or quarter of the year, summers in these New England States, and certainly does not draw its consumption of food from any other than these New England markets. Those great laws of compensation (quite as little capable of formulation perhaps as they are perfectly constant and understood) may be relied upon to provide at least this much, to wit, that the increased facilities for visiting Europe from our large trading cities would themselves enrich a non-Europe-visiting class sufficiently to enable it to itself seek a nearer vacation at home, in New England itself, let us say, and so offset the class which, with increasing wealth, yearly finds itself able to cross the Atlantic for its annual outing.

Why, then, in the teeth of this very law of compensating economy, in the teeth of applied science, and in the teeth of the constant rules of supply and demand, should farms in New England be or seek to become "abandoned"?

I believe that certain statistical societies find the reason in what they call sometimes "overeducation," and again sometimes "sentimental education," and yet again "classical education"—the vast numbers of public schools in which not only are all branches of learning taught, but the text-books for teaching them supplied at the public expense (we are confining ourselves to the New England States); the enormous diffusion of cheap literature, or of good literature at cheap prices; the great preponderance of fiction over other reading matter—all these, they tell us, surely and unerringly tend to depopulate farms and to render farm life distasteful to those who live upon them. The farmer's daughter is unwilling to rise early to milk the cows; the farmer's son does not care to fodder the cattle or drive them to the plow or to the harvesting. The daughter has read higher things and prefers her piano, and the son has heard of opportunities of amassing wealth galore in the cities, and every Sunday newspaper tells him of what others have done and of what, therefore, it is assumed that he can do in amassing equal wealth in their streets. This sort of thing is rehashed until it has become a literature in itself, and need not be more than referred to here. But is this the real reason after all? There used to be a proposition quite equally relied upon by these very statistical societies (though I have not heard much of it lately) which ought to counterbalance or compensate for this tendency of the rural youth to cities. It used to be said, I believe, that the cessation of a certain branch of any given industry released a certain proportion of power, which turned itself to some other; for example, that the loss by a city like Portland of its India sugar trade, or by New Bedford or by Sag Harbor of its whaling interests, would be no loss to the community at large, because the handlers of sugar or of whales would gravitate to other employments, and so the economical balance of the community be preserved. If this principle still obtained, then—in view of the large creation of entirely new industries within the last ten or twenty years, such as, for example, the electric power and light, the telephone, the typewriter, the clipper of newspapers (the last three of which certainly do not discriminate in favor of the stronger sex; or, if they discriminate at all, might be said to discriminate against it)—this principle of mutual release ought to be still to the fore; but somehow or other it is not as familiarly quoted now as it was once. I have, for example, heard it gravely argued by a gentleman in New York city, who writes much and well upon economical and politico-economical questions, and who is an enthusiastic free-trader, that, if the doctrine of protection was carried far enough to create new industries in the United States, those industries would require the building of great mills and factories; and that, while those factories were being built, the time of thousands of working people would be on their hands, and that the loss of wages incurred by some thousands of employees who were waiting for those factories and mills to be built would be a serious item in the national wealth! Most of us would not be kept awake of nights by the fear of decreasing national wealth, I think, from that particular state of affairs! Some labor, no doubt, would be required to build those same mills and factories. The laborers who were to build them would perhaps be drawn from somewhere, and so leave vacancies to be filled from somewhere else. But the prospect as it seems was enough to seriously alarm this gentleman; and I doubt not that, from a standpoint the reverse of his, it might still have its terrors to even less special and specious theorists, who still cling to the old fallacy that figures always tell the truth, and will not hear of the proposition of the Irish gentleman in Christie-Murray's delightful novel, who called figures the biggest liars in existence! Because, then, the farmer's daughter prefers her piano to her milking stool, and her brother his bicycle to his fodder scythe: or—let us say, because the one would rather sell ribbons and the other foot up columns of figures in city establishments than to continue in the duties which a residence upon the ancestral acres imposes —the whims or caprices of a few boys and girls are creating great gaps in the agricultural precincts which the supreme, even if elusive, laws of economical compensation are unable to fill!

It would seem to be a rather violent proposition this: namely, that one's personal whim can explode or dominate the laws of supply and demand.

Instead of the rotation of crops, is it not what might be called the "rotation of the farm," brought on by the exchange of farm for city employments by a constant or periodic ratio, which has called for the Massachusetts pamphlet?

The man who lives in the country yearns for the city. The man who lives in the city yearns for the country. The farmer would seek pent precincts of the town and bend over ledgers; the clerk, already bent double over his ledgers, craves the free air and the unconfined horizons of the farm, the distant hills, and the broad acres between. Variety, is it not, which they both seek? In opposite currents, doubtless, but both continually by immutable tendencies. Such is certainly the optimistic theory of the situation implied by these "abandoned" farm pamphlets. Is it the true one?

To assume that the farmer will farm no more would be a fearful prospect for our race—quite as fearful as to assume that the soldier would not fight for his country against any other country, that the tailor would not make us clothes, or that the shoemaker would not supply us with shoes. Surely it would be great gain, not only to the Commonwealth of Massachusetts but to the national commonwealth, if, instead of drawing grewsome and doleful morals from a pamphlet with the pathetic title, Catalogue of Abandoned farms in Massachusetts (or New Hampshire or Vermont), we could infer that the issuing of these catalogues was but a rational and normal detail by way of facility in the progression of that great law which moves communities of individuals back and forward, and back and forward again, from one precinct to another, and from one vicinage to another on the map of societies and of States, but always conserving and preserving the equation of prosperity, of tranquillity, and of the general content in and between and around them all.

Taking the Massachusetts pamphlet as exemplary of them all, it seems to me that the above is the fact. For I find, first, that this abandonment amounts rather to a desire to sell at some fair or "lump" price (and I may add always one somehow approximate to the general value of the land, which certainly is not even as a figure of speech an "abandonment"); secondly, I find that the "abandonment" is larger the farther we leave the seacoast and traverse toward the interior countries. The pamphlet shows that 3·45 per cent of the total farm average of the State now offered for sale lies outside of the limits of cities, in the extreme interior, while only about 0·87 per cent of such farm land is situated toward the seacoast.

In Nantucket and Suffolk Counties—the one an island and the other a peninsular county open on three sides to the seacoast—no such "abandoned" land is offered for sale at all. In Essex County, adjoining Suffolk, where the interior nature of the territory is a trifle larger than in Suffolk, we have a return of salable land under this pressure, of a trifle less than 0·06 per cent. In Hampshire County, where several settlements are to this day without railroad or telegraphic facilities, containing perhaps but a single town of any size, and where intercommunication is about as rare as an eclipse of the sun, the percentage of land offered for sale is the highest, being 6·85 per cent; thus clearly proving, if figures can prove anything, that it is the desire for community, the weariness of isolation, the craving for society, rather than a seeking for the precariousness of new employments, or a failure of the land he has tilled so long, which leads the ruralist to woo forced markets for his farm lands and new industries elsewhere for himself. And not only is this the case, but in a study of this very pamphlet there appears the confirmation of this proposition that normal forces and attractions invariably find their counter-forces and attractions. It appears that as soon as the Massachusetts authorities announced their purpose of issuing this list of "abandoned farms," inquiries concerning these farms were received in considerable numbers. These the Bureau of Agriculture carefully tabulated to the States whence they came, with the following results: England (London), 1; Canada (Montreal), 2; Washington, D. C., 1: Texas, 1; Illinois, 2; Michigan, 3; Montana, 1; Ohio, 2; Florida, 3; North Carolina, 1; Virginia, 4; Washington Territory, 1; Pennsylvania, 5; California, 1; Iowa, 1; Connecticut, 10; New Hampshire, 4; Vermont, 1; Rhode Island, 9; New York city, 79; Massachusetts coastwise counties, 140.

It certainly seems to me that there could be no clearer proof than this that the desire to move inland comes from the thickly populated coast lines and the vicinities of the larger cities. That, after all, the greatest demand for Massachusetts farms comes from Massachusetts itself must be a glory and a pride to that noble old Commonwealth, and an acquittal from the charge that her thousands of common schools and hundreds of town libraries have cultivated in her sons and daughters a distaste for the life of an independent farmer. It is not abandonment, but rotation, and seems to illustrate one of Emerson's postulates, viz., that "demand and supply run into every invisible and unnamed province of whim and passion." But, apart from whim and passion, there is a great justice in this rotation. The catalogue might have been entitled A List of Farms in Massachusetts whose Owners are willing to sell them rather cheaply, and better express what actually appears to be the situation. The Rotation of the Farm, or the Rotation of the Owner of the Farm, would seem to be the better title.

MR. FRANCIS GALTON avows himself a qualified believer in the possibility of signaling to Mars. Accepting as a fact that the Lick telescope can bring the planet optically to within 50,000 miles, he has found that a reflected beam of sunlight, sent through a hole one tenth of an inch square, is visible as a glint at a distance of ten miles. Hence, with fairly clear atmospheres, the flash from many mirrors simultaneously, whose aggregate width is fifteen yards and their aggregate length, say, to allow for slope, twenty-five yards, would be visible in Mars, if seen through a telescope such as that at the Lick Observatory. "With funds and good-will there seems no insuperable difficulty in flashing from a very much larger surface than the above, and sending signals that the inhabitants of Mars, if they have eyes, wits, and fairly good telescopes, would speculate on and wish to answer. One, two, three, might be slowly flashed over and over again from us to them, and possibly in some years, to allow time for speculation in Mars to bear fruit, one, two, three might come back in response."

THE remarkable pit of the Creux de Souci, France, is situated in a sheet of recent basalt on the south side of the Puy de Montchal. The opening is eighty-two feet in diameter and thirty-eight feet deep; but at that depth a hole about ten feet wide communicates with a hollow seventy feet deep, at the bottom of which is a stagnant pool overladen with carbonic acid which forbids access to the water surface. The interior is a vast vaulted hollow, apparently formed in the basalt when semi-fluid, by an explosion of volcanic gas. The temperature falls from 51° Fahr. in the open air to 34° near the water.

THE LOGIC OF ORGANIC EVOLUTION.

By FRANK CRAMER.

IN his work on the Principles of Science, Jevons described with great clearness the logical phases of scientific theories and illustrated them by a wealth of instances drawn from the sciences of mathematics, physics, astronomy, and chemistry. While he accords to the theory of evolution an importance equal to that of any other theory, he says but little about its evidence or logical history. He practically leaves the biological sciences and geology untouched, except in the chapter on classification, where he says, in closing the subject: "Natural classification in the animal and vegetable kingdoms is a special problem, and . . . the particular methods and difficulties to which it gives rise are not those common to all cases of classification, as so many physicists have supposed. Genealogical resemblances are only a special case of resemblances in general." *

The sciences of chemistry, physics, and astronomy, based as they are on mathematics, allow precise statement and accurate experiment. In geology and biology, on the other hand, the factors are so complex that these sciences take on the nature of historical sciences, with all the difficulties which such a statement implies. The difference can be easily illustrated. Certain perturbations of the planets indicated the presence of another one as yet unseen. The amount of the disturbances could be accurately determined. Adams and Le Verrier almost simultaneously predicted the presence of Neptune at a definite point in the heavens, and the prediction was verified by the immediate discovery of the planet. The human race must have appeared at a definite time in some definite part of the earth; but biological science lacks all the factors with which to parallel the case of Neptune by pointing out by a prediction the time and place of the appearance of the race. It knows that the event occurred, but must wait for accident to reveal the place and depend on the broadest generalizations to reveal even the relative age of man.

The utter lack of rigidity in the relations of living things puts quantitative statement almost entirely out of question; except that in some cases it is possible to work out a valuable system of averages. Individual beings can be measured, but the laws of biology can not be put in mathematical form; hence the lack of mathematical precision, without which the history of a science does not lend itself very easily to logical treatment. Evolution is pre-eminently a historical law, but its relations to the evidence

* Jevons, Principles of Science, p. 727.

for and against it are such that its logical history is both unique and inspiring. If it has passed through a definite series of logical phases similar to those through which the mathematico-physical sciences have passed, if it has fulfilled the same conditions and led to similar and equally brilliant results, its logical status is permanently fixed.

The cell doctrine,* which now lies at the foundation of biological science, illustrates an important principle in the growth of theories. The significant points in its history, for the present purpose, are: 1. It took its earliest shape as a botanical theory, arising from a very small part of the facts that it was destined to explain. 2. Those facts were the most obtrusive of the whole group of facts to which they belong. The most highly wrought products of the forces involved are always first discovered, and thus it comes about that the facts which are most difficult to explain and which are farthest away from the point where Nature began its work, at first form the foundation of a scientific theory. Knowledge increases by traveling backward from the specialized to the generalized, and the theory is perfected only after a complete series of facts has been secured in this way.

One of the results of this principle is that all scientific doctrines in which a historical arrangement of phenomena is involved must pass through what is aptly called the catastrophic stage. The geological doctrine current in the early part of the century, that there have been successive world-wide catastrophes followed by recreations, was perfectly natural in that stage of the science. Only the most obtrusive facts were known. The mountains were regarded as simple products instead of very complex accumulations of the effects of forces working steadily. When geology passed from catastrophe to continuity, it made its great permanent stride forward by providing itself with a key to all the facts that have since been discovered.

The theory of evolution has passed through all these developmental stages. The law itself was not recognized until long after formal relationships had been established, and its discovery was simply a recognition of the principle of continuity. Natural history began with species—the mountain-ranges of biology—and regarded them as simple facts instead of last terms in a long series. The breaches between species, as between mountains, was what made them striking. The evidence that has been destroyed played an important part in the early stages of this as of all other lines of scientific reasoning which are dependent on historical evidence. The more hidden and comparatively insignificant facts, the residuum which constitutes the difficulties of classification,

* Sachs, History of Botany.

here as everywhere, compelled recognition by forcing themselves in increasing numbers upon the attention of biologists. The effort to suppress them by the old theory gave place gradually to the effort to base the new idea of continuity upon them. This period of reversal in scientific activity and the accompanying rapid re-interpretation of both the old and new phenomena, while it is recognizable in the histories of many sciences, is probably most striking in the history of evolution.

Every hypothesis by its nature accords with the facts from which it sprang. But it is the weakness of all hypotheses, true and false alike, that they are at first based on only a small part of the facts, and these are nearly always the most unsafe, because they are, as has been shown, the most highly specialized. The true hypothesis has to pass successfully through the ordeal of assimilating large bodies of facts that are already known by observation apart from the hypothesis. The theory of evolution did this as thoroughly and perhaps more rapidly since Darwin's time than any other scientific theory. There is a vast number of illustrations of this, but a typical one will suffice. Anatomy had long ago established the presence of valves in human veins, and physiology assigned to them the only intelligible function—that of preventing the blood from flowing back toward the capillaries. Had they been distributed throughout the venous system, there would have been no problem; but they are present in some veins and absent in others. No law regulating their distribution could be assigned, and students of human anatomy had to learn their distribution by sheer force of memory. Here was a fine group of arbitrary facts established by empirical observation. Not only was there no law to explain their distribution—their actual arrangement was utterly irrational if it were true that they were intended to prevent the backward flow of blood. It was easy enough to understand, from the old view of creation, why there should be valves in the veins of the arms and legs; but it was stultifying to learn that the spinal, iliac, portal, and above all the inferior vena cava, the largest vein in the body carrying blood upward, are without valves. To make the facts and their functional explanation still more incongruous, there are valves in the intercostal veins, in which the blood flows horizontally; and in the thyroid and internal and external jugulars, in which the blood flows down hill. Valves and gravitation apparently had nothing to do with each other.

Dr. Clevenger * was the first to explain this group of facts by an application of the theory of evolution. If the theory is true,

* Physiology and Psychology, Clevenger, pp. 38–48. American Naturalist, January, 1884.

man's ancestors were quadrupeds, and the time during which he has walked upright is insignificant compared with the time during which they walked on all fours. The structures developed in his ancestors and not yet modified to suit his new posture should be expected to hold anomalous relations. So far as known, the general distribution of valves in the veins is the same in man as in the mammals near him, and when he is placed back on all fours the arrangement of the valves is perfectly intelligible. The veins of the limbs, the jugular and intercostal veins, then carry blood upward; and the venæ cavæ and other valveless veins are horizontal and have no need of valves. Many important facts of a pathological nature are accounted for by the theory of imperfect adjustment of bodily structure and posture.* This explanation of them is so striking that Clevenger irreverently suggests that the original sin of man may have been the act of getting up on his hind legs.†

When a theory has thus assimilated all the groups of facts related to those from which it sprang and which are unintelligible without it, it has fulfilled the philosophical requirements of a true theory. But every great generalization opens more problems than it closes. This has been true in astronomy, physics, chemistry, and geology, and is true of biology. There are now numberless questions to be answered in biology which could not even be raised without the theory of descent. An illustration may be drawn from the case already cited. Some of the cephalic veins have no valves, but should have them if the explanation is true; the azygos vein has rudimentary valves, but does not need them in the quadrupedal state. These facts become new problems and require subsidiary explanations. By regarding some of the imperfect valves as obsolescent and others as nascent, some disappearing because they are no longer useful and others appearing where they are needed, the exceptions are mostly removed. Frequently such exceptions are not simply accounted for under the theory, but form some of its most striking proofs.‡ Fruitfulness in furnishing problems for solution, instead of indicating weakness, proves the strength of a theory. Alchemy, the Ptolemaic astronomy, and the doctrine of special creation alike, could not lead to a thousandth part of the scientific activity that has followed in the wake of the theories that supplanted them, because they furnished no way of approach to the numberless special problems.

The irresistible power of a true theory rests in the end in the

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* Piles, prolapsus uteri, inguinal hernia, etc. † Trout of Yellowstone Park.

‡ For a fine illustration see Wallace, Geographical Distribution of Animals, vol. i, pp. 209–214.

possibility which it opens of asking and answering questions by the deductive method. It might be supposed that a theory without a mathematical basis would exhibit comparatively little power of prediction, although its validity might never be questioned. Quantity of effect can not be measured, much less predicted, by deduction from theories susceptible only of historical treatment. All that can be expected is the power to indicate the presence or absence of things that are still unknown. But the laws of heredity, variation, correlation, etc., although still undefined and perhaps undefinable, furnish peculiar opportunities for brilliant deduction.

Paleontology would be a sorry science without the power of restoration afforded by the principle of correlation. Its fragments of bones and teeth and stumps and leaves would be almost absolutely worthless. But from the standpoint of logic this is as truly prediction by deduction from known laws as the minute predictions for the nautical almanac. Perfect heredity would place the principle on a basis of certainty. Any one character of ruminants indicated to Cuvier the presence of all the rest. But the generalized types of paleontology are transitional forms possessing combinations of ruminant characters, with others belonging to the carnivora, such as he never dreamed of. But the recognition of secular change in the correlations of organs, instead of weakening, has strengthened the possibility of anticipating unknown facts.

In recent years the progress from deduction to verification has been so rapid that frequently the latter has followed at the heels of the former, so that the element of time has hardly entered between them to make them both more striking. Many of the deductions from the theory of descent, afterward verified, are commonplaces to the scientist, but their logical force is not sufficiently emphasized when the nature of the evidence is considered.

The doctrine of descent required the belief that ruminants once had upper incisors and canines. The belief was made almost a certainty by the presence of partially developed fœtal teeth where they are absent after birth. The confident expectation was justified by the discovery of generalized ruminants with full sets of teeth. If man were descended from lower forms, an explanation was required for the absence of the os centrale as an independent bone from the human wrist, for it is almost constantly present in amphibians, reptiles, and mammals. Rosenberg looked for it in the human embryo and found it. Wiedersheim * was moved to declare that this was one of the greatest triumphs that morphology, based on the theory of descent, had yet won. The

* Wiedersheim, Lehrbuch der vergleichenden Anatomie der Wirbelthiere, p. 228.

same logical process was exemplified in the discovery of abdominal ribs in the human embryo.

As long ago as 1801 Blumenbach inferred from the configuration of its skull that ornithorhyncus laid eggs, and his deduction, based on the known correlation of characters, was verified by Caldwell's recent demonstration that the monotremes are egg-layers. There was an unverified deduction that monotremes must at some time have possessed normal teeth; it was verified by the recent discovery of calcified teeth in monotreme embryos. "Thatcher showed in 1887 that fins of fishes are derived from two pairs of lateral folds. In a paper on the significance of bone structure Dwight commented on this and said that if evolution were true he could see no reason why no vertebrate had more than four limbs. He also said that he could see no reason why no vertebrate had more than two eyes. In the same year Watase demonstrated that the Japanese goldfish has eight limbs and Spencer showed that all vertebrates have a third eye in the pineal gland. Spencer predicted that fossils would be found in which the pineal eye was functional; Cope demonstrated in fossils the orbit of this third eye and pointed out the attachment of muscles for its movement." *

"Evolution suggested the annelids as remote ancestors of the vertebrates. Kowalevsky was thus led to the discovery of germ-layers among these animals—homologous with those of vertebrates. In the same way, but on the other side, Semper was led to the discovery of genuine worm kidneys (*nephridia*) in the lower fishes. Starting with the theory of genetic affinity, we have discovered a whole series of organs and tissues that had hitherto remained unknown. For example, we have now the 'spinal ganglia' in worms, the 'spinal nerves,' and, what is perhaps more important, we have discovered the sense organs out of which the sense organs of the vertebrates have been gradually built up." †

One of the best-defined anticipations, and one that found confident expression from different sources, in the way of special predictions, long before it was verified, was the belief that primitive mammals were generalized types. Cope wrote, March, 1874, "I trust that I have made it sufficiently obvious that the primitive genera of this division of mammals (*Mammalia educabilia*) must have been bunodonts with pentadactyl plantigrade feet." ‡ "No perissodactyl or artiodactyl mammal was known at that time to possess such feet, nor was any perissodactyl known to possess tubercular teeth." Since the prediction was made, Cope has described nine species of the Eocene genus *Phenacodus*, "prob-

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* Kingsley. † Whitman.

‡ Journal of Academy of Natural Sciences, Philadelphia, March, 1874.

ably the most generalized mammal known." They had five toes on each foot and a bunodont dentition; with primitive ungulate characters went complete sets of unmodified teeth and foot bones.*

Marsh's famous pedigree of the horse illustrates the same process. Both he and others clearly foresaw many of the results that he afterward worked out. A large part of the logical value of this restoration of the genealogy of the horse family arises from the fact that what is now established by investigation was once an unverified deduction.†

Such verifications, especially in paleontology, are often due to accident. The predictions might, therefore, and often actually do remain unverified and practically unverifiable, because it is not known where to look for the evidence. Such unverified deductions are frequently scouted as absolutely worthless for the purposes of biological science. This attitude is not taken toward similar deductions in other sciences, for the single reason that there are no external reasons for combating the theories. Enumerating a number of such cases from physics and chemistry, Jevons adds, "To my mind, some of the most interesting truths in the whole range of science are those which have not been, and in many cases probably never can be, verified by trial." ‡

The most famous of these unverified deductions in biology is that concerning the descent of man. The facts on which the deduction that man is descended from lower animals is based are derived from anatomy and embryology. The evidence is circumstantial; but one of the most brilliant of the predictions enumerated was based on this deduction and verified by embryology. It is only with respect to the paleontological evidence that the "deduction is unverified." But if the chain of missing links were absolutely complete, it would only be circumstantial evidence. The direct evidence is forever beyond reach, because when the race was born there was no scientist present to observe it.

This case serves well to illustrate the nature of the objections to the theory. The best theory of evidence of a historical nature has been worked out by the law courts. There, no amount of negative evidence has any value whatever in the face of even circumstantial evidence of a positive nature. The only way in which the accused one can shake off the implication is, to furnish positive evidence that some one else committed the crime, or that he was in some other definite place when it was committed. A careful consideration of the well-understood doctrine of *alibi*,

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* Cope, American Naturalist, August, 1884.

† Marsh, American Journal of Science, March, 1874, and other papers in the same journal.

‡ Principles of Science, p. 548.

which involves all negative evidence, might have prevented a generation of logical inconsequence in the discussion of man's origin. The fact that no so-called connecting links have been found can have no value whatever as evidence until it is shown that the whole earth has been searched and that there are none, and that no such fossils have ever been destroyed by natural processes. The deduction is justified by the evidence from other departments.

Agassiz, I believe, made the promise to furnish the positive evidence that no such fossils ever existed by showing that the geological series, at least so far as man is concerned, is complete; and hence that if they ever existed they should have been found. Death interfered with the fulfillment of the promise. He, like others, believed that man appeared at some definite place at some definite time in the world's history. Had he succeeded in proving the geological series complete, he would have caught, not others, but himself, in his logical toils. He first of all men would have been under obligation to show when and where man did appear, and that connecting links were not among the circumstances that immediately preceded his appearance.

The radical disappearance of objections to the theory before the introduction of new and especially the pertinacity of the old evidence is extremely interesting. There are imperfections in the evidence, many of which can never be removed. But the difficulties are not logical but practical; they are due to scientific ignorance. In every phase of its development the theory has fulfilled the conditions imposed upon it by logic, and repeated the history of other established scientific doctrines. At first superficial and catastrophic, but approaching through formality to Nature's path, biological science finally entered upon an explanation of its natural arrangements and formal laws. The theory of evolution itself passed from the condition of a simple induction to the explanation of vast numbers of facts that had been empirically discovered; opened new fields of investigation; led to the discovery of whole series of phenomena that had been previously overlooked; and gave rise to confident expectation frequently culminating in definite predictions subsequently verified by investigation—until, in the words of perhaps the foremost investigator in America, "we are in fact doing hardly anything else to-day than to verify the suggestions which evolution makes." *

* Whitman.

PROFITS OF LEGITIMATE BUSINESS NOT TOO LARGE.

By P. F. HALLOCK.

IN The Popular Science Monthly for November Mr. J. B. Mann discussed the question, "Are Business Profits too Large?" His article is a defense of those business methods which have made the Vanderbilts, the Stewarts, and the Goulds. It is our purpose to briefly examine the statements from which he draws his conclusion.

That labor is at a great disadvantage is admitted, but Mr. Mann says, "It is a disadvantage imposed by Nature, and so need not be discussed." If this were true, there would be greater need of discussion, but fortunately it is not. Nature provides bountifully for all—there is a surplus of everything, and no one is required to be a drudge; but, by following the "gospel of greed," a few have taken possession of the wealth produced by the many, and amid an abundance half our people are fighting for a bare living. The ability to legally take from the masses justifies the taking, in the opinion of Mr. Mann. This is the new version of that barbarous rule of conduct, "Might makes right." A commercial pirate is worse than the one who robs by force, for the former is protected in his robbery. No man, by honest methods, can make millions in a few years. Such a one must, in some way, accumulate without rendering an equivalent. There is no principle of economics clearer than this.

To show that the workingmen get their full share of what they produce, Mr. Mann states that "there is no business of recognized legitimacy that pays labor only a third. . . . There is no business that gives to capital and skill combined even ten dollars out of thirty." If these sentences mean anything, it is that labor gets more than two thirds of production. This is not true of the following industries: The manufacture of iron and steel, the mining of coal, the manufacture of boots and shoes, the manufacture of sewing machines, the petroleum industry as carried on by the Standard Oil Company, the lumber business, the manufacture of clothing, watches, matches, and salt, not to mention the numberless notions that are consumed in every household. The truth is that the actual labor cost of almost every staple is a small fraction of its selling price.

Mr. Mann says that only one in ten has a competency by his own exertions, and that one because he was energetic, faithful, competent, and thoroughly systematic from the start. Before the era of paternalism this was the rule, now it is almost an exception. There are at least a hundred men in the city of Pittsburg who have been more industrious, more economical, and who are fully as skillful as Mr. Carnegie, and yet are not worth ten thousand dollars apiece. How did it happen? They had to depend upon their own resources, while the Government gave Mr. Carnegie the power to tax every consumer of iron and steel. Another set of men are rich because they taxed the consumers of sugar, another made their millions by the duty on glass, another built railroads at the expense of the nation, and another swindled corporate stockholders and robbed the people generally. Yet, in the face of these facts, Mr. Mann would have us believe that great wealth is the product of honest industry and consummate skill, and that the millionaires are our real benefactors.

The way in which the middlemen and the railroad kings help the farmer is cleverly illustrated by Mr. Mann; but the farmer, he adds, is so unreasonable as to find fault with them, simply because they have made more money than he has. In other words, the farmers' complaints arise from envy—they have no real grievance.

A superficial knowledge of human nature, without being acquainted with the facts in the case, would discredit the statement. Men do not seriously complain without a reason; a person making a thousand dollars a year is not envious because a neighbor makes two or three thousand. The village merchant who by fair dealing has accumulated twenty or fifty thousand dollars is not hated by his customers and townsmen. The possessor of a legitimate fortune is invariably respected. Let us now turn to the facts. In 1860 there were practically no tenant farmers in the country, now twenty-five per cent are renters. Before the war, the farmers owned seventy per cent of the wealth of the nation; in 1890 they owned thirty-five per cent, and paid sixty-five per cent of the taxes. More than thirty per cent of the farms are mortgaged, and the average rate of interest will exceed eight per cent.

When the farmer could no longer be blinded by political prejudice, he realized his condition and forthwith discovered that, while he had been paying the taxes and growing poorer and poorer, another class had been growing richer and richer; they were few in numbers but all-powerful; they not only controlled the business of the country, but the legislation; they were the real rulers of the republic. Is it any wonder, then, that the farmers complain, that they have organized for protection? That they have been so slow to move in their own behalf and so conservative is certainly surprising.

Mr. Mann somewhat rashly assumes that the rich pay their portion of the taxes, and that their wealth would not be in existence had they not produced it. It is generally conceded that the rich do not pay their just share of the public burdens. All economic writers admit this, and I never heard it questioned before. Under the present system of taxation taxes are shifted from the landlord to the tenant, from the creditor to the debtor, from the manufacturer to the consumer, from the corporations to their patrons—in a word, from capital to labor.

The second proposition, that the rich create their wealth, is equally untenable. Manipulation and production are totally different. No person can add to the actual wealth of the nation, unless he be an inventor, a million dollars; it is beyond the power of production; but by manipulation, by donations, and by legislation, men may possess millions, but they never created them. Instead of the rich adding to the nation's wealth they take from it, by depriving the producers of the capital which they need to make their work effective; there is a limited amount of money, and when concentrated in the hands of a few the real workers are at a disadvantage, and the amount of wealth produced by them is perceptibly lessened. This applies to the farmers, to most manufacturers, and to business men generally.

Neither in the statement of the question nor in the argument is there a distinction made between business men. The tradesman who with difficulty keeps from insolvency, or actually fails, is classed by Mr. Mann with the Stewarts and the Vanderbilts. No one complains of the great body of business men. As a rule, their profits are not too large. They would make more money if the farmers and the wage-earners were prosperous. Those who are responsible for all the complaints, for all the injustice, for agricultural depression, are the seventy-five thousand who own more than half the wealth of the country, and whose wealth is due to class legislation, to a vicious system of taxation, to national and State donations, to swindling the people through the agency of corporations and limited partnerships, and to gambling in securities and the necessaries of life.

Lieutenant Peary reports as results of his Arctic Expedition, that he determined the northern coast of Greenland and found the ice cape ending south of Victoria Inlet; and that he reached, at 34° west longitude, the latitude 82° north. This is the highest latitude ever reached on the east coast of Greenland, and has been exceeded in all the annals of arctic exploration only by the attainment by Lieutenant Lockwood, of Greely's expedition, of 83° 20′ on the west coast.

According to an address by the Rev. C. J. Ball at the recent International Oriental Congress, the vocabulary and the grammar of the ancient language of China are now being traced back to the yet more ancient speech of the early civilizers of Babylonia. The identity of the two systems of writing is established by detailed comparisons of selected characters; of Chinese terms referred to Accadian originals; of numerals and pronouns; and of features of syntactical arrangement.

TOTEMISM IN THE EVOLUTION OF THEOLOGY.*

BY MRS. CLARA KEMPTON BARNUM.

THE thoughtful student of universal history can plainly see, under the clear light afforded by modern research, that the line of continuity from the lowest savagery, to the highest civilization is unbroken; the vast interval between the two extremes being filled by "the series of advances through which the marvelous and complicated mechanism of refined societies has issued from the savage condition in which the first men long lived."

Anthropologists study closely the myths, customs, and traditions of uncivilized tribes of our own time, as they are thought to present the most reliable ideas of ancient peoples when they were in a similar stage of mental development.

This method commends itself to that large class of cultured minds, trained in the doctrine of evolution, who believe that, in examining things present, they have data from which to reason in regard to what has been; there being no necessity for imagining other causes than those now in action to account for the past in either the physical or psychical world.

The savage regards all Nature as a combination of distinct intelligent personalities. He draws no line of separation between himself and material things, but thinks every object upon which his eyes rest is endowed with life akin to his own. He even believes that the sky, wind, sun, and dawn are persons, "with human parts and passions." He looks upon the lower animals as more powerful than himself, and therefore worships many of them as divine and creative. This crude *personalism* has well been termed the distinctive philosophy of primitive culture.

Totem is a word introduced into our literature by an Indian interpreter of the last century, but it is only within recent years that totemism has been studied scientifically. It prevails almost universally among the aborigines of Australia at the present time. It is also found among savage tribes in North and South America, as well as among peoples in the same primitive stage of culture all over the world. The totem is never an isolated object like a fetich, but always a class, such as species of plants or animals—usually the latter—which certain stocks of men worship, and from whom they consider themselves descended. The clans take the name of their animal deity, such as Wolf, Bear, Serpent, Raven, and Fox. The stock name is generally traced through the female line, and no man is allowed to marry a woman who has descended from the same animal ancestor.

* Suggested by reading A Washington Bible Class, by Gail Hamilton.

There are many conclusive reasons for believing that all ancient races, during their early development, lived under this crude system, and, like the savage stocks of our own time, based their laws, both social and religious, upon the well-marked lines of totemism.

The figures of the gods in ancient Egypt were represented on the monuments for ages in animal form. The organization of the local population ran on totem lines. Each city had different beast gods. In the royal genealogies, beasts are named as ancestors; showing that the early Egyptians actually considered themselves descendants of animals. The primitive element in the early Greek religion has been preserved in the "sacred chapters," fragments of which have been given us by Herodotus, Pausanias, and others—proving that the oldest images of the Grecian gods were represented in animal forms, and that the different royal houses claimed descent from animals, as do the savages of America and Australia. Mr. J. McLennan, in his papers on The Worship of Plants and Animals, calls our attention to many evidences that the early Romans as well as the Greeks worshiped totems. The Old Testament records show—notwithstanding the various revisions through which these venerated books have passed—many indications of animal-worship among the Israelites, which must have lasted for ages before the prohibition inculcated in the second line of the Decalogue was formulated. At a comparatively late date "Jehovah was worshiped under the popular symbol of a bull, while the twelve oxen upholding the laver in Solomon's temple, as well as the horns adorning the altar, were drawn from the prevalent bull-worship." * Modern research has also proved that the cherubim were represented in the form of winged bulls. M. Lenormant, in his famous book on the Beginnings of History, says that, during the time of the kings and prophets, "most assuredly the cherubim, as there described, are animals."

The process by which the anthropomorphic god superseded the worship of the totem deity has been suggested by Mr. Andrew Lang. "The encyclopædia of myths," as he has been rightly called, has gained the lasting gratitude of all earnest students of primitive culture for his lucid explanations of the puzzling problem of animal-worship. He says: "Among certain peoples, as in Samoa, we see the process of advance toward the Greek and Syrian view of sacred animals. They allege that, in these various beast-totems of their various stocks, the one god common to all these stocks is *incarnate*. . . . Savage ideas like these would account for the holy animals of different deities, especially in

* Wrong and Right Uses of the Bible. By Rev. H. R. Newton.

Greece, where each god has a small menagerie of sacred animals; and it seems probable that these animals were originally the totems of the different stocks subsumed into the worship of the anthropomorphic deity."

In Egypt, when animal-worship became associated with anthropomorphic conceptions, the figures of the gods after the twelfth dynasty exhibit a gradual transition by being represented in a mixed figure of an animal's head upon a human form.

Apis, the sacred bull, was worshiped from the earliest period, but does not appear on the monuments until the fourth dynasty. Apis was supposed to have been born from a virgin cow rendered pregnant by a moonbeam, or a flash of lightning. We find in the theology of an African tribe the story of one of their gods being born in a similar mysterious way from a cow; and we see a survival of this savage thought in regard to Indra recorded in the Rig-Veda: "His mother: a cow, bore Indra, an unlicked calf." The mother of Apis shares on the monuments the honors of the bull, and is represented, under the attributes of Isis Hathor, as a goddess with a cow's head. The hieroglyphics represent Osiris adorned with horns, or with the head of a bull, and unite the two names, Apis-Osiris. According to Greek tradition, Apis was the *incarnation* of Osiris.*

Careful study proves to us that "the peculiar mark of the wilder American tribe legends is the bestial character of the divine beings, which is also illustrated in Australia and Africa, while the bestial clothing, feathers or fur, drops but slowly off Indra, Zeus, Dionysus, the Egyptian Osiris, and the Scandinavian Odin."

In following the slow advance in culture from animal-worship to the highest monotheistic conception, we are forced to admit that "*all* religions are one and the same religion, in various stages of evolution, taking on different colors from local soils and climates, and thus developing many varieties." In the earliest phases of religious development we find the idea of two beings, one good and the other evil, who are supposed to be engaged in constant warfare. This widely spread dualistic myth seems to have originated in the primitive mind through an attempt to explain the origin of evil in the world. Men ask in Australia, as in Persia, "Why do things go wrong?" and are answered by the myth—still surviving in modern theology—of the evil one who has thwarted the Creator of all things. Among the Thlinkuts, on our Western continent, the great opponent of their totem deity—the Raven—is the wicked Wolf, the ancestor of the wolf race of men. In certain Australian tribes their creative totem—the Eagle Hawk—is always at war with the evil crow.

* Article Apis, by Dr. Samuel Birch. Encyclopædia Britannica, ninth edition.

While among savage tribes the evil being is represented by different members of the animal kingdom, in nearly all mythologies of civilized peoples the evil power is depicted in the form of a gigantic serpent. Indra—in the form of a bull—fights the demon serpent Vitria. In Persia the same idea is represented in the evil Ahriman, in his continual warfare with the good Ormuzd. In Egypt, it was Osiris and Typhon; in Scandinavia, Odin and Loki; and in Judaism, Jehovah and Satan.

The necessity of a third being to mediate between the two opposing powers seems the natural outgrowth of this dualistic conception, producing the *triad*. It is worthy of note that the idea so prominent in savage theology—immaculate conception—remains imbedded in the mythology of civilized races, the third member of the triads being always represented as virgin-born. In Egypt, Horus, the son of the virgin goddess Isis, overcomes the power of the evil Typhon. Zoroasterism retained for a long period the dualistic conception, finally added to the two antagonistic powers, Mithras as the Savior and Mediator. In India it was Vishnu, who took upon himself the form of a man, and became known as the Restorer.

The same impulse which forced men to rise from the disconnected fancies of animal-worship, compelled a further advance to the adoration of one God. This monotheistic element is seen running through the theological conceptions of savage and civilized peoples, in their worship of one supreme God presiding over a number of inferior deities. Even in polytheistic Rome there can be framed from the leading Roman authors an almost complete system of monotheism; while it is well known that, from the time of Anaxagoras (500 B. C.), the great philosophers of Greece were virtually monotheists. The conception of one God was accepted by the Israelites through the spiritual teachings of the great prophets, a few centuries before the Christian era; yet modern scholarship has proved beyond all doubt that this belief "was the evolution there of a germ implanted in the human mind everywhere." When the gentle Prophet of Nazareth—aided by that energetic philosopher Paul—had freed the Hebrew God from the narrow limit of nationality, and portrayed the Soul of the Universe as the loving All-Father, who is a spirit and should be worshiped in spirit and in truth, the highest monotheistic conception was given to the world.

The striking likeness exhibited in sacrificial ceremonies among all ancient peoples proves that they can be traced to one type of society common to primitive man, and that form, according to the highest scholarship, is based upon the system of totem stocks. The animal worshiped as a totem is never eaten by members of the clan excepting upon occasions of expiatory sacrifices, although among those clans who have what is called a split totem—that is, parts of animals—only a special part is forbidden as food. Dr. Robertson Smith, who has given us so many evidences of totemism among the Semites, says, "In totemism, and in no other system, laws of forbidden food have a direct religious interpretation, and form the principal criterion by which the members of one stock and religion are marked off from all the others." Colonel Garrick Mallery, in his highly suggestive address, before the Association for the Advancement of Science, on the Israelite and Indian, assures us that "the survival of totemism may be inferred from the lists of forbidden food in Leviticus, xi, and Deuteronomy, xiv. It would appear that, at about the time of the Exodus, the Israelites were organized upon the basis of families or clans, tracing through female lines, and named Hezir (swine), Achbor (mouse), Aiah (kite), Arod (wild ass), Shapan (coney), and so on.

Each of the clans refrained from eating the totem animal, or only ate it sacramentally. As the totemic organization declined, the origin would be lost, but the custom lasted, and when the legislation was codified it was incorporated in the code.*

The primary meaning of *sacrifice* is food offered to the gods, for they were supposed to partake of the gifts of food. In Greece originally each clan had its own gods, which were real totem ancestors. Apollo Lycius had his statue in wolf form at the Lyceum, and, at this god's sanctuary in Sicyon, "legend preserves the memory of the time when flesh was actually set forth for the wolves, as totem-worshipers habitually set forth food for their sacred animals." Prof. Smith states that even the highest antique religions show by unmistakable signs that in their origin sacrifices were literally "the food of the gods."

In Israel the conception, against which the author of the fiftieth Psalm protests so strongly, was never eliminated from the priestly ritual in which the sacrifices are called "food of the deity" (Leviticus, xxi).† The idea of a relation between the god and an individual was never grasped by primitive peoples, but they thought the relation existed between the deities and some social group, such as a tribe, clan, or nation. This peculiar method of thought gave rise to the belief that in any offense committed by one member of the tribe all were equally guilty; consequently, when any calamity came upon them it was an evidence that some sin had been committed that must be expiated. This childish fancy developed into atoning sacrifices, the primordial germ of which is found in the worship of totem deities. It is evident that human sacrifices predominated in early times, but as people be-

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* See Popular Science Monthly for November and December, 1889.

† See article Sacrifices, Encyclopædia Britannica, ninth edition.

came less savage the horrors of the ritual were modified by the substitution of animals.

Among totem-worshipers the substitute for the life of a member of the tribe was naturally an animal of the kind which the devotees and god claim as kindred. Among our Indian worshipers of totems the sacred animal is eaten, *body and blood*, once a year, in a solemn sacrifice of *itself unto itself* in a mystical ceremony. These gross rites are thought to have an atoning efficacy, as they claim that the sacred animal shares the nature of their god, who in this manner dies for his people, while at the same time the life of the sacred beast passes into the lives of the communicants and unites them to their deity and each other in lasting bonds. These savages believe, however, that the sacrificed deity is made alive again; just as in Athens, when the sacred bull was slaughtered, the mystic ritual asserts that "the dead was raised in the same sacrifice."

We find strict attention to form and ritual among all primitive peoples, and the more cruel and mysterious the rites the lower the mental plane of the devotees.

That the religious forms called *mysteries*, of Egyptians, Persians, Greeks, and other ancient nations, evolved from the crude mysteries of their savage ancestors, is the firm conviction of our most profound scholars. In the celebration of these mysteries, which were enacted all over the ancient world, it is found that "the doctrine of a future life, connected with the legend of some hero or deity, who had died and descended into the under world, and again risen to life, dramatically represented in the personal experience of the initiate, was the heart of every one of the secret religious societies of antiquity.*

The Egyptian mysteries were devoted to the worship of their supreme god Osiris, whose name we find very near the beginning of what is known of the religion of Egypt. The early form of the legend shows its savage origin. In the constant warfare between Osiris and Typhon, the evil overcomes the good, and Osiris is killed, but afterward returns to life in the form of an animal, and urges his son to avenge him. Horus and Typhon fight in animal form, and the evil one's power is destroyed, but Typhon is not annihilated. As the Egyptian religion lasted for at least five thousand years, it was subjected to innumerable influences, which modified somewhat this crude legend. In time the worship of Osiris spread from Abydos, the oldest royal seat, all over Egypt, until all the religious mysteries and the whole doctrine of life after death attached themselves to the Osirian worship, where every year was enacted with many sad rites the

* Alger, History and Doctrine of a Future Life.

death of Osiris, ending with joyful ceremonies, celebrating the resurrection.

We are assured that the Grecian mysteries originated from the same animistic plane as those of the mystic ritual of Egypt. Even Plutarch admitted that the myths of Dionysus, Apollo, and Demeter, "all the things that are shrouded in mystic ceremonies and are presented in rites," are just as absurd as the legend of Osiris and Typhon.

The mysteries of Dionysus originated in ancient Phrygia, and passed into Greece in early times. Archæologists state that it is impossible to fix a date for the beginning of this kingdom, as it appears to have risen on an older civilization. It was a Greek tradition that the Phrygians were the oldest people, and their language the original speech of mankind. Zabazius was the original name of Dionysus in Phrygia, and his earliest images were of wood, with the branches attached. Later he was represented in the form of a bull with a human head; and when the anthropomorphic stage was reached his image was in human form, sometimes adorned with the horns of a bull. He had many sacred animals, but the bull was the one particularly connected with his worship.

The reproductive forces of Nature being dramatically portrayed in these mystic ceremonies, and the symbols given in forms which would explain their meaning to all beholders, it naturally follows that the method upon which these signs were based might be pure or obscene, according to the mental development of the people by whom they were given. Tradition shows that the latter predominated in the rites of that which has been termed Nature-worship. The class who have made a careful study of this subject state that there is not one of the ancient religions—the Israelite *not* excepted—which has not deified the sexual relation by some ceremonial rite connected with the solemn service of religion. It is evident that these forms evolved from such savage customs, as is still witnessed amid the orgies of the serpent-worshipers in Africa.* The peculiar custom of circumcision is thought to have originated in these gross symbols, as a sacrifice to the deity supposed to rule over the reproductive forces, as well as being also a substitute for human sacrifices. After the Phrygian mysteries were introduced into Greece, Sabazius was known under the name of Dionysus, or Bacchus, the god of the vine, whose functions were similar to those of the Vedic god Soma. Here Bacchus was called the son of Zeus and Demeter, and his birth, death, and resurrection were dramatically represented in the Grecian mysteries. Out of the combined rites connected with

* See Vudu Worship, by Major Ellis, in The Popular Science Monthly, 1891.

the worship of Bacchus, Apollo, and Demeter evolved the famous and widely popular Eleusinian mysteries. These religious ceremonies are thought by those who have made a study of early Greek life to have been instituted about the time of the first record of the Olympian games—776 B. C.—but the final molding of this elaborate ritual was not completed before the sixth century B. C. "The mysteries of Eleusis were the one great attempt of the Grecian genius to construct a religion that would keep pace with the growth of thought and civilization." The survival of savage thought in these rites, the progressive spirit of this cultured age, attempted to overcome, while trying at the same time to preserve, their fervor and self-devotion. There were four successive stages in the ceremonies connected with the celebration of the Eleusinian mysteries—confession, purification through immersion in water, the initiatory rites, followed by the last and crowning one, when the communicants were admitted to the most holy place and partook of the flesh of Demeter, or Circe, and drank the blood of Bacchus—this rite taking the place among these people of the holy sacrament in the Christian Church. We find many evidences from the Greek authors of that period that the people who joined this religious assembly were thought to lead better lives, and that through this connection *salvation* after death was assured them. Sopater asserted that "the initiation establishes a kinship with the divine nature." Plato wrote: "He that has been initiated has learned that which will insure his happiness hereafter." Plutarch, in a letter to his wife, wrote: "Some say the soul will be entirely insensible after death, but you are too well acquainted with the doctrine delivered in the mysteries of Bacchus and with the symbols of our fraternity to harbor such a thought." Thomas Taylor has given us these lines from an old Orphic hymn:

> "The soul that uninitiated dies,
> Plunged in the blackest mire of hades lies."

Modern research has proved that the celebration of the Eucharist, in the mysteries of all ancient peoples, was considered by them as their highest act of worship and the most solemn ordinance of their religion. In the Egyptian mysteries the communicants partook of bread which had been consecrated by their priests, and was then regarded as the veritable body of Osiris, just as in ancient Mexico the worshipers of the supreme Mexican god ate sacramentally paste images made of corn and blood, after a sacred formula was pronounced over the symbols. The devotees informed the Spaniards who witnessed these ceremonies that they were partaking of the body and blood of their god. When the Mithraic mysteries were introduced into Rome, and were celebrated in the world's metropolis, the holy sacrament of bread and wine was a prominent feature in the worship of Mithras.

"There is a remarkable syncretist painting in a non-Christian catacomb in which the elements of the Greek mysteries of Demeter are blended with those of Sabazius and Mithra, in a way which shows that the worship was blended also." The most important rite of all these antique mysteries being the Eucharist, led the celebrated Cicero to exclaim, "Can a man be so stupid as to imagine that which he eats to be a god?" It has required a great effort for intelligent minds in all ages to reconcile their imaginations to the bloody ritual so prominent in all religious ceremonies from the earliest age. It is a relief to refined and spiritual natures to be able to look down the long ages of time and see that the early rite from which each evolved was instituted by savage peoples, and celebrated in their ignorant worship of animals.

It is a self-evident truth that "*the ideas which the religious instinct has once grasped it seldom abandons*"—consequently there are countless survivals along the entire line of religious progress, of beliefs and customs belonging to lower planes of culture, which have been, as far as possible, adapted to higher systems by giving them new names or more spiritual explanations. To this cause must be ascribed the fact—so evident to all students of comparative theology—of the early Christian Church becoming incrusted with the rituals and religious customs of the pagan world. The late Dr. Hatch, in the Hibbert Lectures of 1888, demonstrated, in the most convincing manner, "the influence of Greek ideas and usages upon the Christian Church." Every thoughtful person who has made even a slight study of this all-important subject is compelled to unite with him in saying: "Greece lives—not only its dying life in the lecture-rooms of universities, but also with a more vigorous growth in the Christian churches. It lives there, not by virtue of the survival within them of this or that fragment of ancient teaching, and this or that fragment of an ancient usage, but by the continuance in them of great modes and phases of thought, of great drifts and tendencies, of large assumptions. . . . No sooner is any new impulse given, either to philosophy or religion, than there arises a class of men who copy the form without the substance, and *try to make the echo of the past sound like the voice of the present.* So it has been with Christianity. It came into the educated world in the simple dress of a prophet of righteousness. It won that world by the stern reality of its life, by the subtile bonds of its brotherhood, by its divine message of consolation and hope. Around it thronged the race of eloquent talkers, who persuaded it to change its dress and to assimilate its language to their own. It seemed thereby to win a speedier and completer victory. But it purchased conquest at the price of reality." Rev. Dr. Hatch not only proves that a majority of the rites of the Grecian mysteries have been transported into the Christian Church, but he also solemnly asserts that the peculiar tendency of the Greek mind to speculate, define, and dogmatize led to the establishment of the orthodox faith. The original meaning of dogmas are "*simply personal convictions*," and, while the statement of one man's convictions may be accepted by other men, still they never can be quite positive that they fully grasp the meaning of the original framer. "The belief that metaphysical theology is more than this, is the chief bequest of Greece to religious thought, and it has been a *damnosa hereditas*. It has given to later Christianity that part of it which is doomed to perish, but which yet, while it lives, holds the key to the prison-house of many souls."

SKETCH OF LEWIS MORRIS RUTHERFURD.

AN article by M. L. Niesten, published in the thirty-ninth volume of the Monthly, showed how greatly science is indebted to amateur astronomers; that about half of the living astronomers whose work had gained a footing in science were amateurs; that many of the most important discoveries in the heavens had been made by them; and further, that "other laborers than astronomers have assisted in the advance of the science by furnishing amateurs easier means of examining the sky and bringing the greatest exactness into their observations." An eminent demonstration of the truth of M. Niesten's remark, and of the value of the assistance which an amateur has been able to render astronomy in both sides of the work as described by him, is afforded by the subject of this sketch. Educated for the legal profession, and having begun his career in it, he gave it up for the more favored pursuit of astronomical observation; perfected instruments; and performed the most essential part in introducing and establishing the photographic method under which the most rapid advances in the science are now made.

Lewis Morris Rutherfurd was born at Morrisania, N. Y., November 25, 1816, and died at his country home, Tranquillity, N. J., May 30, 1892. He could trace a Scottish ancestry on his father's side through seven hundred years. His grandfather, John Rutherfurd, was a nephew of our Revolutionary major-general William Alexander, or Lord Stirling, and was United States Senator from New Jersey from 1791 to 1798. His mother was a direct descendant of Lewis Morris, one of the signers of the Declaration of Independence. He entered the sophomore class of Williams

College when fifteen years old, and was graduated from that institution in 1834. Having studied law with William H. Seward in Auburn, he was admitted to the bar in 1837, and practiced with John Jay, and after his death with Hamilton Fish. His tastes, however, drew him toward the physical sciences. While in college, he had yielded to them, and became assistant to the Professors of Chemistry and Metaphysics in preparing their class lectures, and had made pieces of apparatus with his own hands for them; and having found the scattered parts of an old telescope in the lumber-room of the college laboratory, he had reconstructed the missing pieces and put the whole in order. His own means, to which was afterward added the fortune brought by his wife, made the transition from a life of professional work to one of travel and study and amateur experiment an easy one. During a residence of several years in Europe, he studied optics under Prof. Amici, a famous adept in that science, and acquired knowledge which he was destined to put to most fruitful use in after-years.

After his return home he built upon the lawn of his home at Eleventh Street and Second Avenue, New York, an observatory which has been called the finest and best-equipped private astronomical observatory in the country. It had a transit instrument, and a refracting telescope with an object-glass eleven and a half inches in diameter, made by Fitz, with a second glass for photographing, corrected by his own new methods and finished by himself; the seeing lens, when photographs were to be taken, being unscrewed from the tube and the photographing lens being put in its place. A similar instrument was constructed under his direction for Dr. Gould and taken by him to the Argentine Republic, where it is still in use, a portion that was broken during the voyage having been replaced under Mr. Rutherfurd's directions.

For use in his own observatory, in place of this instrument, Mr. Rutherfurd made with his own hands an equatorial telescope having an object-glass of thirteen inches aperture. In order to employ it for photography without being compelled to take out the seeing object-glass, he constructed a third lens, which, being placed outside of the ordinary object-glass, converted the telescope into a photographing instrument. The visual focus of this telescope was of fifteen feet two inches distance, and its photographic focus of thirteen feet. In this construction he took account of the effect of temperature on the length of the galvanized iron tube. He devised and constructed a measuring machine for measuring the star-plates, arranged to determine the position-angle and distance of every star on a plate from a central star; and with this had measures made on many of the star-plates, among them the

Pleiades and Praesepe clusters. The measuring machine was improved in 1868 by using a glass scale, one division of which was equal to ten revolutions of the micrometer screw. Mr. Rutherfurd continued his photographic work for twenty years, or till 1877, after which year no photographs were taken by him. "Mr. Rutherfurd," says Prof. Gould, "was the originator and the introducer of the photographic method of observation. To him is due the first idea and employment of an object-glass constructed for employing the chemical rays rather than the visual ones; as also, later, that of the 'photographic corrector' for adapting an ordinary object-glass to its best use in securing sharp definition of the stars upon the sensitive plate. He personally planned the construction of the first instruments of these classes, prescribed the curves for the several surfaces of the lenses, and superintended the preparation of the object-glasses, which were made, with the assistance of Mr. Zitz's son, in his own house, by methods devised and made practical by himself alone. So, too, was it he who introduced the precautions by which the sensitive film was guarded against distortion; it was he who first devised and constructed micrometric apparatus for measuring the impressions upon the plates; and he who first put this apparatus into practical use in executing his measurements. The large and delicate micrometer screws were made by him or under his constant supervision, at his dwelling-house in this city [New York], and the measurements were effected in his study." It is related by a writer in Nature, in illustration of the pains he took to secure the utmost perfection in the cutting of the threads of his micrometer screw, that he took three years to make a single screw. "In order to test the quality of his work, it struck him that it would be a happy thought to see if it would enable him to rule a grating. He accordingly set the apparatus up in his workroom, and by means of an automatic arrangement kept it going all night, as at that time the local vibrations were fewest. The result was that he was able to make the most perfect gratings [then] known."

For many years Prof. Gould says Mr. Rutherfurd labored at the photographic method of observation without the sympathy or encouraging faith of astronomers generally; "and in 1865 he did me the honor of placing in my hands a large number of measurements, and giving me permission to study and compute them. They had been made in his house, with apparatus designed and in great degree constructed by himself, from photographs which he had personally taken by aid of the telescope which he had himself devised and which was also in his house." At the session of the National Academy of Sciences, held in Northampton, Mass., in August, 1866, Prof. Gould presented a memoir containing the results of computations, made from these data, for determining the relative positions of thirty-one stars in the Pleiades. On the same day Mr. Rutherfurd communicated orally to the Academy a detailed account of his experiments, difficulties, and successes, and of the methods which he had finally adopted. His photographs of the moon are remarkable for the fineness of their details.

In 1863 Mr. Rutherfurd published in the American Journal of Science a paper dealing with the spectra of the stars, the moon, and the planets, the first published work of the kind after that of Bunsen and Kirchhoff, and the first attempt at classifying the stars according to their spectra. In this paper he said: "The star spectra present such varieties that it is difficult to point out any mode of classification. For the present, I divide them into three groups: first, those having many lines and bands, and mostly resembling the sun, viz.—Capella, β Geminorum, α Orionis, etc. These are all reddish or golden stars. The second group, of which Sirius is the type, present spectra wholly unlike that of the sun, and are white stars. The third group, comprising α Virginis, Rigel, etc., are also white stars, but show no lines; perhaps they contain no mineral substance, or are incandescent without flame." In 1864 he presented to the National Academy of Sciences a photograph of the solar spectrum obtained by means of bisulphide-of-carbon prisms, containing more than three times the number of lines that had been laid down within similar limits on the chart by Bunsen and Kirchhoff. In the course of his spectrum work, to which he now gave increasing attention, he found, as he had done in photographing, that the apparatus in use was insufficient for his purposes. He noticed that diffraction gratings of finely ruled lines upon glass and metal were preferable to series of prisms for the decomposition of light in spectral study. The best gratings in existence—still imperfect—were those of Nobert, who kept his process a secret. Mr. Rutherfurd—as usual helping himself in invention—devised a ruling engine capable of turning out much finer gratings than those of Nobert, some of which had about seventeen thousand lines to the square inch, and which have been surpassed only by those since made by Prof. Rowland. With these gratings his great photographs of the solar spectrum—more than eleven feet long—were made.

After he ceased to take an active part in astronomical work, Mr. Rutherfurd gave his instruments and photographs to Columbia College: the telescope in December, 1883—and it is now mounted in the observatory one hundred and ten feet above the ground; the machine for making measures in the same year; and his best negatives in November, 1890. This valuable collection of photographs of the sun, the moon, and the star clusters has been placed in a fire-proof vault. It contains, according to a list published in the annals of the New York Academy of Sciences, one hundred and seventy-five plates of the sun, one hundred and seventy-four of the solar spectrum, four hundred and thirty-five of the moon, and six hundred and sixty-four of star clusters. The reduction of the measures of the Pleiades plates, taken with the thirteen-inch instrument and measured with the improved machine, undertaken according to the understanding between Mr. Rutherfurd and the college authorities by Prof. Rees and Mr. Harold Jacoby of the observatory, and completed and published only a few days before Mr. Rutherfurd's death, but too late to be examined by him, seem, says Prof. Rees, to indicate an accuracy of measures comparable with the best recent heliometer work. Yet they were all taken between 1865 and 1874. It is intended to continue the reductions till all the measures made with the improved machine—filling some twenty folio volumes of about two hundred pages each—are finished; then to measure the negatives that remain unmeasured, and proceed to their reduction.

Prof. Gould emphasizes the fact that all these plates were made some years before the discovery of the dry-plate process, by the aid of which celestial photography has made such wonderful progress in recent years; and "we owe to him not merely the first permanent records of the relative positions, at a given moment, of all the celestial objects impressed upon the sensitive plates, but the means and the accomplishment of the actual conversion of these records into actual numerical data."

Mr. Rutherfurd demonstrated, contrary to the prevailing opinion, that the albuminated collodion film could be made stable on glass under all conditions of atmospheric change.

Mr. Rutherfurd was a member of the International Meridian Conference that met in Washington in October, 1885, and took a prominent part in its work, framing and presenting the resolution that embodied the conclusions of the conference. He was invited by the French Academy of Sciences in 1887 to become a member of the International Conference on Astronomical Photography held in Paris in that year, and was given by the President of our National Academy of Sciences the appointment as its representative, but the condition of his health forbade his serving. He was an Associate of the Royal Astronomical Society. He was an original member of the National Academy of Sciences, which was incorporated by act of Congress in 1863. In 1867 he was elected President of the American Photographical Society, in the official board of which he had served for many years as first vice-president. During his administration the society became the Photographical Section of the American Institute. For many years he was not only a trustee of Columbia College, but one of the most active and hard-working members of that body. Mr. Rutherfurd's physical condition was delicate during the later years of his life, and not suitable for sedentary occupation, or that which exposed him to sudden changes of weather; but he continued his astronomical work as long as prudence permitted it, then retired wholly from it. His death was brought on by a cold, contracted while traveling to his winter residence in Florida, to which was added the shock caused by the sudden death of his daughter.

Of his personality, Mr. O. G. Mason says, in the Photographic Times: "No one could be long in his presence without feeling that he was a man of rare ability. His tall, erect figure and scholarly face made him conspicuous wherever he went. His dignified, courtly bearing and genial nature made earnest friends of all his acquaintances. His dislike of ostentation and show was a conspicuous trait of his character. He was never known to wear any one of the many decorations, emblems of rank, or acquirements which had been conferred upon him." His signature was his plain name, without the addition of any of the literary and scientific honors and titles he had a right to use. "His liberality in the diffusion of the knowledge which he had gained was known and appreciated by hundreds who sought his advice"; and "his wise counsel was sought and recognized as being of the highest value."

In his address as President of the English Folklore Society, Mr. G. Laurence Gomme mentioned as one of the most important of the folklorist's duties the tracing of the influence of Christianity on traditional belief and usage. The heroes and heroines of folk-tales were certainly not Christians, and Christianity was not even nominally represented, except in Slavic countries and in Spain. Thus a dual system of belief was manifested in many of the tales and traditions. This dualism was illustrated in the cry of an old Scottish peasant when he came to worship at the sacred well: "O Lord, thou knowest that well would it be for me this day, an' I had stoopit my knees and my heart before thee in spirit and in truth as often as I have stoopit them afore this well. But we maun keep the customs of our fathers." In like manner there is still a superstition in Lancashire of a long journey after death. Of a man who died of apoplexy at a public dinner, one of the company remarked: "Well, poor Joe, God rest his soul. He has at last gone to his long rest, wi' a belly full of good meat, and that is some consolation." This survival of paganism was frequently noticed by the early Christian fathers; and the pagan conceptions, as a whole, lasted much longer than many of us would conceive possible. In a sermon preached in 1659 by Mr. Pemble, of the Church of England, the case of an old man is given who, being questioned by a minister touching his faith and hope, replied that God was a good old man and Christ a towardly youth; that his soul was a great bone in his body, and after he was dead, if he had done well, he should be put in a pleasant green meadow. This conception of the soul as a bone in the body was paralleled by the notion of the New-Zealanders that a peculiarly sacred character attaches to the backbone. Other curious customs illustrating the mixture of faiths were referred to in the address.

EDITOR'S TABLE.

ANCIENT AND MODERN SUPERSTITIONS.

IN the interesting work by M. Maspero, entitled Ancient Egypt and Assyria, a translation of which has lately been published in this country (Appletons), a vivid description is given of the way in which, in the fourteenth century B. C., an Egyptian physician would have proceeded to cope with a serious case of disease. Psarou, an officer of high rank, has fallen sick. His wife Khait—here let us quote the author's words—"summons an exorcist to see her husband. Nibamon is unequaled in Thebes for his skill in curing the most violent headaches. He arrives toward evening, accompanied by two servants; one carries his black book, the other a casket filled with the necessary ingredients for manufacturing every variety of talisman on the spot—clay for modeling, plants, dried or freshly culled, consecrated linen, black or red ink, small figures in wax or baked earth. One glance at the patient tells him the cause of the illness: a dead man visits Psarou every night and is slowly devouring him. After a few moments' reflection he takes a little clay, mixes some blades of grass with it, and kneads the whole into a rather large ball, over which he recites in a low tone one of the most powerful incantations contained in his book." Returning next day to ascertain how the sick man is faring, the exorcist finds that the symptoms are worse than the day before. "These incidents distress Nibamon, but do not surprise him. The evil spirits are always unwilling to leave their prey, and always endeavor to dispute it inch by inch with the magician who opposes them. The ghost driven from the head now attacks the stomach, and he will only yield to a new spell." The second incantation succeeds no better than the first, and in a few days the man is dead.

Such were the superstitions of ancient times. Did the exorcists lose their credit because their spells produced no effect? By no means. Whatever recoveries took place would be set down to their credit, while failure to cure would be ascribed to occult causes into which it was either vain or impious to inquire. Had any one in those days proposed a statistical test of the physical efficacy of incantations in the cure of sickness, by tabulating the cases in which such measures had been resorted to and those in which they had not been resorted to, and striking a percentage of recoveries under one and the other system, there would have been a fourteenth-century B. C. anticipation of the execration which a kindred proposition of Prof. Tyndall's met with a dozen or more years ago. Lucky indeed would the ancient skeptic have been, had he escaped with no more unpleasant consequences than averted gazes and a scolding all round. Yet what other method than the statistical could any one now suggest for proving or disproving the efficacy of the incantation business?

Could the ancient Egyptian exorcist be revived in our times it would not be difficult, in the very heart of civilization to introduce him to quarters where he would feel that his art might still be pursued with much pecuniary and social success. There are hundreds of thousands of our fellow-citizens who are willing to pay hard and honestly earned money for medals and charms of one kind and another which by virtue of some ecclesiastical benediction are supposed to have the most remarkable specific properties. One medal will give success in agricultural operations, another in domestic matters; others are efficacious in the sick-room. The Egyptian exorcist sought to place his patient under the protection of different divinities, and thus to scare away the malignant ghosts that were preying on him. To-day he would find that, in lieu of the divinities whose names he was accustomed to invoke, there were hosts of others, or at least of semi-divinities, with names strange to him, who were credited with exercising tutelary powers exactly similar to those of Isis and Osiris, of Amen and Horus, and the rest. And he would find that the idea of verification as in any way applicable to such pretended powers was just as odious to-day, alike to the victims of delusion and to the priestly class, as it could have been in his own day and generation.

Yet verification will triumph. Slowly but surely the world will come into the conviction that beliefs which shun verification, and practices which can not be brought to the test of utility, have no claim to respect. The edifice of superstition seems still all too solid; but the structure of ordered knowledge which science is building is growing in extent day by day, and little by little is expropriating the ground on which the temple of intellectual darkness has been reared. The gains of science are definitive gains, the losses of superstition are definitive losses. The human mind will never resign to occult and arbitrary agencies any sphere of phenomena which has once been reduced to law. Still, there is much to be done in helping individual minds to cast off their fetters, and to put on instead the wholesome restraints of reason and moral self-control.

> "'The sensual and the dark rebel in vain,
> Slaves by their own compulsion."

The bonds of superstition will only be irretrievably broken when the truths of science are welcomed and honored, not alone for the mastery they give over the outward world, but for the clearer light they throw upon questions of moral obligation.

THE SCIENTIFIC METHOD IN POLITICS.

The Popular Science Monthly is not a political journal, at least as the word "political" is commonly understood. In the wider and truer sense of the word it is political just in the same degree as it is industrial, commercial, educational, and a dozen other things as well; that is to say, it is interested in the political, as in the industrial, educational, etc., development of the country, and believes that in the extension and application of scientific modes of thought the key to the best possible political and other development will be found. If any recent change in the aspect of our national politics has caused us satisfaction it is in no sense from a party point of view—for parties we utterly ignore—but because, as it seems to us, the change is one which tends to place our national life upon a more natural and rational basis than that which it has occupied for many years past, and to favor the growth of a healthy individualism throughout the whole social organism. We have not hesitated in the past to speak of the false and hurtful relations which a general policy of what is commonly called "protection," but what, as Mr. Spencer points out, should properly be called "aggression," establishes between the national Government and various more or less powerful private interests; and it is not unnatural, therefore, if we now rejoice at the prospect of at least a very sensible abatement of the evils of that system. But we rejoice still more to think of the ulterior and indirect results of the approaching change in our national policy. True intellectual manhood has not been attained until men have learned to trust Nature, to test all opinions and schemes by the touchstone of natural law, and, as a necessary result, to despise swaddling clothes and leading strings and all the paraphernalia of creeping childhood or timorous imbecility. We see before us, as we believe, a prospect of manhood for the American people—such a manhood as they have never before attained to—one of the chief signs of which will be a proud confidence in themselves, and, in connection and through harmony therewith, a noble and generous bearing toward all other nations. Heretofore men politically prominent among ourselves have not been ashamed to suggest that the best policy for us was the one that wrought most evil to other countries, and have thus fed and stimulated all that was meanest and most malignant in the minds of those whom they addressed. There has thus been cultivated among a people which ought, from its advantages of position, to be the most cosmopolitan and broadly philanthropic of all nations a tone of feeling more petty and parochial than could perhaps be found in any other community of the modern world. The mark has, however, been overshot, and the better feeling and better sense of the American people are now, we may trust, about to assert themselves. To be too sanguine in regard to the coming change would only lead to disappointment; but that in the main a better spirit will preside over our national life in the future we confidently believe. Once let the American people make fair trial of themselves under a *régime* of liberty, and nothing will lure them back to the lame and sinister devices which have been so delusively put forward in the past as the props and safeguards of national prosperity.

But not in the political sphere alone, as we have already hinted, is progress to be anticipated. The moment is propitious for an advance all along the line. It is science that has won the battle of liberty, and science should reap its reward in a fuller recognition of its claims. When we say that science has won the battle of liberty, what we mean is that the full, ample, and exhaustive discussion of economical questions that has taken place before the American people has brought certain conclusions into a clear light; the truth has forced its way through the mists of sophistry and all the obstructions that selfishness and prejudice could place in its path. The result, the great result, is that many minds have been opened to the recognition that in the recent election it was not a party that triumphed, but a principle, a truth, that vindicated itself. Hence the conclusion will inevitably be drawn that in the region of human action there are principles capable of demonstration; in other words, that science, which points the way to demonstrations and is itself built on demonstrations, is the proper guide of life. The applications of this conclusion are too numerous to point out on the present occasion; but we may hope that many such applications will spontaneously suggest themselves to our readers, and that, in such efforts as we ourselves may make hereafter to bring home the lesson, we may have many zealous helpers. The less we can all think of party and the more we can think of principles at the present crisis the better it will be; for it is upon the thorough comprehension and acceptance of a principle, and not on the triumph of a party, that the future welfare of the American people depends.

GOOD ROADS AND COUNTRY LIFE.

An unmistakable demand for good common roads is being heard in all parts of the United States. This demand is rapidly growing in volume and is taking on the systematic organization which is essential to the success of such a movement. That bad roads in this country cause an enormous loss of money each year to those who use them may be clearly proved, but this fact is veiled from many persons because they have never known anything better.

Just how loss arises from bad roads is being shown very ably in the magazine, Good Roads, now in its second year, which is edited by Mr. Isaac B. Potter, of New York. The farmers are the greatest sufferers. Where wagon wheels sink hub-deep in mud at some seasons, a farmer who has much hauling to do must keep one or two more horses than he would need if he had only hard, even roads to go over, and his loss in the wear and tear of horseflesh, harnesses, and wagons is a heavy tax on his income. It often happens that a farmer finds the roads absolutely impassable with a loaded wagon just at the time when some of his produce would bring the highest price if he could haul it to a railroad, and he is forced to wait and take a lower price later. Livery-stable keepers and all other owners and users of horses and vehicles suffer from bad roads in similar ways.

The welfare and prosperity of a district that has bad roads suffer in many respects. If getting about for business or recreation is unreasonably difficult, its inhabitants tend to crowd into the towns and cities rather than live in the more wholesome conditions of the open country. Manufacturing concerns are often driven to place themselves in the villages and draw their employees to them there, when, but for the one item of teaming over bad roads, they could be carried on to better advantage in the country. Good roads would keep the employees of these concerns and the other persons above mentioned in the farming districts, thus making these districts more thickly settled and increasing the value of their lands.

In order to obtain better roads two things are necessary. The first is to create a general conviction that the improvement of our highways is imperative, and that money wisely expended for this purpose is sure to return. The second requisite is to place all road making and mending under the charge of competent road-builders. Various efforts to secure these ends are being made, and the aid of county and State authorities, and even of the national Government, has been invoked to further the movement. While it is very desirable that the highways of adjoining localities should be under some central supervision, so that they may be made to form a connected whole, it may yet be questioned whether the national Government could be an effective agency in road improvement. Why, for instance, should the dwellers beyond the Mississippi and on the Pacific coast be taxed to maintain in Washington a school for road engineers and a museum of road construction that few, if any, of these distant communities could derive any benefit from? A more practicable scheme would be to have instruction in road engineering given at each of the State Colleges of Agriculture and Mechanic Arts. In a country showing such wide differences in soil, rainfall, temperature, and topography between different sections as the United States does, road-building can be taught and administered far more efficiently by the State or the county than by the nation.

There is need of much intelligent care in framing legislation in the interest of the movement for better roads. Annoying prohibitions should be no part of the policy of the road reformers. For instance, large loads carried on wheels having narrow felloes and tires do great damage to roads; hence it has been proposed to prohibit narrow tires on heavy wagons. A much better policy is that adopted in Michigan, of giving a reduction of one half their road-taxes to those who will use broad tires. The movement for good roads shows a lusty vigor. The success that it has already achieved is splendid testimony to the efficiency of voluntary association of individuals, and if its leaders continue to carry it on without the paralyzing patronage of the General Government it is likely to attain great results.

LITERARY NOTICES.

MORAL INSTRUCTION OF CHILDREN. By FELIX ADLER. New York: D. Appleton & Co. International Education Series. Pp. 270. Price, $1.50.

THIS book is a sign of the times. It is one among many responses to the deepening public conviction that character, no less than intellect, demands education if it is to come to its best; education as well reasoned, systematic, and thorough as science and sympathy can make it. In giving this conviction effect, a formidable difficulty is encountered at the very outset. A portion of the American people, neither few in number nor lacking weight in legislation, maintains that the teaching of right conduct can proceed only upon religious sanctions. Hence come the reiterated demands for a division of school-taxes to enable separate schools to be administered by specific churches. On the threshold of his subject Prof. Adler considers these demands, and reviews in particular the example of Germany in uniting church and state education, pressed as it so often is for acceptance in the United States. He points out that in Germany the churches founded the schools; that their control has now passed to the state marks the advance to supremacy of political sentiment. In this country the state it was which founded the schools; were it to admit the churches into partnership in their control, the change would mean a reversal of the current of progress as progress is understood in Germany. Prof. Adler argues that the American nation has a paramount interest in keeping its schools unrestrictedly public, in ignoring the party walls of sects, for in no other way can the diverse elements of its population be fused into unity. And the state in disregarding the sects does not array itself against religion. As to rules of right conduct, all good men are agreed; let these rules be taught in the public schools, leaving their sanctions to be enforced in the churches and Sunday schools, whose work can accompany without antagonism that of secular instruction. In the public school the teacher has a vastly better opportunity to observe character and direct its development than is possible in the brief and casual work of the religious instructor on Sundays. Moreover, education in duty should be dominant in school work, not incidental. An ethical atmosphere should pervade and mold every lesson. Knowledge and skill are valuable; character is priceless; and knowledge and skill take on a new edge when wisely subordinated to ideals of duty.

Taking a rapid survey of the ordinary course of school instruction, Prof. Adler suggestively brings out the moral side of each study. A child is asked to describe a bird placed before it, and the teacher is not satisfied until the description is strictly accurate. In making the eye conscientious science thus begins; it proceeds step by step only as it faithfully keeps to truth, as it brings thought and word to absolute accordance with fact. History, properly taught, also has high moral utility. It presents examples of heroism, of self-sacrifice, of love of country, of unswerving devotion to principle. The best literature, and especially the best poetry, make an appeal not less stirring to rightward impulses. The great creative books—the masterpieces of Plato, Dante, Shakespeare, Goethe—touch the deepest springs of character; the student rises from their study ennobled by a new sympathy, with a quickened sense of the dignity of human nature. Music, apart from its subtle power to arouse refined emotion, has distinctive value in socializing the will. Love of home and country made the themes of song are echoed in life. Sentiment can be wisely used to re-enforce the reasoned claims of hearth and country, so that at last public opinion brought to a new breadth and soundness shall deservedly have a profounder influence than ever upon the individual life.

Coming to moral instruction proper, Prof. Adler points out that it should always be suited to the age of the child, and he sketches courses for primary and grammar grades. For young children he holds the best vehicle of instruction to be the fairy tale; the excursions of fancy delight a budding mind; the love of adventure, the delight in disguises, can be made to play a telling part in arousing interest in the faithfulness of a Cinderella, or the merciful traits of the younger brother embalmed in the story of the Queen Bee. A good fable always has interest apart from the lesson it conveys; it is essentially truer than history, for it is history's composite photograph; a judicious teacher can select from Æsop, from the Jataka tales, a great many fables of sterling significance, which, from their point and brevity, can be borne as easily as proverbs in the memory. Advancing to pupils of riper years, our author shows what can be done in adapting the Iliad, the Odyssey, and other great classics to the education of admiration, to the discrimination between motives worthy and unworthy, to the building up of lofty ideals of life. That conduct may be the better practiced as an art, we are next given an outline of morals as a science; the duties which relate to the physical life and the feelings are described and enforced; then, filial and fraternal duties receive attention; third, come the duties to all men of justice and charity; and, lastly, a word regarding the duties of citizenship.

Prof. Adler gives us this book as an outcome of fifteen years' successful work in the class-room, and he intends it to be simply an aid, not a guide, to the teacher. While the founder and leader of the ethical movement, and on fire with the ethical spirit, he is too wise a man not to see the folly of being righteous overmuch. He warns the teacher against that moral microscopy which absorbs itself in trifles, only to find strength lacking when a genuine battle has to be fought. But even strength is not everything. It is, after all, at surfaces mainly that we touch, and so we have emphasis laid on grace, on fine manners, as the true efflorescence of high character, enabling it to win where mere strength would fail. He would not have the aim of the moral teacher too much in evidence, well knowing that it is because the marksman does not point at the bull's-eye that he hits it. While a disciple of Kant and an upholder of a moral law underived from the reckoning of consequences, he is willing to give due credit to the utilitarians. Duty goes further and higher than prudence, yet for a long distance they are companions; righteousness does not work for wages, but why blink the fact that it receives goodly rewards? But, however much character in the making may be aided by prudential considerations, character in its perfection has left them far behind. Duty, at first a matter of conscious purpose, becomes confirmed as the habit of the soul, and flowers at last as impulses from which all sense of effort or calculation of gain has passed away.

On every page this book shows that it comes from a strong, judicious, and richly freighted mind. It demonstrates how the culture of conscience, supplementing and completing the culture of the intellect, can lift education to a plane where it shall address itself not to part of human nature but the whole. Its chapters have been written for the teacher; they contain counsels that every parent in the land would be the better for laying to heart.

The Electric Railway in Theory and Practice. By Oscar T. Crosby and Louis Bell. New York. The W. J. Johnston Company (limited), 1892. Pp. 400. Price, $2.50.

Among the industrial applications of electricity none have attained greater commercial importance in recent years than electric traction. Although experimental work in this field had been carried on both here and abroad for many years, it was not until the great electric revival of a dozen years ago that the subject began to have importance. Even then this form of traction did not take a commercial place comparable with the other applications of electricity. Much detail work had to be done before it could enter upon the industrial stage, and its economy and adaptability to actual service had to be demonstrated by the test of time. Up to about six years ago electric railways may be said to have progressed no further than the experimental stage, but since that time the application of electric traction to street-car service has gone on at an unexampled rate in this country, until now a large number of the cities and towns have one or more electric railways. As is usual in the practical development of a new art, many fruitless experiments had to be made and much money and time wasted. It was early recognized that the method of operation which promised the largest measure of success was that in which the current was conveyed to the moving car by means of a circuit carried along the line, and connection with which was made by some sort of elastic contact carried by the car. But it was not demonstrated until after many trials in just what manner this could be done to provide a reliable and economical service. Attempts were made to use the rails as the conductors, and also to carry the conductor in a conduit laid between the rails, connection being made between this conductor and the moving car by a contact arm carried by the car. The numerous difficulties apparently inherent in all forms of surface or underground conductors have led to their total abandonment in this country in favor of the overhead conductor familiarly known as the trolley system. In this system the conductor carrying the current to supply the moving cars is strung on poles eighteen or twenty feet from the ground, and connection is made between it and the moving car by means of a long arm affixed to the roof of the car, and carrying at its upper end a contact, generally in the form of a grooved disk. This arm is held against the conductor by springs and is controllable from the car by a rope connection so that it can be pulled down out of connection with the conductor or readily replaced when jolted out of position by the motion of the car. Although this system has encountered much hostility on account of its supposed danger, it has steadily made its way on account of its capacity to adapt itself to all manner and conditions of service, and handle the varying traffic of a street railway expeditiously, economically, and reliably. Inventors are still busy working upon other methods of applying the current, among which probably the most promising is the storage battery. Despite the fact that this method is now in practical service upon two lines in this country, it can not be said to have passed the experimental stage, but it is very generally recognized that this would constitute a final method of electric traction if it can be worked out so as to have the reliability and economy of the trolley system.

This brief epitome of the work in electric traction is set forth in detail by the authors of the present volume. As they state, their work is the first systematic presentation of the subject, and it is therefore a welcome addition to the current literature of the applications of electricity, the more so that it is an extremely well executed one. One of the editors is the editor of the Electrical World, and has, therefore, been in a position to keep himself informed on the history of the subject and to realize what the practical difficulties have been in the development of the art. The authors begin their exposition with a brief consideration of the general electrical principles involved in the dynamo and electric motor, and then pass to a consideration of prime movers, in which they devote considerable space to the theory of the steam engine as well as to a description of the best types of engine to perform the work required in electric traction. They also consider the theory and best forms of water-wheels available. The forms of motors suitable, and the method of mounting them upon the car so as to apply the motion of the armature to the driving of the wheels, are given an amount of space commensurate with their importance, as it is here that the largest amount of detail labor has been necessary in working out the practical problems of the system. A chapter is given to the line, the track, and the power stations, which deal with the practical considerations to be taken into account in this part of the equipment. In the chapter on the efficiency of electric traction there is a very excellent discussion of the subject, ranging from the efficiency of the engine to that of the complete system. A chapter is given to storage-battery traction, in which the authors describe the best forms of battery which have been devised, and point out clearly the difficulties encountered with this form of apparatus, and the large amount of work that yet remains to be done before the storage battery can take its place in economic competition with the trolley. In a chapter on high-speed service an account is given of the experiments conducted by Mr. Crosby at Laurel, Md., with an electric car driven at a speed of over a hundred miles an hour. The authors believe that it is quite practicable to establish an electric railway service in which speeds of one hundred and fifty miles an hour may be maintained, and give calculations of the power required and designs of the electric apparatus and cars. The authors conclude their volume with a chapter on historical notes in which they detail the early experiments in electric traction in which the broad principles were worked out, at a time when the electric battery was the only source of current. Owing to a lack of any economical source of electricity, these early attempts resulted in nothing practical in the way of the establishment of actual roads, but they served the purpose of laying the subject open to future workers and prevented that pre-empting of the field which would have been given by controlling patents at a time when the art was ripe for development. Various miscellaneous matters, that could not well find a place in the body of the work, are treated in an appendix.

Silk Dyeing, Printing, and Finishing. By George H. Hurst. London and New York: George Bell and Sons, 1892. Pp. 226. Price, $2.

This is one of the series of technological handbooks, edited by Sir Trueman Wood, Secretary of the Society of Arts, and, like the rest of the series to which it belongs, is excellently done. It is addressed especially to those concerned with the art of which it treats, but is of interest as well to the general reader who may care to know something about an extensive and important industry. The book is made up of a series of papers contributed by the author to the Dyer and Calico Printer, which have been largely recast, and of additional chapters on silk printing and finishing, and testing dyed silks. The author treats of silk fibers, how they are produced by the silkworm, the method of handling the fiber and reeling it, how it is dyed, and how printing is performed. In an appendix he gives a number of recipes for the preparation of color compositions and in a number of plates at the end of the volume he gives samples of dyed materials both of the fiber and the woven goods.

The Science of Nutrition. By Edward Atkinson. Pp. 179.

Mr. Edward Atkinson, the well-known writer on economic and kindred subjects, has in recent years been devoting his attention to the subject of cooking, and has reached some startling conclusions. He contends that the present method of quick cooking at high temperatures is a fundamental mistake; that cooking should be done slowly at temperatures of from 300° to 400°, and in closed vessels which will retain all the vapors and juices. He has found by extended experimenting that when this is done the amount of heat required is but a fraction of that now used, and has in consequence devised an oven in which a meal for six or eight persons can be cooked over an ordinary kerosene lamp, such as the Rochester. His apparatus, which he terms "the Aladdin oven," is simplicity itself. It consists of a box made of non-conducting material, such as paper or wood, in the upper part of which is placed an oven of thin sheet metal. The oven is smaller than the box, so that there is a space all around it for the circulation of the hot products of combustion from the lamp, which sets in the oven portion of the box. The oven is provided with trays upon which different articles may be placed. Mr. Atkinson claims that bread may be baked, meat roasted, fish and vegetables cooked in a much superior manner than by current methods. Cereals, such as oatmeal, hominy, etc., can be cooked overnight, so that the longer time required is not a feature that presents any difficulties.

The present volume is made up of an address by Mr. Atkinson at Columbia College on The Science of Nutrition, of description of the oven and the work it does, and elaborate data upon the value of foods, and the quantities of the different classes of foods necessary for healthy adults. If Mr. Atkinson's contention is well founded, and it appears to be abundantly so by the data he submits, he has made a very distinct step in advance in the important field of domestic economy, and his labor is one with which every housewife should make it a point of becoming acquainted.

Questions and Answers about Electricity. A First Book for Students. Edited by E. T. Bubier. Bubier Publishing Co., Lynn, Mass., 1892. Pp. 100. Price, 50 cents.

Of the making of popular books upon electricity and its applications there appears to be no end. Many of these are of value and of real help to the readers to whom they are addressed, while many more are quite useless. To this latter class belongs the present book. Although four writers have contributed to its make-up, and the entire work has probably undergone the scrutiny of each of its authors, they have failed in producing anything approaching an adequate treatment of the subject. The book is addressed to beginners, presumably those who know nothing of the subject, and consequently should be a clear and concise presentation of the subject, beginning with the simplest phenomena and advancing by steps to the more complex. Instead of this, subjects are treated in no particular logical order, and the reader could only get a very confused jumble of ideas after going over the book. The authors start out with a brief discussion of the theory of electricity, which, even if clearly stated, which it is not, could be comprehended only after some acquaintance with electrical phenomena. The Holtz and Topler static electric machines are described, so far as their mechanical construction is concerned, before the reader is acquainted with any of the phenomena of static electricity, and no attempt is made to explain the principles of their action.

The meaning of electric terms is in many cases not explained until after they have been used in the description of apparatus, and even then in the most cursory way. On the whole the beginner could read the book with but little profit, and it is too scrappy and incomplete to be of much service to any one at all acquainted with the subject.

Pictures from Roman Life and Story. By the Rev. A. J. Church, M. A., lately Professor of Latin in University College, London. Illustrated. New York: D. Appleton & Co. Pp. 344. Price, $1.50.

In this series of sketches, Prof. Church, the author of Stories from Homer, Stories from Virgil, has depicted various phases of life at Rome under the emperors. We are introduced to the friends of Mæcenas at his villa; pass a day at the home of Horace; attend the elder Pliny at his studies, and follow Martial about the shops of Rome and to the poet's club. Not very different was this early institution from its modern namesake. It included thirty members, but might have had three hundred, and the only drawback to enjoyment was that the poets had to listen to each other's verses! Overwork was not suspected in those vigorous days, and the indefatigable author limits his hours of study only by his capacity to keep awake. He listens to reading at the bath and a shorthand writer accompanies him in his carriage journeys. By such remarkable industry, during a life of fifty-six years, the elder Pliny accomplished a history in twenty-one volumes, a natural history in thirty-seven, and one hundred and sixty note-books. But there are stirring sights to be witnessed in Rome as well as marvels of literary labor—the great fire, the gladiatorial contests, the burning of the Capitol. These, and pictures of conquest, intrigue, and cruelty, fill the darker spaces of the panorama. However, we learn "there were noble men and women even in the worst days of Rome," and their fidelity to high purpose and true heroism challenge the admiration of all ages.

Elementary Lessons in Heat. By S. E. Tillman. New York: John Wiley and Sons, 1892. Second edition. Pp. 162.

These lessons have been prepared by Prof. Tillman to meet the requirements of his class-room at the West Point Military Academy, and are designed for the use of teachers and students generally. They cover the usual subjects of a text-book on heat put in a clear and consise form, and, besides this, Prof. Tillman has given special attention to meteorological phenomena, following Prof. Ferrel in the subject of atmospheric circulation, and the theories of tornadoes and storms.

Sunshine. By Amy Johnson, LL. A. London and New York: Macmillan & Co. Pp. 502. Price, $1.75.

It may be judged that the author of this work, a teacher of science at South Kensington, has been extremely successful in holding the interest of her audiences. The material of this volume is mainly a reproduction of lectures to her classes upon the subject of light. These are given in the form of stories, and the experiments to which they naturally lead are performed conjointly by teacher and children, while suggestions are added for other tests to be made at home. Sun images, shadows, and photographs are studied in turn. The laws of reflection and refraction, lenses and their uses, the spectrum and the rainbow are explained and variously illustrated. The beautiful phenomena of fluorescence and phosphorescence and the action of sunlight upon the leaf-green form interesting chapters. Soap-bubbles are treated in four lectures. The films are shown in the shapes of windmill, mushroom, and liquid prism. A bubble is blown within a bubble, one tinted with aniline green being seen plainly within another of ordinary color, and a letter-weight is constructed with a film to test its elasticity. One lecture is devoted to a journey to Moonland which the children take seated at their desks, and two others give information about the sun, related in the form of a dream.

Many of the experiments are novel, and all can be performed with simple apparatus.

The author states that her aim has been to write so that any child who reads the words can understand their meaning; and although children may thus use the book alone, its purpose will be more nearly fulfilled when parent or teacher, thoroughly familiar with the text, tells it in story-fashion to the hearer. The work is also adapted for lectures before evening classes and reading circles, and to this end 127 of the illustrations have been prepared as lantern slides. The practical hints and appendix furnish directions for apparatus and contain further explanation of the principles involved in the lectures, so that a novice in science may begin to learn by teaching others. According to the preface, the author "looks most particularly to the lanternist as the future exponent of popular science."

The Footpath Way. By Bradford Torrey. Boston and New York: Houghton, Mifflin & Co. Pp. 242. Price, $1.25.

Those who follow Mr. Torrey in his rambles through grove and pasture will surely return with sharpened vision. Even in December there are wild flowers to be found in Massachusetts. Not only the belated aster and dandelion, but mallows, groundsels, shepherd's-purse, and cinquefoil, sixteen kinds in all, blossom at this bleak season. In the same month and locality are noted thirty varieties of birds. Not more than ten of these would probably be seen from a window. They, as well as the flowers, must be traced to their haunts. What patience is needed to know the ways of humming-birds can be gathered from the papers entitled A Widow and Twins and The Male Ruby-throat.

But, whether on mountain-top or in the hollow, there is more to be learned than the habits and genealogy of bird and flower. The author gleans much philosophy by the way. The borer gnawing beneath the fallen spruce teaches him content; the pine tree shows him a brave example; while in the diversity of flowers he reads the advantage of individuality, and in the distinguishing excellence of leaf, bark, and fruit he finds the value of specializations.

Calmire. New York: Macmillan & Co., 1892. Pp. 742.

The aim of this anonymous novel is somewhat complex, including both social morality and the influence of scientific thought upon religion. It is shown in the progress of the story that loose notions result in a ragged character, and the author makes an original effort to patch the hero creditably before the close of the scene. The greatness of to-day and the novelty of ideas no longer new exhale from much of the dialogue. The main part of the book consists of lectures upon the conservation of energy and the principles of evolution, relieved by a generous use of slang.

Those who are eager for the story may not care to swallow this diluted science, while those who are in search of science will scarcely look for it here.

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POPULAR MISCELLANY.

Early Electric Railways.—According to Mr. Edward Trevett's book on Electric Railroad Engineering, the first electric railway was constructed by Thomas Davenport, a blacksmith, of Brandon, Vt., who exhibited in Springfield, Mass., in 1835, a small model electric engine, running upon a circular track, the circuit being furnished by primary batteries carried in the car. The invention was crude and of little practical value, "but the idea was there." Three years later, Robert Davidson, of Aberdeen, Scotland, began experiments in order to supplant the steam railway locomotive by the electric locomotive. He constructed a powerful electric motor which was run successfully on several railways in Scotland, attaining a speed of four miles an hour. In 1849 Moses Farmer exhibited an electric engine which drew a small car containing two persons. In 1851 Dr. C. G. Page, of Salem, Mass., constructed an electric engine of considerable power, which drew a car on the Baltimore and Ohio Railroad, between Washington and Bladensburg, with a highest speed attained of nineteen miles an hour. In the same year Thomas Hall, of Boston, built an electric locomotive in which the current was conducted from a stationary source through the rails and the wheels to the motor. Dr. Joseph R. Finney, of Pittsburg, about this time devised a trolley apparatus. In 1879 Messrs. Siemens and Halske exhibited their electric railway at Berlin. The car carried about twenty passengers at about eight miles an hour. In 1880 Mr. Edison worked an experimental road at Menlo Park, N. J. The first commercial electric railway was constructed at Lichterfeld, Germany, in 1881. It is operated by the third rail system. Since then the development of the electric railway has been rapid.

An Indian Girl's Life.—Prayed over at birth, Dr. Shufeldt says, the pueblo girl of Wolpai (Moquis) must have her delicate baby skin well rubbed with fine wood ashes, or else her bones might become loose as she grows older. Very soon she is strapped in her portable cradle and toted about upon her mother's back, but while in the house must, in the same apparatus, be either stood up against the wall or even hung up, where for an hour or more together, in either situation, her sole amusement consists in peering about the "living-room." As soon as she is able to walk she is permitted to toddle about everywhere, and to ascend and descend the house ladder before the second summer has passed over her head. She has no end of toys and playthings to amuse her. Till about seven years old "her days are spent mostly in romping and playing with the numerous children in the pueblo. Innocent of all clothing, and possessing a wholesome dread of water for any other purpose than to drink, she is at this age as wild as a mountain sheep, and can with almost equal celerity run up and down the steep, rocky crags that so abruptly slope down from the pueblo on all sides save one." After her tenth year she assumes the costume of her elder sisters and her girl companions, and is instructed in the duties that pertain to the kitchen, and in pottery and basket-work; and as she grows stronger, in carding and dyeing wool and weaving blankets, mantles, petticoats, garters, and sashes of cotton or wool. At or a little before fifteen she is considered nubile. "She can bake, sew, dye, card, weave, and spin; her nimble fingers fashion the plastic clays into every shape needed for use or ornament; the tender shoots of the willow or the pliable roots of the grasses respond to her fairy touch and round themselves into beautiful baskets, vivid with coloring and repeating the sacred emblems of the butterfly, deer, or thunder-bird. In the number of stews, ragouts, and broths which she knows how to compound of the flesh of the kid or sheep, and such vegetables as the onion, bean, and the aromatic chile, or in the endless diversity of hominy mush, popcorn, and piki bread, she will hold her own with the most ingenious American housewife."

The Eskimo Woman's Knife.—The *ulu*, or woman's knife of the Eskimo, as described in Mr. Otis T. Masons's paper on the subject, finds its modern representative in the saddler's and shoemaker's knives, the tailor's shears, the butcher's and fishmonger's knives, and the kitchen chopping knife. The last presents a curious survival of form with change of function. There are a great many examples of the *ulu* in the National Museum, and there are thousands of pieces of slate, shell, quartzite, and other stone which correspond exactly with the blades of the Eskimo woman's knife. They have been gathered in countless numbers from the places where relics are found; for every woman and every girl among the American aborigines had one or more of these indispensable implements. While some of the number are of a very primitive character, the *ulu* as it now exists is a complex affair, consisting of a blade and a handle, or grip, with or without some form of lashing. The blade is either a thin piece of slate ground to an edge, a bit of cherty or flinty rock chipped to an edge, a scrap of steel or iron from wrecks of whaling vessels, or good blades made and sold to Eskimos by traders who visit their country. The handle of this common implement varies greatly in material, form, and finish. In form alone the specimens from each typical area are unique. Many of the blades are tightly fitted into a socket or groove of the handle. The woman's knife is found throughout the Eskimo region, from Labrador to Kadiak, of materials in the handles and the blades dependent most largely on what are furnished by the locality. Some of the specimens in the National Museum are as coarse as savagery could make them; others are very beautiful. The same locality furnishes both and intervening kinds; but some areas furnish only coarse work, while others supply the most beautiful. The problem is a complex one, and white influence has crept in to embarrass the question.

Dirt and Cholera.—"Boil your ice," the pithy counsel given by Dr. Daremberg to the people of Paris, in view of the danger of cholera, is made a text by The Lancet for an exhortation to cleanliness. The saying refers to the ascertained fact that the cholera germ is not destroyed by freezing, and there may therefore be danger in ice, but there are lessons in it of much wider application. We have made great advances in sanitary practice, or cleanliness, which is the same thing, but are still guilty of a great many faults; as The Lancet says, speaking of England, but with apt applicability to our own country: "There are spots in abundance that seem almost to be waiting their opportunity to impress more emphatically the lesson that epidemic cholera and filth go hand in hand. There is the barbarous and revolting midden-stead system of our northern counties, polluting air and soil by its emanations and soakage; there are similar systems in the south and elsewhere under which it has become a custom to dig two holes in every man's garden and then to pour all liquid filth into one which is called a cesspool, while the drinking-water is drawn from the other one which goes by the name of a well. There are houses by the thousand in which the drinking-water is drawn from a cistern which also serves a water-closet, and which is also placed in direct communication with the house-drain by means of its overflow pipe; and there are houses in every town by the score, and even by the hundred, in which there is no such proper disconnection of house-drain and waste-pipes from the public sewer as to free them from risk of the ingress of that sewer air from public culverts, which may at any moment be a means of conveying the contagium of imported cholera. . . . There are communities who deliberately elect opponents of sanitary reform because they prefer a risk which seems somewhat remote to a certainty of increased rates; there are public bodies who leave individual inhabitants to perform works of cleanliness and scavenging which they are aware they can not properly carry out; and there are householders who live on year after year in dwellings into which they know sewer air can make its way by one channel or another—indeed, such people can be everywhere found in abundance."

Curious Lightning Phenomena.—A curious story is cited in Chambers's Journal of a specimen of the kind of lightning called the fireball, which came down a tailor's chimney in Paris, showing itself the size of a child's head, and moved slowly about the room, at a small height above the floor, looking, as the tailor described it, "like a good-sized kitten rolled up into a ball and moving without showing its paws." It was bright and shining, yet did not seem to give out any heat. After making several excursions in different directions, it rose vertically to the height of a man's head, steered toward a hole in the chimney above the mantel-piece, and made its way into the flue. Shortly afterward there was a violent explosion, which destroyed the upper part of the chimney and threw the fragments on to the roofs of some adjoining buildings. The phenomenon of lightning prints is one of which little is yet known, but which deserves attention. Prof. Poey mentions twenty-four cases of impressions like photographs made by lightning on the bodies of men and animals. Of these, eight were impressions of trees or parts of trees; one of a bird, and one of a cow; four of crosses; three of circles or of impressions of coins carried about the person; two of horseshoes; one of a nail; one of a metal comb; one of a number or numeral; one of the words of a sentence; one of the back of an arm-chair. Many other instances of similar impressions are recorded.

Diseases of Advancing Age.—Dr. J. F. Alleyne Adams, in his Shattuck Lecture on the Prevention of Diseases, considers some of the causes of the increase of the diseases of mature or advancing age. The first is the natural tendency of an advancing but still imperfect civilization. We have arrived at nullifying the law of natural selection in youth by the care we take of our weaklings, but have not yet reached that high moral condition and power of self-restraint which are needed to enable us to carry out the contest to the end, and these weaklings consequently succumb early in the downward course. A second cause is found in the rapid growth of cities, the influence of the life in which is to degeneration. A third cause appears in the influence of the war, which took away our most vigorous men. Other causes acting more directly are, the general prevalence of digestive disturbances, due in part to an improper diet and in part to a weakness of digestion caused by lack of exercise and mental strain; a lack of general vigor due to insufficient exercise; the excitement and anxiety which pervade all occupations at the present day; and—most potent and destructive—the intemperate use of alcoholic stimulants.

The People of Mashonaland.—A paper concerning the country in South Africa "which has somehow or another got the name of Mashonaland" was read in the British Association by Mr. Theodore Bent. The inhabitants are an oppressed and impoverished race who, raided upon from both sides by Zulus, take refuge in the mountains. They are obviously a race which has seen better days, retaining traces of a higher civilization in their skill in smelting iron, their ornaments, their musical instruments, and many other kindred points. Though of different tribes, the inhabitants all call themselves by one race name, Makalanga. This is philologically the same as Mocaranga, which a Portuguese writer of the sixteenth century called the people of the country; and in the accounts, given at that time, of the manners and customs of the tribes we recognize certain salient features which connect them with the present race. They describe to us the tribal witch-doctor, the ancestor-worship which is still carried on, their methods of catching game, the filing of their teeth, and numerous other customs indubitably connecting them with the present race. Hence it is very clear to us that the country now called Mashonaland has been inhabited for at least a thousand years by the ancestors of the present barbarous race—a race of men who at one time became powerful and almost civilized, owing to their intercourse doubtless with foreign traders, but who during the later centuries have fallen away into barbarism. Among the traits connecting them with external races and pointing to Semitic influences, are: the assumption of a dynastic or tribal name with the disuse of his old name, by each chief, of whatever degree, on his inheriting his chiefdom. Such names are used just as the name Pharaoh was used in ancient Egypt and continue for centuries. Each of the Makalanga tribes has its totem. In M'Topo's country it is the lion into which the spirits of their ancestors are supposed to go, and this animal is believed to fight for them in battle. To the lion they sacrifice annually, and the chief priest of the tribe is called the lion priest, the Mondoro. Other tribes have the crocodile, the leopard, and so forth. Totems of similar nature are found, as Prof. Glover demonstrates, among the tribes of southern Arabia in remote antiquity. In religion the present inhabitants of Mashonaland are distinctly monotheists. They believe in one god whom they term *Muali*, a great and mysterious personage unapproachable by mortals; so they have elected as their intercessors *Mozimos*, or spirits of their ancestors, to whom they sacrifice annually, and offer prayers for their well-being. The existence among the Makalangas of a day of rest during the plowing season is very curious. They call it "Muali's" or "God's day." In Mangwendi's country the chief ordains it and orders that his tribe abstain from work on every sixth day during the periods of industry. This day is invariably employed by the men in drinking beer and lying about idle on the rocks. The wooden pillows are the same as the ancient Egyptian pillows. The favorite game of the country, called *Tsufuba*, is closely akin to a game played in India. The common drink, a millet beer, is called *doora*, as in Abyssinia, and is the same as an ancient Egyptian and Asiatic drink. The so-called Mashona piano, consisting of over twenty iron notes fixed to a scale on a square piece of wood and played on a calabash to bring out the sound, has its parallel to-day in Nubia and Lower Egypt. The Makalangas are decidedly a musical race, and easily pick up tunes to play on this instrument. Every chief has his private musician, who plays at all the public entertainments and dances. As to type of countenance, the Makalanga is far the most refined of any of the Kaffir races Mr. Bent has seen.

The First Transatlantic Steamer.—A publication of curious interest is that of the Log of the Savannah, the first steamship that crossed the ocean, which J. Elfreth Watkins has contributed to the report of the United States National Museum. The Savannah was built for a sailing vessel, but attracted the attention, while upon the stocks, of Captain Moses Rogers, who had been associated with Fulton and Stevens in commanding several of the early steamboats. At his instance it was fitted up with engines by a business firm in Savannah, who wished to give that city the credit of starting the first transatlantic steamship line. Her first voyage was made from New York to Savannah, and on the second day occurs the entry: "Got steam up and it came on to blow fresh; we took the wheels in on deck in thirty minutes." This taking in the wheels during a storm through fear of having them washed away or damaged is not mentioned in connection with any other vessel. The ship reached Savannah in eight days and fifteen hours from Sandy Hook. After a voyage to Charleston and return, the vessel was visited by President Monroe, who was greatly pleased with it, and wished it to go to Washington after its Atlantic voyages, to be examined and possibly purchased for the Government service. The voyage to Liverpool began May 22, 1819. On the 24th, at 5 A. M., the Savannah "got under way of Tybee light, and put to sea with steam and sails. At 6 A. M. left the pilot. At 8 A. M. took off the wheels in twenty minutes." This was to insure the wheels getting safely to Liverpool. The Savannah reached Liverpool, steaming up the Mersey, in twenty-nine days eleven hours from Savannah, having run eighty hours under steam. Marwade's English Commercial Report described her steaming, "without the assistance of a single sheet," as being in a style "which displayed the power and advantage of the application of steam to vessels of the largest size." Vessels which saw her steaming on the passage took her to be on fire. The Savannah visited Stockholm, St. Petersburg, and Copenhagen; and returning home, reached Savannah on November 30th, the fortieth day after leaving Arendale, Norway, not using steam till she got inside of the bar. She visited Washington in December. Her owners became embarrassed in consequence of the great fire in Savannah in 1820, and were obliged to sell her. She was stripped of her machinery, and served as a sailing packet till 1822, when she ran ashore on Long Island and went to pieces.

The Two Schools of Psychology.—At the second session of the International Congress of Experimental Physiology, held in London in August, the president, Prof. H. Sidgwick, spoke of the subsidence of the antagonism that prevailed a few years ago between one-sided extreme views on the neurological side and the psychological side respectively. On the one hand, the crude materialism or positivism which pushed contemptuously aside all results of introspective observation had now mostly given way before the general recognition that psychical processes are objects of experience, altogether distinct from the nervous processes which invariably accompany them; and, though we might regard them as "two faces of the same fact," they must admit that they were "incapable of seeing, or even imagining," how the two were connected; and that, in order to know what could be known of the double fact, they must give systematic and careful attention to both its sides. On the other hand, the attempt of some students of mind to mark off a department of mental phenomena elevated above the condition of being accompanied by nervous change, was now, he thought, generally abandoned, even by the psychologists who were most strongly opposed to materialism; they found, as Shakespeare's Troilus said, that "we can not fight upon that argument."

Insects Injurious to Fruit.—In his paper read at the late meeting of the American Pomological Society on Recent Advances in dealing with Insects affecting Fruits, Prof. C. V. Riley discusses the methods of combating the plum curculio, codling moth, red scale, fluted scale, and other injurious insects, giving the results of recent experiments on those insects. He questions whether more injury is done to-day to our fruits than was done fifty or one hundred years ago. In fact, it is patent that with the advances made of late years in our methods of warfare against these fruit pests less injury relatively is done, but, as the area of fruit culture increases, so does the aggregate of injury and also the number of species that we have to contend with. He warned pomologists to be on their guard against two foreign insects likely soon to appear in this country—the peach ceratitis, a subtropical insect resembling the apple maggot, which is extremely destructive to the peach crop of Bermuda and likely to be troublesome if it once becomes established in Florida and Georgia; and the Japanese peach fruit-worm, which is allied to our codling moth, and in some seasons damages ninety per cent of the peach crop of Japan. He suggested that provision be made for the inspection, at ports of entry, of fruits and plants received from any part of the world from which we know danger threatens.

Leaves of the Water Lily.—Prof. Miall read a paper in the British Association on the leaves of the giant water lily (*Victoria regia*). He exhibited a photograph of a leaf with a child standing on it to illustrate its flotative power. The leaf differed from that of the English water lilies in that the stalk was affixed almost to the center of it, while the deep slit at the base of the leaf was reduced to a mere notch, and in the presence of a raised rim. This latter feature was probably not useful for preventing waves breaking over the leaf, as had been supposed, but for preventing one leaf from sliding over another. This was proved by the fact that if a leaf was allowed to grow apart from others the rim bent down and the whole leaf lay flat upon the water. Any solid object touching the young growing leaf would cause the rim to be retained all round. It had been shown, furthermore, that when one leaf slid over another, the portion which was covered degenerated and lost its power of repelling water. The notch at the base of the leaf was formerly supposed, by Prof. Miall himself, to be of service in getting rid of water from the surface, but further experiments had convinced him that this was an error. He believed that submergence, the means by which he had previously tested them, was not likely to occur in nature, so he resorted to the use of a garden syringe in order to imitate the effect of rain in filling the leaves. He then found that after fifteen minutes' watering the leaf was no fuller than before and that no water had run out through the notch. On holding the leaf up to the light it was found to be as full of pores as a sieve. The spines with which the leaf was covered were probably a protection against the attacks of the apple snail (*ampullaria*), one of the chief enemies of the plant. When the young leaves were unrolling the spines were so close that no animal could possibly get between them to eat the leaf, and in the full-grown specimens it was only the margins of the rim which were accessible.

The Future of Water Powers.—In his address before the Section of Mechanical Science of the British Association, Mr. H. Cawthorne Unwin said that in 1878 Mr. Easton expressed the opinion that the question of water power was one deserving more consideration than it had lately received, and he pointed to the variation of volume of flow of streams as the principal objection to their larger utilization. Since that time the progress made in systems of transporting and distributing power has given quite a new importance to the question of the utilization of water power. There seems to be a probability that in many localities water power will, before long, be used on a quite unprecedented scale, and under conditions involving so great convenience and economy that it may incite a quite sensible movement of the manufacturers toward districts where water power is available. When textile manufactures began to pass from the condition of purely domestic industries to that of a factory system, the principal mills were erected near river falls, no other power than water power having been found practically useful. "About 1790," says Mr. Kennedy, "Mr. Watt's steam engine began to be understood, and waterfalls became of less value. Instead of carrying the work-people to the power, it was found preferable to place the power among the people." The whole tendency of the conditions created by the use of steam power has been to concentrate the industrial population in large communities, and to restrict manufacturing operations to large factories. Economy in the production of power, economy in superintendence, the convenience of the subdivision of labor, and the costliness of the machines employed, all favored the growth of large factories. The whole social conditions of manufacturing centers have been profoundly influenced by these two conditions—that coal for raising steam can be easily brought to any place where it is wanted, and that steam power is more cheaply produced on a large scale than on a small scale. It looks rather, just now, as if facilities for distributing power will to some extent reverse this tendency. Water power, where it is available, is so much cheaper and more convenient than steam power that it has never been quite vanquished by steam power.

Electric Units.—The committee of the British Association on electrical standards have proposed the following resolutions, with a view to their adoption internationally: "(1) That the resistance of a specified column of mercury be adopted as the practical unit of resistance. (2) That 14·4521 grammes of mercury in the form of a column of mercury 106·3 centimetres long at 0° C. be the specified column. (3) That standards in mercury or solid metal having the same resistance as this column be made and deposited as standards of resistance for industrial purposes. (4) That such standards be periodically compared with each other, and also that their values be redetermined at intervals in terms of a freshly set up column of mercury." With regard to the units of current and electromotive force, it was agreed that the number ·001118 should be adopted as the number of grammes of silver deposited per second from a neutral solution of nitrate of silver by a current of one ampère, and the value 1·434 as the electromotive force in volts of a Clark cell. Prof. von Helmholtz expressed his full concurrence in these decisions.

Power of Hypnotic and Verbal Suggestion.—Some most remarkable instances, taxing credulity, of the power of hypnotic suggestion were related at the recent International Congress of Experimental Psychology in London. A communication from Dr. Liebault told of a case of suicidal monomania cured by suggestion, the effect of which he hoped would be, with a few renewals, durable. In such cases the practitioner insists on making repeated affirmations of cure and multiplying the *séances*. Prof. Delbœuf had removed pain by causing the patient to exercise his will, and had cured a woman possessed with the idea of killing her husband and children—charming away the morbid thought by degrees for two hours, then for a day, and then for a week. Dr. Bramwell, of Goole, presented four of his patients in proof of his claim that he could command pain away by the mere spoken word, without inducing the hypnotic trance. He had recently painlessly extracted seven teeth from the woman of the group by merely ordering her not to feel pain; but failed in the eighth tooth, because she had previously formed the conviction that she would feel pain, so that her self-suggestion overbore his suggestion. The same patient had suffered from myopia, being able to read only the third line in the ordinary table of test letters. On his suggestion she had been able to read all the lines; and he could put her into the myopic state or relieve her from it by the word of command. He had been able to produce the same satisfactory results with all his patients by the mere command in a waking state that he had previously produced in a trance. The mere fact of his giving a written order to a patient to sleep enabled the patient to take that order, read it, and go to sleep whenever he needed to do so. He had repeatedly sent patients to a dentist carrying with them a written order not to feel pain, which they read when they sat down in the dentist's chair. He had now patients who go to sleep by reading the order to do so; the orders would retain their power when he had not seen the patients for weeks; in fact, he had been repeatedly called upon to give them new pieces of paper when the original talisman had worn out. A captain's wife, in the habit of taking sea voyages and being sick, was now regularly relieved by the author's suggestion.

Useful Bacteria.—It is true, says Dr. H. W. Conn, in a paper on Some Uses of Bacteria, that bacteria are occasionally injurious to us, but it is equally true that they are of direct benefit to us; particularly useful are many of them to the farmer. There are the yeasts, for instance—not bacteria, but microscopic plants closely related to them—the fermenting agents by the aid of which we make bread, wine, and beer. Cider having been fermented by yeast into an alcoholic liquid—hard cider—is further changed in time by the agency of bacteria into vinegar. These bacteria grow on the surface of the hard cider, forming a sort of scum which is the "mother" of vinegar. In the ensilage management of silos, the whole process of procuring proper and sweet ensilage is one of properly managing bacteria growth. During the ripening of cream and the development of the aroma that gives its flavor to butter, bacteria are growing within it "with absolutely inconceivable rapidity" to produce the precious changes. But, "if the butter-maker owes something to bacteria, the cheese-maker owes everything to them. The butter-maker can not get the proper aroma without the agency of bacteria, but the cheese-maker can not get anything. By them unpalatable fresh cheese is converted into ripened, strong, pungent, well-flavored cheese. The quality of the cheese depends on the kind of bacteria that are planted in it, and the selection of these bacteria or the method of introducing them constitutes one of the arts of cheese-making, in which much is yet to be learned; and there is another art in keeping out the noxious bacterium, tyrotoxicon, which poisons the cheese. Bacteria are the powerful agents through which dead animal and vegetable matter is removed by decay. Bacteria also have an important agency in plant life, by promoting the decomposition of compounds from which plants are fed. Of special importance is one particular kind of organism known as "the nitrifying organism," which produces nitric acid. But this is not the end of the agency of bacteria in plant life. They are not only of value in ripening your fertilizers and in keeping up this constant growth of Nature, but we have learned . . . that at the very foundation the growth of plants is absolutely dependent upon these organisms, and similarly in the future the continuance of the vegetable world must be also dependent upon them."

Prehistoric Fish Weirs.—The stone implements, potsherds, and other objects found by Dr. H. T. Cresson in the mud near the mouth of Naaman's Creek, Claymont, Delaware, form the subject of a special paper in the records of the Peabody Museum. The objects were found in close association with the decayed remains of stakes or piles, indicating an aboriginal structure of an unknown character. This structure (or structures) Dr. Cresson conjectures to have been originally fish weirs. Herein he agrees with Prof. H. W. Haynes, who deems it safe to consider them fish weirs rather than the remains of a pile-dwelling people. This confirms the words of the fisherman who first brought the stone implements to notice, when he suggested that "the Indians in old times used to hitch their canoes to them and spear fish, and that was the reason why their darts, axes, etc., were found there." Fish weirs have been mentioned by certain early explorers on this continent, and remains resembling such structures have been referred to by more modern writers.

The Ribs of the Gorilla and of Man.—Describing the articular processes of the gorilla as compared with those of man, Prof. Struthers said, in the British Association, that in the gorilla the chest was planted a vertebra lower than in man. The seventh presented all the characters of the normal sixth, the eighth all the characters of the seventh. In man he had seen the whole chest a vertebra too high. He had met with three cases of a rib more than usual. It was common enough in the human body; instead of the ordinary twelve you had one more at the neck much more commonly than below. In the cases of three out of fourteen gorillas the extra rib was in the lower part of the chest. The gorilla had one more rib than man, but he had never met with the cervical rib in the gorilla in the upper part of the chest. The tendency in the human chest was to move upward; the tendency in the gorilla's chest was to move downward. President Archibald Geikie said that in man the last rib was a diminishing element, that nothing was more striking than the excessive variations in the length of it. Every organ in the body had a marvelous power of persistency, but it seemed as if the last rib was passing out of existence.

Ancient Peruvian Vegetables.—According to Prof. Wittmack, the ancient Peruvians did not suffer from lack of variety of vegetable foods in their bill of fare. The examination of the ancient cemetery at Aricon has brought to light a large number of plant products which were useful to them for various purposes. Among cereals they had several kinds of Indian corn from which they prepared a kind of beer and a brandy. The quinoa (*Chenopodium quinoa*) was also much valued as a breadstuff, and is still cultivated. They had two kinds of phaseolus beans (*Phaseolus pallar* and *P. vulgaris*), and the beans of the mezquite (*Prosopis glandulosa*), which were eaten as a St. John's bread, or ground were much enjoyed with water. Only a few seeds of lupins have been recovered, but the peanut (*Arachis hypogæa*) has been found abundantly. The bulbous foods included manioc, potatoes, which were cultivated on the mountains, and the sweet potato. Of fruits they had bananas and the lucuma (*Lucuma obovata*) of the present Peruvians; the guava, the sapota, peaches, the passion-flower, the anone, and the anana. The large seeds of the *Inga feuilli*, called pacay, were much liked. For greens they had the tender leaves of the quinoa, cucumbers, and tomatoes. Their narcotics included the coca, which was chewed with pulverized bones or lime, but which in the time of the Incas common men were not permitted to enjoy without permission of the king. Tobacco was used only in snuff or as a medicine, but was not smoked. One of the most important drinks was chica, a kind of corn beer. Spanish pepper was in general use. Of plants useful in the arts, they had white and brown cotton, hemp from the agave, and fourcroya and ananas leaves, for fibers. The pith of the agave furnished tinder. For dyestuffs, they had indigo for blue, *Bixa orellania*, the fruit of *Coulteria tinctoria*, the bark of *Rhopala ferruginea*, for black and brown, *Bignonia chica* and *Rubia nitida*. The seeds of the soap tree (*Nectandra* or *Mucuna inflexa*) were worn as beads. Weaving implements and canes were made from the soft wood of the *Porliera hygrometrica*; and idols, spoons, and other carved articles from the likewise soft wood of *Pavonia paniculata*, while hard woods were fashioned into lance-shafts, etc.

Ethics in Engineer's Work.—Some Moral Factors in the Engineer's Career, as outlined by Mr. Alfred R. Wolff, of the Stevens Institute of Technology, include in the beginning the subordination of the money consideration to the improvement of opportunities for acquiring further knowledge and the right kind of experience in judgment; an impartial estimate of one's own capabilities and the following as a specialty of that in which he can best excel; self-respect; strenuous effort to gain wide culture and foster broad interests outside of his special profession; and good citizenship, with active interests in movements which tend to humanitarian, social, and political advance. Under the maxim "Be honest," the author describes a kind of bribery which is insinuating but powerful. It is when a special machine or device has been recommended or some contract awarded with sole reference to its merits, and the proprietor then offers a commission or gift. All appears harmless; but an inducement has been offered silently for taking, if not on this occasion, then on the next, a more favorable or a biased view to the donor's interest.

Origin of Color Blindness.—After describing the phenomena of color blindness in his address at the British Association, Prof. William Rutherford said: "It must be admitted that the production of nerve-impulses within the terminals of the retina is almost as obscure as ever. It is still the old question, Does light stimulate the optic terminals by inducing vibration or by setting up chemical change? Whichever view we adopt, it seems to me necessary to suppose that all the processes for the production of nerve-impulses can take place in one and the same terminal, and can be transmitted to the brain through the same nerve-fiber. From Lippmann's recent researches on The Photography of Color it appears that all parts of the spectrum can now be photographed on films of albumino-bromide of silver to which two aniline substances, azaline and cyanine, have been added. It seems, therefore, reasonable to suppose that a relatively small number of substances could enable all rays of the visible spectrum to affect the retina. It seems to me that the question becomes narrowed down to this, Do the nerve-impulses arise from mere vibration or from chemical change in the molecules of the nerve terminal? The photo-chemical hypothesis has much in its favor. We know how rapidly light can induce chemical change in photographic films, and we know that light induces chemical change in the vision purple in the outer segments of the rod-cells of the retina. The fatigue of the retina produced by bright light is best explained on a chemical theory, but it could also be explained on a mechanical theory; for we must remember that even if the nerve-impulses produced in the visual cells were merely a translation of the energy of light into vibration of nerve-molecules, the nerve-impulse has to pass through layers of ganglionic cells before reaching the fibers of the optic nerve, and in these cells it probably always induces chemical change. I have endeavored to place before you a subject that involves physical and physiological considerations of extreme difficulty. I have not attempted to solve the difficulties, but rather to show their nature."

Work of the Forestry Division.—The year 1891, according to chief Fernow's report, witnessed greater activity and interest in forestry than any previous year. A bulletin, What is Forestry? issued by the division, showed that the forestry interests of this country rank second, if not first, in the value of our annual products reaching the market. The largest share of the expenditure of funds as well as of attention was bestowed upon investigations into the character of our timber trees, or "timber tests." These relate to a judgment of mechanical properties from a simple microscopic or macroscopic examination, and to the determination of the relation in which structure, physical conditions, and mechanical properties stand to the conditions under which the tree is grown. A wide and deep interest is manifested in this work throughout the country. In connection with it a study has been made of the lumber pines of the Southern States, the results of which are given in the present report of the chief of the division. The revision of the botanical and the common names of our arborescent flora is nearly completed and will soon be ready for publication. Distributions have been made of packages of seeds of nine important conifers to State agricultural experiment stations, and twenty species of important conifers and deciduous trees to general applicants, besides seeds of the Australian tan-bark wattle to applicants in the Gulf States, the arid Southwest, and the southern part of the Pacific coast region.

The Forerunners of Matches.—Besides the primitive devices for fire-making, Mr. Walter Hough, in a paper on that subject, describes several that were used in civilized countries before matches became universal. The brimstone match is found in Japan as a broad, thin shaving tipped with sulphur; in Mexico it is a cotton wick dipped in sulphur. These are used to catch the sparks from flints or steels. The "spunk," or splint tipped with sulphur, was in common use in this country prior to 1825, and lingered in out-of-the-way places long after the introduction of matches. In parts of France it is still in use with the *briquet* or tinder box. A variation of the spunk match was curled shavings tipped with sulphur. Attempts to supersede the clumsy *briquets* produced the tinder piston, the tinder wheel, and later the first chemical match. The first employment of phosphorus was by dipping the match into a bottle full of phosphorous mastic mixed with oxide of phosphorus. The next was the "instantaneous light box," "eupyrion," "dip splint," or, in the United States, "match-light box"—a tin box or wooden receptacle, containing a glass bottle filled with asbestus soaked with sulphuric acid, and wood splints tipped with sulphur and then dipped in a paste made of chlorate of potash, powdered sugar, and gum arabic, with water. The "prometheans" were tubes of glass filled with sulphuric acid, surrounded with an inflammable mixture made chiefly of alum and sugar, which, on being broken, gave an instantaneous light. Another "promethean" was composed of equal parts of chlorate of potash and sugar mixed with a solution of gum, while the sulphuric acid was contained in a glass bead imbedded in the paste and rolled up in gummed paper. Chemical contact and flame were produced by crushing with a pair of pliers. The "Döbereiner," named after the German inventor, was an apparatus of some complexity for bringing hydrogen to impinge upon spongy platinum. It was extensively used in Germany and other countries, and is still found in laboratories and can be purchased from instrument-makers. The invention of friction matches is variously assigned to an Englishman and to a German, and to the years 1829, 1830, and 1832. The first United States patent for a friction match was issued in 1832 for a chlorate match.

Silicified Wood in Arkansas.—The occurrence of silicified wood in the sands and gravels of the Tertiary of the lower Mississippi Valley has long been known, but the mentions and studies of it have for the most part been only incidental. No attempt has hitherto been made, according to Mr. R. Ellsworth Call, to recognize the species and fix their value for classification. The fossil woods occur throughout the area covered by Tertiary sands and gravels in Arkansas. When in large masses, they are apparently rarely far removed from beds of Tertiary lignite; if in small masses or in small fragments, they occur in the gravels of nearly all the region and in the beds of the streams and brooks of the area covered by the Tertiary. Occasionally, whole trunks of trees are found, often partially buried in the sands or deeply imbedded in the gravels which cover the flood plains of the creeks and ravines. The microscopic studies of Prof. F. H. Knowlton have shown that the woods belong to both dicotyledonous and coniferous types, the former constituting the first known dicotyledonous wood found in this country in rocks older than Pleistocene, and the first dicotyledonous forms determined by internal structure. The forms described by Prof. Knowlton are new, and therefore of no use for purposes of classification, but otherwise valuable results have been reached by the studies. The specimens found indicate comparatively few species, but these few must have existed in great numbers. Mr. Call's attention has been directed to tracing the connection between these silicified woods and the lignite beds; and he concludes that they are silicified lignite, the silicification of which occurred either while they were still in the clays, or, most often, after they were removed and buried in the sands and gravels.

NOTES.

Mr. T. C. Stearns records, in the Popular Science News, as a result of his observations of many snakes of every usual size, that he finds them lying in the spring on hill slopes in their torpid state. He never saw them lying straight, but they were all in the form of the letter S. He has also noticed that the first movement they make when aroused is toward the tail, and that indifferently whether he is standing at the head or the tail.

A mask in the National Museum which was found in a grave in southeastern Alaska, is described in a special paper by Lieutenant T. Dix Bolles, U. S. N. It is skillfully carved from cedar wood and painted in the usual grotesque manner with native colors, and is marked by the unique peculiarity of having for its eyes two large bronze Chinese temple coins. The grave in which it was found is more than two hundred years old. Lieutenant Bolles regards it as proof that a Chinese junk was, at some time in the past, driven upon the Alaskan coast.

The British Association for the Advancement of Science has been invited to meet in Toronto in 1895 or 1896. Its first visit to Canada took place in 1884, when it assembled in Montreal. Since that year the scientific interests of the city have made rapid strides, the impulse thereto being in large measure due to the interest evoked by the Association's work. In its new technical departments, established through the bequest of the late Mr. Thomas Workman, and by the princely gifts of Mr. William C. McDonald, McGill University is as thoroughly equipped as any university in America. Mr. Peter Redpath, who gave the beautiful building for its Natural History Museum, has given a handsome building, fast approaching completion, for its library. The muster-roll of McGill is now 650.

At a meeting held in October the trustees of Columbian University, Washington, D. C., elected three chemists to as many chairs in the faculty: Dr. E. A. de Schweinitz, lately of the United States Agricultural Department, Washington, was elected Professor of Chemistry in the medical department; Prof. Charles E. Munroe, formerly of the Annapolis Naval Academy and lately of the United States Torpedo Station, Newport, R. I., was elected to the chair of Chemistry in the university; Prof. H. Carrington Bolton, of New York city, was elected "Non-resident Lecturer on the History of Chemistry," a position created expressly for him, and the first of this title in the United States.

PROF. G. C. CALDWELL, of Cornell University, regards the healthfulness of oleomargarine as dependent largely on the quality of the material from which it is made; and finds that there is no positive proof that it has ever been made from unwholesome materials, or that any disease has ever been communicated to man by its use. He is of the opinion that when it is properly made from fresh and clean materials it differs but slightly in healthfulness from butter. Yet it is not so good as butter; for when oleomargarine was substituted for butter in a blind asylum at Louisville, Ky., the children, although they had no knowledge of the change, gradually ate less and less of the new butter, and finally declined it altogether—without making any complaint, or exhibiting any evidence of bad effects on their health.

ACCORDING to a description by Prof. Pickering, of the Boyden station observatory near Arequipa, Peru, the air is so clear there that stars of the 6·5 magnitude are picked out by the naked eye with great ease, and when the moon is not too bright the eleven Pleiades can always be counted. The nebula in Andromeda forms also a very conspicuous object, "appearing larger than the moon," while in the thirteen-inch Clark refractor "the whole photographic region of the great Orion nebula, first shown in the Harvard photographs of 1887, is clearly visible to the eye," rendering it "the most splendid object in the stellar universe."

SIR WILLIAM MACGREGOR, British High Commissioner of New Guinea, reports having passed in a recent coasting trip several islands which appeared uninhabited; but on landing he discovered that this appearance was due to their singular configuration. A narrow belt of gently sloping land led from the sea to a steep wall of coral rock, from three hundred to four hundred feet high, from the summit of which an undulating plateau was seen dipping inland. Here the villages were built, from fifty to a hundred feet below the level of the encircling rim, and sheltered from the trade winds. Sir William considers these islands to be upraised atolls, modified in most cases by subsequent wave action on the shore strips.

A MOUNTAINEERING party in the Himalayas, under the direction of Mr. Conway, report having climbed a peak of 20,000 feet and a pass of 18,000 feet in the neighborhood of the mountain K^2; they attempted the ascent of a new peak, which Mr. Conway named the Golden Throne. At 23,000 feet they found that they were on a peak distinct from the Golden Throne, which was still 2,000 feet above them. The peak they ascended was named the Pioneer Peak. It commanded a magnificent view, extending at least 200 miles in one direction. The party suffered from the great altitude, but not severely, and could have climbed a thousand feet higher, if not more.

IN an electric heating apparatus devised by M. M. Olivet, of Geneva, a current is sent from the dynamo into receivers of special metallic composition, which become rapidly heated, but without exceeding a certain temperature, and a heated air current is set up as with steam heating.

AN English paper has an account of a fog in the valley of Wensleydale, near Leyburn, which resembled a great lake with rising hills on either side, that more than half filled the valley; while the hillsides above the level of the apparent flood were reflected with extraordinary distinctness in it. The sun was shining brightly at the time, and the mist began to disperse and the mirage to fade away almost immediately.

ANTS, according to the experiments of Mr. H. Devaux, perceive the difference between sugar and saccharine. They swarmed around sugar that was laid out for them, but deserted saccharine as soon as they tasted it. Even sugar became unpleasant to them when it was mixed with saccharine.

PROF. OTIS T. MASON has been surprised, in examining a large collection of American aboriginal musical instruments, to find that not one was peculiar to women, and that those of the men were never played upon by the women. He is seeking fuller information on the subject.

CANCER has been detected by Prof. Scott, of New Zealand, in specimens of American brook-trout confined in one of the ponds of the Dunedin Acclimatization Society. The author was able to examine several individuals, showing the disease in various stages of advancement; and he gives in his paper a short account of the naked-eye and microscopic appearances of the growth. The occurrence of cancer in animals has been frequently observed of late years.

IN the Shattuck Lecture, on the Prevention of Disease in Massachusetts, accepting the germ theory of the origin of consumption, and in view of the swarms of bacilli in phthisical sputa, Dr. J. F. A. Adams lays down the following rules for precaution against transmitting the disease: (1) Let all sputa be carefully collected and destroyed by fire. (2) Let sputa never be deposited on handkerchiefs, carpets, floors, or any other place where it may dry and become mingled with the atmosphere. (3) Never drink from the same glass with a consumptive. (4) Never kiss a consumptive upon the mouth. These rules are equally applicable to pneumonia and perhaps also to bronchitis. It will, therefore, be best to call them, not rules for consumptives, but for *all persons who cough and expectorate*. This will save the patient from the shock of a positive and perhaps too hasty diagnosis.

Dr. J. S. Burdon Sanderson, Waynflete Professor of Physiology in the University of Oxford, has been nominated for President of the British Association at the Nottingham meeting, 1893.

The claim of Prof. Cyrus Thomas that he has found the Maya hieroglyphics to be in part phonetic, and has ascertained the interpretation of a sufficient number to form a key to the solution of the problem, having been disputed by the distinguished Americanist, Dr. Seler, Prof. Thomas is preparing a paper corroborating his views for publication by the Bureau of Ethnology. In the mean time he has published a paper, presenting some of his proofs, in Science for October 7th.

The programme of lectures of the Franklin Institute, Philadelphia, for the season 1892-'93, includes the topics of thirty-two lectures to be delivered on Fridays and Mondays, from November 4th to February 27th, on subjects relating to transportation, mining and engineering, economics, electricity, chemistry and physics, evolution, art, and other subjects of scientific and popular interest.

The name of *fluorography* is given to a process for transferring pictures to glass by means of inks containing fluorides. These inks, when sulphuric acid is applied to them, disengage hydrofluoric acid, which etches upon the glass. A composition, described in the *Génie civil*, consists of 400 parts by weight of glycerin, 200 of water, 100 of fluor spar, 100 of tallow, 50 of borax, and 50 of lampblack.

Old newspapers are said to be of value for wrapping up winter clothing in summer, because the printer's ink is as noxious to moths and their larvæ as camphor and coal-tar. Being impervious to air, they also make good wrappers for ice and for liquids which it is desired to keep cool.

The measure of a snail's pace has at last been found. Camille Flammarion is quoted in Daheim as estimating it at fifteen ten-thousandths of a metre per second.

The modern case of exorcism, related by Prof. Evans in the December Monthly, is supplemented by a news item in the New York Herald of November 21st. The woman Herz brought an action for slander against Father Aurelian, on account of his saying that she had sent a devil into her boy. The case was tried in the courts of Eichstadt, Bavaria, and the woman was awarded small damages. In his defense Father Aurelian testified that he had exorcised the devil from the boy, and supported this evidence by quotations from the writings of the fathers. The boy himself deposed that he knew nothing of the alleged exorcism.

OBITUARY NOTES.

Prof. C. Schorlemmer, a distinguished chemist, Professor of Chemistry in Owens College, Manchester, England, died on June 27, 1892. He became assistant to Prof. Roscoe in Owens College in 1861, and was appointed to a professorship in 1874. He was the author of A Manual on the Chemistry of the Carbon Compounds, and, in conjunction with Prof. Roscoe, of an extensive treatise on chemistry.

Lieutenant Frederick Schwatka, the arctic explorer, died in Portland, Oregon, November 2, 1892, from the effects of an overdose of laudanum which he had taken to relieve a habitual stomach pain. He was born in Galena, Ill., in 1849; studied at the university in Salem, Oregon; worked as a printer; was graduated from West Point in 1871, and became a lieutenant in the cavalry; was admitted to the bar in Nebraska in 1875; and received a medical degree at Bellevue Hospital Medical College, New York, in 1876—all while in the army. In 1878 he organized an Arctic expedition, and, accompanied by William H. Gilder, sailed for King William's Land in order to recover relics of Sir John Franklin which the Eskimos said were buried in that region. This expedition, which was successful in its main object, was marked by the longest sledge journey that had been made at that time, and by the discovery of the branch of Back's River that was named after President Hayes. Lieutenant Schwatka afterward explored the course of the Yukon River in Alaska, and commanded the New York Times Alaska Exploring Expedition in 1886. He was the author of several books and magazine articles relating to his travels, and was a popular lecturer. He was an honorary member of several foreign geographical societies, and wore some of their medals.

The death was recently announced, in the seventy-ninth year of his age, of Robert Grant, Professor of Astronomy in the University of Edinburgh. He was appointed Professor of Astronomy in the University of Glasgow in 1859. In observing the eclipse of the sun in 1860 he discovered the proof of the existence of a continuous envelope round that body. He was the author of numerous astronomical papers and cyclopædia articles; and of a catalogue of 6,415 stars, which is in considerable use.

ROBERT BOYLE.

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THE GLASS INDUSTRY.

By Prof. C. HANFORD HENDERSON.

THE DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS. XVII.

Along the eastern base of the Rocky Mountains there is found a hard, dark mineral known as obsidian, or volcanic glass. It is a variety of feldspar. In the chemical sense, it is a true glass, since it is a silicate of at least two metals, aluminium and potassium. Physically, it half deserves the name. Though too dark to be transparent, it is at least translucent; and in its luster, hardness, and glassy fracture it is quite comparable to the products of industrial glass-houses. Travelers in New Mexico are offered bits of this volcanic glass by the Pueblo Indians who congregate at Wallace and other dining stations along the railroad.

The manufacture of glass in America seems, then, to have been first set up by Nature, and may easily claim priority to all our other industries. It was one of the native products used in the early receptions given to the invading white man; but lest the spirit of the hospitality be misunderstood, it should be added that it was served in the form of swiftly flying arrowheads. When Columbus came to this country the glass industry was limited to a rude fashioning of the material supplied by Nature. It had been melted in fires burned out long centuries before.

In the Europe of 1492, the operations of glass-making were still very crude and inadequate. It was a rare thing to have glazed windows, even in castle and palace. For many years the luxury was limited to the churches, and there it was an article of decoration rather than of utility. In domestic service, the supply of glassware was equally limited. Yet it was only a hundred and sixteen years after the discovery of America that the first glass works were established in the colonies. It was a modest venture in an industrial way, but one to which much importance is attached, since it was the starting point in that interesting history which it is the purpose of the present paper to outline; and still more, because it was the first industry started by Europeans on American soil. It thus heads a list which is to-day certainly as long as human needs and almost as long as human desires. It is a list which has been nearly three hundred years in the making.

This was in the year 1608. The pioneer glass-house was a part of the activities at Jamestown. The spirit of the London Company was distinctly commercial. It had gold and silver in mind as the ultimate goal, but, with a prudence characteristic of British enterprise, it had also an eye to nearer and smaller profits. The plan of colonial manufacture was meant to serve this end. On the second voyage of Captain Newport, eight Poles and Germans were sent over for the express purpose of making glass, pitch, tar, and soap-ashes. The glass-house was out in the woods, about a mile from Jamestown. It was a crude affair, but it seems to have been the center of considerable activity, for when the ship returned to England in the following year, "a trial of glass" was among her cargo. The glass was presumably exported in the form of common black bottles, for the state of the art in those days, and the limited time, would scarcely have allowed the evolution of anything more difficult of manufacture.

The progress of the glass industry in America has been far from constant. It has suffered severe and violent fluctuations, amounting almost to annihilation. Several times it has needed to be born again. But the sum total of these successes and vicissitudes has been the establishment of an industry which, while it is the oldest, is also at the present time one of the most promising and most highly developed of all our industries. To understand its rise and progress, one must be familiar with the elements which go to make it up.

Four things are needed to make glass: crude materials; refractory substances for crucibles and furnaces; suitable fuel, and intelligent labor. To make glass commercially, a fifth factor is all important, and that is an accessible market.

The history of the industry has consisted in the various possible interchanges between these elements. They are far from permanent. The causes which led to the early establishment of the Jamestown glass-house were good and valid for the year 1608, although a somewhat pessimistic writer declared the energy misdirected, but they would not hold in the year 1893. The compelling force which gathers our present glass-houses to such centers as Pittsburg and southern New Jersey may shift during the course of a decade or so, and bring about a migration of the industry, similar to the migrations which so many of our industries have undergone. It requires a nice technical and commercial judgment to strike a balance which shall equally satisfy all these requirements. So it has come about that in certain branches of the industry, and notably in the manufacture of plate glass, the record until quite recently is an almost uninterrupted record of financial disaster.

A word, then, in regard to these elements, beginning with the first, the crude materials.

In many respects the most important ingredient is silica, since every true glass is a silicate of two or more metals. Sands and sandstones are its commercial representative. They are found the world over, but not of equal purity. Much of this material is quite unfit for the glass-maker's use, on account of the iron and other impurities which it contains. Here we reach at once a determining cause in the habitat of the industry. But the discrimination does not end with a chemical examination of the sand rock. It concerns itself quite as strenuously with the physical structure of the material. As it is needful that all the ingredients of the batch shall be in a state of fine powder, the condition of the silica supplied by Nature is a matter of no small importance. If Nature has already done the grinding, and sandstone and quartz ledge have relapsed into the form of a sand bank, so much the better for our purpose; or, if the choice be between two sand rocks of unequal hardness and tenacity, the softer and more easily reducible rock will be the available one. In this respect America is exceedingly well off. Her sands are among the finest in the world. Both English and French writers on glass declare them to be superior to their own supplies. They are as abundant, too, as they are excellent. The best deposits in New England are those of Berkshire County, Mass. In Pennsylvania the sands of Juniata and Fayette Counties are extensively mined. Other notable localities are in Hancock County, W. Va., Fox River, Ill., Crystal City, Mo., and southern New Jersey. New deposits in various parts of the country are constantly being announced. The importance of this wealth of sand to the glass-maker will readily be appreciated when it is remembered that the average glass contains from sixty to seventy per cent of silica. It is indeed the very foundation of the material.

The next most important constituent is the alkali, which is generally a carbonate of either sodium or potassium. At the present time the sulphate of soda, or salt-cake, is also frequently employed. The function of the alkali is to furnish one of the metals of the double silicate. Where the carbonate is used, sodium is now chosen—the "soda" of the markets, as it happens to be the cheaper. Our forefathers used potash. As none of these substances are furnished directly by Nature, the supply is subject to more rapid and more extreme fluctuations than in the case of silica. Before the Napoleonic wars, and indeed until within comparatively recent times, the chief source of the alkaline carbonates was the ashes of wood and sea-weed. Whole forests were burned, and vast piles of sea-weed were annually collected and reduced to ashes to gain the alkalies. To-day at many a country hearth the wood ashes are carefully put aside for the annual soap-making. Our earlier glass-makers were thus dependent upon the coastman or forester for their supply of alkali, and it can readily be seen that this dependence was a large determining factor in the development of the industry. The poor quality and the uncertain supply were an inconvenience particularly felt in France, where war so often cut off the foreign commerce. To protect French industries from these international hazards, as well as to secure a better supply at all times, the French Government offered a prize for the invention of a process by which soda could be made directly from common salt. The Leblanc soda process was the result. It was published in 1792. By means of the new process any nation which possessed salt springs or brines—and there are few without them—was enabled to make its own soda. The process came into use but slowly, though its effect has been very far-reaching, since it transferred the soda manufacture from the wilderness to the laboratory. In the development of glass-making in America these improvements were quite without influence until within the last half century or so. At the present time we are still largely dependent upon England for our supply of alkali, but there is a promising increase in the home manufacture. The large production of salt in Michigan and New York yields an assured supply of the crude material within comparatively short distances of the glass-making centers, while recently invented processes have greatly improved upon the method of Leblanc.

The third constituent of ordinary glass, limestone, is so abundant and so free from impurity that it is scarcely a determining factor in the development of the industry. One stone is almost as good as another. There is a tendency toward the increased use of lime in modern glass-making, but it is a tendency which may be indulged at very slight expense.

In the finer grades of tableware and decorative products lead takes the place of lime as the second base in the silicate, but with this material, again, America is well supplied. The immense deposits of lead ore in the Mississippi Valley, and the large output of the metal from the silver smelters of the West, make the supply of the oxide quite up to the demand.

But a locality which furnished silica, alkali, and lime would still be badly off as regards the needs of glass-making if it were out of reach of adequate supplies of substances refractory enough when fashioned into crucibles to permit the fusion of the mixture. For this purpose fire clay is the material *par excellence,* since it withstands both the chemical action of the molten glass and the disintegrating effect of the intense heat of the furnace. It is an essential to glass-making. Bulk for bulk, however, much less fire clay is needed than crude material for the batch, so that it is less needful that the fire clay shall be a local product. It can be brought to the batch more economically than the batch can be taken to it. It does not happen, therefore, in the history of the glass industry, that the mere presence of suitable clay ever determines the location of works. At the present time much of the clay used in both England and America comes from Germany. It is significant, in looking over the columns of our trade journals, that the advertisements are for the most part of the imported rather than the native article. There are, however, large deposits of excellent clay in northeastern New Jersey, in western Pennsylvania, in Missouri, in Ohio, and in other parts of the country, which must eventually be utilized. The American clay is, if anything, purer than the foreign, but it is less dense, and will probably require somewhat different treatment from the German. The attempt to substitute it for the imported in the earlier days, before the requirements of the pot clay were so well known and our own deposits had been so well exploited, led to financial disaster, and even to the suspension of a large works at Boston, where the experiment proved absolutely fatal. Our knowledge of refractory materials is less scientific than of any of the other materials used in glass-making. In consequence we are the more dependent upon rule-of-thumb methods in working them, and pay the more dearly for the experience when we venture any innovation.

The third element involved, fuel, is of all the most important, both as regards quality and cost. In America it has been the dominant element, and largely determined the location of our glass-houses and the measure of their success. The choice lies between four varieties—wood, coal, petroleum, and natural gas. In the earlier days a fifth fuel is found on the list, North Carolina rosin, but it can hardly be said to figure in the present production. In England coal does not seem to have been used as a fuel to any extent until the beginning of the seventeenth century. About 1623 Sir Robert Mansell obtained a patent for a "method of making glass with sea coal, pit coal, or any other fuel not being timber or wood." The patent was probably for some particular method, as the simple use of coal was well known, even in the preceding century, though by no means common. The early Virginia glass works were operated entirely with wood. The same practice prevailed in Europe, and for many years wood was preferred to coal. This made it necessary to establish glass-houses near the forest districts, for in the absence of railroads and of steam navigation it was impracticable to carry so bulky a fuel for any great distance. With the substitution of coal a new condition was introduced, and the question of fuel became for the time of less moment than the supply of crude materials. These could only be obtained in certain localities, while the fossil fuel was available in many. In our own day, and within the last half dozen years, another and much greater disturbance of the industrial equilibrium has been brought about by the displacement of coal by natural gas. It is no exaggeration to say that, as far as quantity and the perfection of the processes of manipulation are concerned, the development of the glass industry has been greater, since the introduction of natural gas than in all previous time. The immense advantage of the fluid fuel over the solid, both in economy of operation and superiority of product, has made the geography of the glass industry and of natural gas nearly identical. One might almost use a geological map of the United States for a chart of the glass-making districts. Wherever the Trenton limestone and the upper coal measures are near the outcrop, one may reasonably expect to find glass-houses scattered over the surface.

It does not follow, of course, that glass-making at the present day is limited entirely to the natural gas country. There are occasional glass-houses in various localities, and there are districts so favorably located in other respects that they can overcome the disadvantages of the solid fuel and still rank as recognized centers of the industry. Such a center is found in the large bottle-making establishments in southern New Jersey. But these works are generally quite old, and already had expensive plants in operation before the utilization of natural gas.

The character of the fuel has thus given rise to three distinct eras in the industry—that of wood, of coal, and of gas. The use of petroleum has been too limited and for too secondary purposes to mark a distinct chapter.

The fourth essential element is labor. While it is, in a technical sense, the most important element of all, it has had much less influence than the material factors in deciding the history of the industry. Since its emancipation from serfdom, labor has displayed a portability which has made it available in any quarter of the globe. A large degree of dexterity, if not of intelligence, is needed in the glass-worker; but if one is to judge from the mixed nationality of our American representatives of the craft, he does not belong to any country, and is ready to go wherever he is wanted. It is easier to bring him to the work than to take the work to him. Once located, he is fairly permanent, and his dexterity is soon reproduced in the band of apprentices who gather around him.

With our present increasing output, the question of a market is no less important than the technical operations. The product is so fragile antl so bulky that the market must needs be fairly accessible. Difficulties of transportation wrecked a number of the earlier enterprises. An observer of the first attempts at glass-making in Virginia reported that the industry would have done very well had there been any market for its wares.

These are the five elements which in the kaleidoscope of industrial progress have given us the series of pictures constituting the history of the glass industry. These pictures are the more intelligible when one has studied their elements separately.

The Jamestown venture in 1608 was evidently undertaken because of the abundance of timber. This gave the necessary supply of potash as well as of fuel. The early colonists in America suffered indeed from an embarrassment of riches in the way of forests. They needed no arbor-days. As a consequence, any enterprise which cleared the land for farming, and did it at a profit, commended itself to their thrift. So in the colonial records of the seventeenth century we find not infrequent mention of existing or projected glass works. The early Virginia enterprise was followed, in 1621, by a more extensive attempt. Subscriptions were opened in London for funds to build a second glass-house—the first having fallen into decay—to be devoted to the manufacture of beads for the Indian trade. Italian workmen, probably educated in the famous factories of Murano, were sent over to the colony to take part in the new enterprise. It was, however, brought to a tragic end by the Indian massacres of the following year, when the glass-house was destroyed. The natives seem to have been for the time quite blind to the allurements of glass beads, or they may have thought that they were paying too high a price for them. With this double failure glass-making in Virginia entirely ceased, and was not revived until many years after.

Meanwhile, Massachusetts was starting her first glass works. These were at Salem, and were built in 1638. In New England the town has ever been an active agent in all affairs concerning the public good. It took a lively and possibly at times a trouble-some interest in these early manufactures. The establishment of glass works at Salem was held to be an event of public importance, and the town voted the projectors several acres of land, which passed into record as the Glass-House Fields. In 1641 it showed its further interest in the enterprise by granting a loan of thirty pounds. The works continued in operation for some time, turning out for the most part simply bottles and the rougher sorts of domestic wares. They finally stopped operations in 1670, "for lack of capital."

In New York, Jan Smeedes was making hollow ware in glass somewhat before the year 1664, and his enterprise gave the name of the "Glass-Makers' Street" to the lane in which he worked. He does not seem to have had any successor, however, for after his death the industry disappears from the records until the following century.

Well-meaning efforts were also made to establish the industry in Pennsylvania in the closing years of the century, but they do not seem to have been successful. In a letter, written in 1683, Penn alludes to a glass-house then existing in Philadelphia, and speaks hopefully of its prospects; but these were never realized. Yet there seems to have been a good market for window glass at least, if we are to credit the following doggerel, written by Holme in 1689:

> "The window glass is often here
> Exceeding scarce and very dear,
> So that some in this way do take
> Isinglass windows for to make."

These are the only known records of glass-making during the seventeenth century. None of the attempts became permanent industries. The advantages of cheap and abundant fuel and of easily obtainable alkali were more than offset by the corresponding disadvantages found in all new communities. In some of the colonies there was no accessible market. But the greatest obstacle was the pressure of more remunerative occupations upon the attention of the glass-workers. Land was everywhere abundant and could be had almost for the asking. The temptation to pass from the artisan class to the ranks of the gentry was a strong one in the minds of European workers. It was an unusual opportunity, and in both this and the following century the privations of early agriculture were willingly endured for a time by those who had originally come to the colonies for the purpose of service or the trades, in order that they might ultimately enjoy the satisfaction of being landholders. This "desertion," as it was called by the wage-paying classes, led to the abandonment of many promising manufacturing enterprises. America stood then, perhaps more than now, for personal liberty and individualism. Men seem to have been less willing to sell themselves into industrial slavery, and more anxious to remain their own masters.

The eighteenth century witnessed an extensive revival of the glass industry, and gave birth to some of the most important establishments of the present day. This activity was, however, crowded into the latter part of the century.

Massachusetts took the lead. About 1750 works were erected by German artisans at the village of Germantown in Braintree. They were intended for the manufacture of bottles. After a short run they were destroyed by fire, and were never rebuilt. Two years later the General Court attempted to encourage the industry by granting Isaac C. Winslow the sole privilege of making glass; but he seems not to have profited in his monopoly, for in 1787 the same exclusive privilege was granted to a Boston company. The monopoly covered fifteen years, and had attached to it a penalty of five hundred pounds for each infringement. By this time there was a sufficient home market to warrant somewhat extensive operations. Public sentiment was overwhelmingly in favor of American products. The company devoted itself to the manufacture of crown glass, and was one of the first makers of window glass in America. It started out rather badly by erecting a large and ill-adapted factory at the foot of Essex Street. This had afterward to be taken down and another structure put up in its place. Then came difficulties in obtaining workmen, so that the new industry did not get under way until the fall of 1792. In the following year the company was fortunate in securing the services of a skillful German glass-blower named Lindt, and under his management the enterprise was wonderfully successful. The Boston window glass was reported to be equal to the best imported glass, and possibly even superior. The shares of the company sold at a good price, and the industry enjoyed, or suffered, something very similar to a modern boom. By the end of the century the annual output of window glass amounted to seventy-six thousand dollars. But the confidence born of success finally brought the company into difficulty. They extended their operations in several directions, and made the dangerous experiment of substituting native fire clay for the imported. They were also embarrassed by a lack of suitable fuel. These difficulties, combined with subsequent bad management, finally led to failure, and the works were shut down.

In New York, glass-making was again undertaken in 1754. The factory was located in what is now Brooklyn; the venture being made by a Dutch gentleman of the name of Bamper. But the enterprise was of short life. A little later, Albany seems to have been the center of the glass industry. A Flemish family by the name of De Neufville were the chief spirits in these enterprises. It is uncertain how many glass-houses they established, but one at least seems to have been in operation in 1786, and to have had a very hard time of it. In 1788 Leonard de Neufville and his partners appealed to the State for aid in behalf of the Dowesborough glass-house. Their patience must have been severely taxed, however, for it was not until 1793 that their petition was granted. The Legislature voted them a loan of three thousand pounds for eight years, three years without interest and five years at five per cent. Three years later the enterprise was moved to Hamilton, a manufacturing town which had just been laid out some ten miles to the west of Albany. The plant consisted of two glass-houses with three large furnaces. Thirteen glass-blowers were employed, and turned out twenty thousand feet of window glass a month—nearly half an acre—besides a fair output of bottles and flint glass. The fuel was gathered from the pine forests of the neighborhood. The methods employed seem to have been much the same as elsewhere, except that they were carried out with much system, and that kelp, the ashes of sea-weed, were substituted for the purified potash. The product found a ready market, and for some time the industry was in a most flourishing condition. But, with the cutting down of the surrounding forests, fuel became more and more scarce. The final abandonment of the enterprise in 1815 is said to have been due to this cause.

But in none of the colonies were the conditions for glass-making, and particularly of bottles and the coarser kinds of hollow ware, so entirely favorable as in southern New Jersey. Extensive pine forests covered thousands of acres, while sand of sufficient purity existed in large quantities and had only to be carted a few feet to the glass-house. Qualities which make the region most unpromising for other purposes have devoted it to the use of the glass-maker. For more than a hundred years it has been the home of the bottle trade. About the middle of the last century a glass-house was established in Salem County. It was known as Wistar's, and employed a number of German glass-blowers. Other glass-houses were established throughout the county, illustrating even at that early day the now well-recognized gregariousness of manufactures. Many of them were subsequently abandoned. There was a general exodus of German workmen to the spot, which has since been called Glassborough. Here in 1775 they established a bottle factory which is still in existence, and is the oldest continuous glass-house in America, as well as the largest of our present bottle factories. It was, however, many years before the manufacture of other grades of glass was attempted. The conditions best adapt the region to the production of green glass. Though window glass has since been successfully made, the competition with other districts farther west is very unequal; so long as the locality continues to be a glass producer, it will probably always maintain its original place in the glass industry.

There is a certain picturesqueness about the development of the industry in Pennsylvania. In Penn's time, and indeed for many years after, it was simply a succession of failures, but these failures are hardly less interesting than the successes elsewhere.

The most extensive attempt was that made by the Baron Steigel in 1762. He built the village of Manheim, eleven miles from Lancaster, and erected iron furnaces and glass works in the neighborhood. Operations were conducted upon quite a grand scale, and the glass produced was of excellent quality, but the enterprise was far from successful. The baron was too dramatic. His home was a veritable castle, and from its battlements the discharge of cannon announced the return of the lord of the manor, and summoned his retainers from furnace and factory to do honor to the occasion. This is thought to have somewhat interfered with the processes of glass-making. The war cut off his income from across seas and forced the abandonment of the works. The iron establishment passed into the hands of the Coleman family, and is still in operation.

West of the Alleghanies the industry was slower in finding a footing, but the conditions there made its establishment a matter of destiny. Mr. Albert Gallatin and his associates established a flourishing window-glass factory at New Geneva in Fayette County, somewhere about the year 1797. Various dates have been assigned for this undertaking, one published statement placing it as early as 1785, but the most reliable evidence appears to be in favor of the later date. The abundance of good glass sand and the wealth of timber were the attracting forces. The glass-house was forty feet square and contained one eight-pot furnace. The enterprise was reasonably successful and continued for thirty or forty years. But more significant was the opening of a glass-house in Pittsburg somewhat earlier than this, since the city has now become the center of the industry in America. There is a tradition that this early factory was established in 1795, and was located on the west side of the Monongahela, at what is now called Glass-house Ripple. It was devoted extensively to the production of window glass, and is reported to have been about the same size as the New Geneva plant. Two years later, in 1797, General James O'Hara and Major Isaac Craig established more extensive works, whose date and history are quite authentic. We believe that these were the first works in America to use coal in the manufacture of glass. As the supply of fuel was right at hand and practically inexhaustible, they escaped a source of danger which constantly menaced those establishments which depended upon wood. The works were intended for the production of window glass, but, like many of the plants in those days, also turned out some bottles. A memorandum found among General O'Hara's papers suggests that for a time at least the outgo made more impression upon him than the income, for it reads, "To-day we made the first bottle, at the cost of thirty thousand dollars." Many difficulties had to be met and overcome before the works proved successful. They were subsequently enlarged and improved, and glass-making became one of the recognized industries of Pittsburg. A glass-house has ever since been in continuous operation upon the very site of this early factory. It can not be said, however, that glass-making was really an assured success in Pittsburg until as late as 1830.

The other colonies were also more or less active in glass production. Attracted by the cheapness of fuel and labor, Mr. Robert Hewes, of Boston, set up a glass-house at Temple, N. H., in 1780. Like most industrial pioneers, he had rather a hard time of it, and, after making some window glass and hollow ware, abandoned the enterprise in the following year. A reference in Washington's diary shows that glass was made in New Haven, Conn., in 1789, and a glass-house is known to have been in operation at about the same time in Hartford. In Maryland the industry obtained quite a firm footing. The Legislature encouraged it by loans, and the General Government in 1789, at the instance of Mr. Carroll, gave American glass works the protection of a ten-per-cent customs duty. The first factory was located at Tuscarora Creek, near Frederickstown, and was known as the Etna Glass Works. Like so many other glass factories, it was under German management, the owner being Mr. John F. Amelung. The works were started in 1775 and were moved to Baltimore in 1788. Both sheet glass and bottles were produced, the output enjoying a high reputation for superior quality. But, in spite of its technical success, the venture was a financial failure, and had finally to be abandoned. The "Baltimore Glass Works," established in 1790, were more successful, and, I believe, are still in operation.

[*To be continued.*]

By the death of Lord Tennyson, says Nature, "not only does England lose one of her noblest sons, but the world loses the poet who, above all others who have ever lived, combined the love and knowledge of Nature with the unceasing study of the causes of things and of Nature's laws. When from this point of view we compare him with his forerunners, Dante is the only one it is needful to name; but although Dante's knowledge was abreast of his time, he lacked the fullness of Tennyson, for the reason that in his day science was restricted within narrow limits. It is right and fitting that the highest poetry should be associated with the highest knowledge, and in the study of science, as Tennyson has shown us, we have one of the necessary bases of the fullest poetry—a poetry which appeals at the same time to the deepest emotions and the highest and broadest intellects of mankind. Tennyson, in short, has shown that science and poetry, so far from being antagonistic, must forever advance from side to side." Tennyson was a Fellow of the Royal Society, and that body was represented at his funeral by its president and officers. Prof. Lockyer speaks very highly of Tennyson's interest in astronomy and acquaintance with it.

MAN IN NATURE.

BY M. PAUL TOPINARD.

MAN is an animal, by the same title with other animals, without any more rights than those conferred upon him by virtue of the law of the strongest, by his physical organization, his physiological attributes, and his success in the struggle for existence. His body is of the same substance, is composed of the same tissues, and possesses the same organs. His forms are simple variants, produced by the same force that urges other beings to differentiation. Like every animal, he participates in the everlasting round of being born, reproducing, and dying. He was such when Galen dissected the ape to study it, and he has continued the same, resembling the ape in some respects and differing from it in others, subject to the same wants, the same physical experiences, the same instinctive impulses, the same inner feeling urging him to take everything to himself. In consideration of the highly developed properties of his cerebral organ, of his judgment, which permits him to see things exactly as they are, of his memory, which enables him to store up observations and draw inductions of the whole from them, of his routine-breaking initiative, and of his ideal conceptions, he may by a turn of mind regard himself as forming a separate kingdom in the Cosmos. But, in his body he is and always will be an animal—a vertebrate, a mammal, a monodelph, a Primate. None of the characteristics of these groups is wanting in him; eminently none of those of the Primates. He possesses peculiar characteristics which give him a special place of favor among them; but he begins by having their general characters.

"Then," you will tell us, "you place man by the side of the monkeys, of those beings which are often so abject. Could you not find a nobler animal?" That is prejudice, judgment by appearances. The monkeys are not disinherited beings, but the contrary. Some of the ungulates—the deers and the horses—have reached a high grade in the scale of the mammals: we esteem them because of the perfect adaptation of all their parts to an ideal of existence; their forms are elegant, their paces are graceful and rapid; they render us service while contributing to our pleasures; they are the last efflorescence of a branch which has been growing and blooming since the Eocene epoch. Some of the carnivores, like the cats, are likewise objects of our admiration for the complete harmony of their whole organisms to their peculiar modes of life; they have power, nobility, and freedom. But neither of these possess what the humble monkeys have—a cerebral type, predicted among them all from its origin, and already developed in the ugliest among them. The brain of the horse, nearest by virtue of its less rudimentary anterior lobe to that of the Primates, is rude, notwithstanding its well-formed convolutions, in comparison with that of the simians in general. Even the skull of the monkeys has something human, and reflects the interior cerebral organ. The brain has been evolved in all the branches of the tree of the mammalia, and at the end of some branches is elaborate in its convolutions, sometimes surpassing that of man in their richness. But in only one branch, that of the monkeys, does that exist from the beginning which gives the brain a special value, and causes them eventually to excel, whether the number of convolutions be equal or unequal.

We are amused with the monkeys, without remarking how marvelously they too are organized for their peculiar mode of life. We see them sporting, grimacing, swinging from one branch to another, and performing the most incredible feats of real acrobats. But we do not reflect that these habits, these necessities of their existence, are precisely what has given rise to the organ to which man owes most, after the brain—the hand. That hand, which by a curious aberration had in some of the marsupials abandoned the anterior for the posterior extremity, still occupies that extremity in the lemurians. In the monkeys it returns to take possession of its natural place of election, there to perfect itself gradually and to result in the incomparable apparatus which has caused Franklin to define man as "the maker of instruments."

The brain and its accompanying type of skull, the hand and its annexes the nails, are the characteristics which have produced the privileged situation of those animals which are correctly grouped together under the designation of the order of Primates. With some modifications in the proportions of the limbs to height and some accessory characteristics, their variants give place in them to divisions ranging from the lowest up to man. These divisions, whatever may be their relative value and their respective distances, are five: The lemurians—the monkeys of the New World, or the cebeans, from which the arctopithecans are sometimes separated; the monkeys of the Old World; tailed monkeys or pithecans; tailless or anthropoids; and man. A question which we had set before ourselves, and which had been much discussed in the Société d'Anthropologie, was whether the anthropoids of this list are nearer to the pithecan and cebean monkeys or to man. Shall we place in the same group monkeys and anthropoids or anthropoids and man? The question was then one of measuring in some way the interval between these anthropoids and man and comparing it with the subsequent intervals between the lower monkeys. From the result came the adoption of one or other of the rival systems of classification, some separating man from the Primates as a special order, others isolating him among the Primates as a suborder or family, and others including man and the anthropoids together. We said we must draw up a general balance sheet. As the divergences sometimes pertain to what we consider only one aspect of the problem, it was necessary to regard all the aspects; and we have done this. We have given our conclusions respecting each characteristic, respecting each group of characteristics. Our present purpose is only to summarize the most affirmative of them, those that concern the brain and the skull, the adaptation of the body, and particularly of the lower limbs, to the bipedal attitude, and of the upper limbs to prehension.

In the general type of the brain we have only determined common characteristics in what concerns the profound structure.

The type of the convolutions appears to us rudimentary in the lower Primates; gradually developing, already characterized in the papion; absolutely established, according to Broca, in the gibbon; becoming more complicated in passing from the anthropoids to man, but without appreciable change to a characteristic which must not be neglected, the transformation of the third frontal convolution. Man alone presents the speech centre, a characteristic corresponding with the acquisition of the faculty of articulate language. The conclusion results that, even without regard to the richness of man's convolutions, there still exists between him and the anthropoids a difference—capital in its physiological consequences—which forbids any relation on this ground between them and him. As to the volume of the brain the conclusion is express. It is triple in man and leaves the anthropoids with the other monkeys.

The consequence of this increase of volume, general, but predominant in the anterior lobes, is the complete transformation of the skull. While it retains some of the characteristics peculiar to the Primates in general, which it had already assumed, it becomes what we know it in existing man, profoundly different in all its characteristics from the skull of the anthropoids, including the craniometrical characteristics. The face itself is transformed. All bends before the supremacy of the organ which, near or far, governs the whole human organism and separates it completely from the anthropoids.

The hand is the second fundamental characteristic of man, but a characteristic common to all the Primates, starting with the first ones and advancing continually toward perfection. With the monkeys, the forearm comes to the aid of the hand; with the anthropoids, the whole fore limb concurs in the function; in man it acquires its final degree of precision. Till then it was simply a grasping apparatus related to tree life. With him its operations are associated with those of touch, sight, and the muscular sense, and it becomes the faithful executant of the orders of the brain. Is there anything more wonderful than the movement imperceptibly and gradually impressed by the fingers on the screw of the microscope in micrometrical operations? The hand, therefore, relates the anthropoid to man, but more in appearance than in reality, for in the anthropoid it still remains the brutal grasping apparatus of the monkeys.

The last characteristic is that of attitude. It is complex in the monkeys, similar in some respects to that of quadrupeds generally, but really special. Signs of the erection of the trunk are already manifested in some monkeys—as, for instance, the cynocephalus. This erection is emphasized in the anthropoids, but without reaching the upright position, and really permitting standing on the feet. With them the characteristics leading to that attitude bear on little else than the viscera and the vertebral column. They are inappreciable in the head, and are hardly more marked in the lower limbs, where the calves, thighs, and buttocks, characteristic of the effort necessary for keeping the upright position, are wanting.

Contrary to what has been said, the anthropoids are less qualified to hold themselves erect than the other monkeys. These can walk on the ground with extended sole; the anthropoids are less able to do so. The monkeys had in the lower as well as in the upper limbs a hand competent to act as a foot. This hand is improved in the anthropoids in the direction of its function of grasping, but to the detriment of its accessory function as a foot; in the lower limbs it is turned in in such a way that the palm can grasp a tree by the side, but can only painfully set itself on the ground upon its outer edge, and very likely, too, upon the backs of the toes. The hinder hand, therefore, hollows out a gulf between the anthropoids and the monkey; but the gulf between man and the anthropoids is wider.

Cuvier's reasoning was correct. The monkeys, and still more the anthropoids, deserve the name of quadrumana on condition that we do not understand the word *hand* in the rigorous sense that is given it in the case of man, but in the sense of an instrument that adapts itself to some kind of prehension. To us man alone has two real hands, as he alone among the Primates has two feet capable of supporting the entire weight of the body standing. When we suppose that the anthropoid is in a stage of advance toward a vertical position, we confound in him characteristics relative to the adaptation of the arm and forearm to the prehensile function and characteristics relative to the vertical attitude. If we suppress the former and whatever bears upon the straightening of the trunk in arboreal life—a straightening which in no way implies a vertical position of the lower limbs—there is nothing left particularly to the credit of the anthropoids. The other distinctive characteristics of man and the anthropoids are secondary, but lead to the same conclusions. Hence the two groups should be separated in classification, and the anthropoids continue monkeys.

Employing Dalley's formula, we should say, but in an inverse sense, that the anthropoids differ from monkeys infinitely less than they differ from men. We need not even specify from what monkeys, whether pithecans or cebeans, for it is sometimes members of one, sometimes members of the other family, that are more removed from man. In the general shape of the skull, in a certain adaptation to the erect attitude of the head, in the development of the hemispheres above the cerebellum, and in still other characters, some of the cebeans are further advanced than the pithecans and the anthropoids. In short, taking the interval between the cebeans (arctopithecans excepted) and the pithecans as one, that between the pithecans and the anthropoids would be one, and that between the anthropoids alone or the cebeans, pithecans, and anthropoids together and man would be three.

Reasoning according to the monophyletic hypothesis, we suppose that man is derived from a single stock. But the possibility is suggested of his having had a multiple origin from different stocks, and possibly at different epochs. To determine this point, we must learn what the comparative study of races teaches us concerning the unity of the human species in the present and the past, from the lessons afforded by the actual remains of the races that have been produced by incessant minglings and changes during a succession of ages that defy all chronology.

We have shown that there are, properly speaking, no races within mankind such as we find among animals—that is, constant varieties, perpetuating their likes in a certain manner. There are only historical or philological elements of peoples to which we attribute, whether rightly or wrongly, a certain number of common physical characteristics. In any other sense the races of anthropology are simply products of our minds, suppositions of substantial affiliations of unmixed blood, working hypotheses. There are no persons corresponding with the types we assume.

These types themselves are not tangible realities, but groupings of characteristics which we suppose to have been continuing for an indefinite time through the events of history and prehistory which, without destroying the characteristics, have not ceased to scatter them and to arrange them anew in different combinations. As Lamarck has said, types are products of art; we pick them out as we can in existing populations. From particular types we rise to the notion of general types, which are likewise only probabilities, going up gradually to historical, prehistorical, and Quaternary types, and, by inductive constitution, to primitive types. Hence the necessity of a classification of types; or, to use the current erroneous language, of races. Every anthropologist has his classification. M. Deniker in his, published in 1889, admitted thirty types; in the classification of our lectures and our *Eléments d'anthropologie générale* we enumerated nineteen, without concealing the existence of many gaps. This is all not very favorable to the idea of the unity of the human species. But it must not be forgotten that a number of these types are artificial, provisional, and, as we have said, simple mental views. Whether these were originally one or many types, the results are the same. At present all men are capable of unlimited crossing, and new types are in continual formation. If we would go up to the origin of things, we should have to put away all these secondary products and simplify more and more. We should thus come, in the first stage of our synthesis, to the conception of eight general types, viz.: A fundamental European blonde type, a Mediterraneo-Semitic, a brachycephalic Asiatic, a dolichocephalic Asiatic, an Americo-Polynesian type, a black type with curly hair, a brachycephalic negro, and a dolichocephalic negro type. But perhaps dolichocephaly and brachycephaly are only secondary differentiations that may be produced in all the types, as large and small stature may be too; the black man with curly hair may be only a cross.

Nothing is easier, in fact, than to conceive in the light of anatomy and physiology that all types of mankind can be reduced to three original types—the Europeo-Semitic, the Asiatico-American, and the negro; or to two—the white, which is differentiated into those of flat and of sharp faces, and the negro. A further reduction would be hazardous. But if we lost ourselves in the depth of the ages, we might conceive the negro as first born and giving birth in succession to the curly-haired Australian, to one of the brown forms with straight or waving hair, and finally to the blonde European.

Hence, the monogenistic system, or the doctrine of the unity of type and origin, and the polygenistic system, or the doctrine of plurality of type and origin, are equally tenable.

But, it may be said, prehistoric skulls and bones should assist us in our task. Only a little! With the single exception of the Neanderthal skull, which has a type of its own, all the few specimens which the prehistoric peoples have left us are obviously only duplicates of existing types, and those of Europeans and Americans. Of the ancient negro, Africa and Oceania, which were supposed to be the promised lands for primitive anthropology, have furnished us none. The most ancient man known to us by his bones is that one of Spy, which dates from the epoch of the mammoth. Yet it is demonstrated by flint implements that man primarily existed in both hemispheres. We see him, as the great Quaternary glaciers of Europe and America retired, going up toward the north. Europe was then only a narrow promontory which man traveled along in coming from Asia. That is all we know about our primitive ancestors. Beyond that we have no sure trace, no flints. The flints of Thenay are of the Roman epoch. To hazard a few conjectures respecting the Miocene ancestor, whether it was man or a precursor—one or the other certain, although direct proofs are wanting—we should be obliged to recur to the general probabilities furnished by natural history.

As we have seen, natural history proves indisputably that man is the issue of a Primate. It is opposed to the idea that we are descended from an anthropoid like those of the present time, although one of them—the chimpanzee—offers, perhaps, fewer objections to the supposition than the others. It furnishes arguments very favorable to the supposition that our stock comes from a Miocene monkey. It is not contrary to the theory of a direct descent from the lemurians, which were in their turn issue of the marsupials. But nowhere does it permit us to discern whether man came from one or two stocks, or originated at one epoch, or two epochs remote from one another.

The question whether the monkeys are of single or multiple origin is likewise not answered. According to MM. Vogt and Schmidt, the monkeys of the New World had not the same derivation as those of the Old World. This doctrine would support the theory of man having two origins, one common to Asia and America for the white and yellow races, the other on some southern continent joining Africa and Oceania for the negro.

Whether the moment of this origin be single or double, two periods are to be considered: one previous to the acquisition of language, in which the precursor of man is concerned; and the other after this, during which the real man was constituted. With the acquisition of speech a new life begins. Man, more able to associate with his fellows and to come to an understanding with them, would spread, become cosmopolitan, face every kind of climate, meet various necessities of existence, and thereby differentiate himself. This differentiation was all the easier, because his species was of more recent formation and less fixed, and because the media acted with certainty under those conditions. From that time the brain increased, the skull was transformed, prognathism diminished, and the facial angle opened.

But a new factor intervened at the same time. Till then the struggle for existence had been carried on by physical force; now it is sustained by intelligence, and those with the best brains win the victory. While it is doubtful whether Darwin's natural selection can, in the existing conditions of the globe, engender new species separated by physiological barriers, it is certainly very efficacious to the improvement of the types within the species, and it constitutes one of the most powerful factors of progress. In this way to mediocre types have succeeded more and more favored types, whether by the general conformity of these forms to the aim to be met, or by the development of the brain in conformity to the increasing wants of man, and to the various kinds of life which he has made for himself. Adaptation, that marvelous natural force that rules the organic world as universal attraction rules the inorganic world, has performed its part as to him as well as to all animals—to each in view of its peculiar kind of life. With man the peculiar kind of life is the intellectual life.

We may illustrate the relations of man, the anthropoids, and the monkeys by comparing the order of Primates to a tree. The lemurians are the roots, giving rise to one or several stocks. One of these is the stock of the monkeys, one of the limbs of which sends up a higher branch—that of the anthropoids. Another branch, of which the point of its origin or contact with the preceding branch escapes our search, gives the actual human branch, which rises parallel to the anthropoid branch, has no relation to it, and passes beyond it.

Has man reached his culmination? Is he at the end of his evolution, or is he a little short of it? Will he suffer the fate of the paleontological species, which, having reached the maximum height of their lives, halted and perished, or will he continue to advance? Will his senses acquire greater delicacy, his hand more readiness? Will his brain gain in volume, or in convolutions, or in the number or the quality of its cells?

We doubt, regarding the equilibrium of the head and the harmony of its parts, whether the brain will gain greatly in volume. Its anterior lobes may perhaps increase till the axis of gravity passes the middle of the base of the skull. Dolichocephaly will be replaced by a universal brachycephaly. The quality of the cells is sure to improve. On that side no limits can be discerned, and in that direction man may hope to reach the Buddhist's ideal.

When man shall have thus been exalted by his intellectual faculties, the lower types nearest to him will have disappeared, and those animals which are now most closely related to him will be no more, and the interval between him and the other types will have widened to an unfathomable gulf.

Man, with some show of reason at last, intoxicated with his power, and looking down from his giddy height, may come to fancy that he is a being without limitations, the center around which the universe gravitates, the sovereign for which all Nature has been created. He will, in fact, constitute a separate kingdom —the human kingdom.

Even then, in the midst of his triumphs, his body will continually call him back to himself, and the anatomist will still be able to cry to him, in words but little changed from an expression of Broca's, "Remember that you are one of the animals!"—*Translated for The Popular Science Monthly from the book L'Homme dans la Nature.*

BIRDS OF THE GRASS LANDS.

By Prof. SPENCER TROTTER.

AN eastern North American landscape is chiefly characterized, at least in the more settled portions of the country, by its diversified aspect of woods and fields. All other distant features gradually melt away and leave to the involuntarily closing eye a checkered expanse of darkly shaded masses and broadly open sunlit spaces. In the wilder parts, along the ranges and spurs of the Appalachians, the forests still hold undisputed sway over the fields, yet surely and rapidly the venerable woods are falling away as the axe sweeps with ever-widening swath along the clearing's edge. Year after year we have gone to some beloved spot of wilderness and learned to love the great, tall hemlocks that were ever whispering their secret to the wind. Some spring morning we are again at the old place; alas! what a pitiful sight awaits us! The giants of a hundred springs are fallen, and their long, white trunks and ghostly arms make a picture more desolate than the deepest gloom of the forest. To me the sighing of the hemlocks is a death song—a melancholy prophecy of the fate that awaits them.

The forest does not yield without a struggle. The tangled underwoods and seedlings so long stunted in the evergreen shade spring up with renewed life in the refreshing sunlight, and a sturdy "second growth" takes in a few years the place of the primeval forest. These are the woods of oak, hickory, and chestnut; of maple, birch, beech, and gum; of dogwood and sassafras, tulip, elm, ash, and linden, that invite us with their shade, their cool depths and reaches of sunlight, their fragrant blossoms and mystery of hidden things, from the broad fields of grass and grain that encompass them on every side.

Not less diverse than the woods and fields themselves are the living things that people them. Each offers its own peculiar environment and each has brought its own peculiar changes. There are woodland flowers and flowers of the field, and flowers that grow on the border line among the briers and cripple as though undecided which dwelling place to choose, or lingering in the delights of both. Who ever found the mullein and the toadflax in the depths of a wood or picked an anemone in open fields? Yet there are flowers that find a congenial home in each, like the bluets, spring beauties, and the star of Bethlehem. In every province of life we find forms peculiar to the open grass lands and forms characteristic of the woodland, each "to the manner born."

These points of comparison apply especially to bird life. Every boy who has indulged the natural propensity to haunt running streams and wild, delectable places, to pursue shy birds and pry into the secret of their nests, knows full well that there are birds of the fields and birds of the woods. A student of ornithology soon learns that certain groups or families of birds are peculiar either to the woods or to the fields, and that their organization is in more or less entire accordance with the manner of life induced by the physical conditions of the area they inhabit. Among our Eastern American birds the titmice, wrens, creepers, nuthatches, wood warblers, tanagers, vireos, shrikes, waxwings, tyrant fly-catchers, the woodland group of thrushes, crows, jays, and woodpeckers are all tree-lovers, for the most part nesting in trees, and, if on or near the ground, usually in the depths of tangled underwood. On the other hand, a number of species belonging to the large family of the finches (sparrows, buntings, etc.) are strictly birds of the grass lands, and this is true also of some members of the closely allied family of starlings, blackbirds, and orioles, notably in the case of the field lark, some blackbirds, and the bobolink.

Fig. 1.—Vesper Sparrow.

Among the finches that are strictly grass-loving and dwellers in fields are three well-known Eastern species—the vesper, savanna, and grasshopper sparrows. The vesper sparrow, so called from its soft, rich song that fills the still evening air on upland pastures and immortalized by the pen of John Burroughs, is a familiar inhabitant of open fields and roadsides. Like most of its relatives it is a plain-colored bird, streaks of soft brown blending into gray, but easily distinguished by the white-edged tail that it flirts open when started from the dusty highway or flitting before us along the fence-rows. In old fields and pastures the darker-streaked savanna sparrow and the little earth-colored grasshopper sparrow with its yellow-edged wings and dry, cricket-like song, start out of the grass beneath our feet; and if in June days we search long and patiently, a glimpse of a nest and its treasures may reward our pains.

FIG. 2.—SAVANNA SPARROW.

Every one knows the meadow lark stalking over fields of short grass or swiftly rising from weedy cover with sharp note of alarm; the bobolink with throat full of song hovering above the lush meadows and acres of waving herd's grass or gathering in dense autumnal flocks among the river reeds; the swamp blackbird with its brilliant epaulets of red; the shore lark and titlark—all these are birds of the open, grass-grown fields.

Glancing at a physical map of North America we see that the continent is characterized by regions of widely different aspect. By far the largest area is forest clad, including the vast territory east of the Mississippi Valley and the great portion of British America. West of this, and extending from the Gulf and the Mexican highlands northward to the Athabasca River, is the region of the great plains, rolling, grass-covered prairies, dry and treeless, except in the river bottoms of the eastern portion. To the west the plains rise into the greater plateau of the continent, a steppe region crowned by the lofty, pine-clad ranges of the Rocky Mountain system. Between this and the Sierra Nevada ranges lies an alkaline waste, the Great Desert Basin, while along the Pacific slope a forest region again prevails.

FIG. 3.—GRASSHOPPER SPARROW.

It is evident, from this hasty view of the entire continental area, that we have before us precisely the same factors, though on a much larger scale and much more pronounced in character, as are present in the settled Eastern portion, namely, an open grass-covered region bordered by a vast forest. The same conditions hold good as in the case of the smaller areas of field and woodland, and we are not surprised to find differences in life of a corresponding nature. A fauna and flora distinct and characteristic of the prairie region on the one hand are in contrast with a more or less distinct forest life.

America at the time of its discovery presented a vast and unbroken expanse of forest embracing all the now cleared and thickly settled portions of the Eastern wooded region. Early explorers, as their records clearly show, were forcibly impressed with this endless reach of forest. The past two centuries have witnessed the steady downfall of the woods and their conversion over a wide territory into fields of grain and grass. Conditions of a prairie nature have, in other words, been introduced into the forest region, and we are naturally led to reflect upon the effect that this has had upon the life. When the region was one unbroken forest, where were the birds that to-day are found only in our fields?

Two solutions of this problem offer themselves to the mind. There has either been a radical change of habit among certain species in the past two hundred years, or an emigration and occupancy of the new lands have taken place from the prairie regions on the Western border. This latter view is, I think, the more probable from the fact that all the above-mentioned field birds are found on the plains or are represented there by varieties which differ only in slight shades of color.

Fig. 4.—Black-throated Bunting.

The range of the vesper sparrow covers the entire United States from the Atlantic to the Pacific and north to the plains of the Saskatchewan, so that it appears to be equally at home in the Eastern fields and on the Western praries. A paler variety occurs in the middle province, undoubtedly the result of the arid conditions of the region. Equally as extensive is the range of the savanna sparrow, though in the choice of localities it is not so entirely an upland bird as the vesper sparrow, haunting marshes along the coasts and river valleys as well as the higher open country. Several geographical races occur in the West and North. The little grasshopper sparrow is another East and West form, spreading over the dry central plains and presenting a paler variety in the latter region. The familiar song sparrow, whose bright, cheery ditty enlivens the closing days of winter, though a haunter of garden shrubbery and brier patches, is a bird of the grass, building its nest upon the ground. It is widely distributed over the continent, and in the West is broken up into a number of geographical races.

A remarkably interesting case is that of the black-throated bunting or dicksissel. This bird is one of the most abundant species in the grass lands of the Mississippi Valley and on the prairies of Kansas and Nebraska. In the time of the ornithologist Wilson and to within fifteen or twenty years ago, it was an abundant bird in the fields of the Eastern States. Now it is rarely seen along the Atlantic seaboard. Some years ago I knew of several pairs breeding each spring in a restricted area in southeastern Pennsylvania. Timothy and clover fields were their favorite nesting places, and a bird-loving friend who had watched these pairs from year to year suggested a cause for their increasing scarcity. About the time the young were hatched the remorseless reaper appeared upon the scene, and the keen-edged knife soon laid waste the home of the unfortunate dicksissel. It was not long before these birds disappeared altogether from their once favorite fields, and a probable clew to the cause seemed to point toward the reaping machine. This I have never been able to verify, as the harvests on their prairie home must be equally as destructive unless a much larger territory or a difference in the times of hatching and reaping has prevented the rapid destruction of the young birds. Be this as it may, the evidence before us goes to show that the grass-loving dicksissel came early from the Western prairies to the newly opened fields of the East, and has abandoned them for its Western home, disgusted, we may imagine, with the innovations of civilized man.

FIG. 5.—MEADOW LARK.

The meadow lark of the East is replaced on the Western plains by a lighter form. Our curious cowbird, stealing its egg into the nests of other birds, is abundantly spread over the continent, and the remarkable habit of associating with cattle for the purpose of feeding upon the flies that swarm about them suggests the question, Was this habit acquired since the settlement of the country, or did the birds haunt the herds of buffalo on the plains and begin to straggle eastward after the cattle were introduced? An allied form in the West, the yellow-headed blackbird, has similar habits, trooping among the cattle and horses on the plains, though it is a good householder, unlike the loose, vagabond cowbird.

The bobolink may have been a denizen of the river marshes of the East long before the discoverer first set foot upon these shores, though from its wide range toward the West, breeding on the plains of the Saskatchewan, we might infer that it had come eastward with the opening of the country. Similar conclusions might be adduced concerning the red-winged blackbird from its life and distribution, but it is a bird more of marshy land than of upland fields. Certain shore birds seem also to have taken advantage of the clearing of the country, as the killdeer and the grass plover, both being frequenters of plowed and fallow land.

Several characteristic prairie birds have at times by some accident found their way East, notably in the case of the lark finch, a beautiful Western form, and the yellow-headed blackbird above mentioned, both of which have wandered east as far as Massachusetts and Pennsylvania. This fact at least shows the capability of a bird to wander far from its original home, the regular phenomena of migration being still another proof.

Birds, owing to their superior organization and power of flight, have, more than any other forms of life, a constant tendency to widen their ranges and to occupy adjacent territory whenever the proper physical conditions are presented. This has been very clearly shown in the case of certain species along the Mexican border occupying the lands on which chaparral has lately grown up as a result of the invasion by cattle.* We can picture to ourselves a few prairie stragglers finding their way into the newly cleared lands of the settlers and gradually establishing themselves in the Eastern fields. By what route they came is a matter of conjecture—probably from the southwest in the northward-setting tide of the spring migration, or possibly by way of the Great Lakes and St. Lawrence Valley.

Thus has man in his history of progress and discovery unconsciously affected the distribution of other living beings. It is a very small fragment in the history of a country, but one of especial interest as showing how remotely and by what strange means causes and effects operate. Man appears in a new land, clears its face of timber, and erects his home. By and by the swift forsakes the hollow tree to build in the settler's chimney, and the swallow leaves the overhanging tree trunk or rocky ledge for the

* See a paper by S. N. Rhoads on The Birds of Southeastern Texas and Southern Arizona, etc. Proceedings of the Philadelphia Academy, January 26, 1892.

shelter of the eaves and barn. The robin builds within hand-reach of the doorsill, and the wren and martin, leaving their old homes in the forest to some woodpecker more lazy than his fellows, scold and quarrel for the possession of any hole or box, so long as it is near the dwelling place of man. Last, but by no means the least, this subtle influence reaches across a waste of tossing tree tops, and from the yet unknown prairie land come birds to dwell within his fields and gladden his heart with their sweet evening songs.

A MARINE BIOLOGICAL OBSERVATORY.*

By C. O. WHITMAN,
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IT is now twenty years since the memorable attempt to found a seaside laboratory on Penikese. Prof. Louis Agassiz lived long enough to demonstrate the impracticability of maintaining a summer school in such an inaccessible place, but unfortunately not long enough to repeat the experiment under more favorable conditions. The idea of transplanting the laboratory to the more convenient locality of Woods Holl, proposed by Alexander Agassiz, was abandoned on account of the little interest shown by the colleges which were appealed to for support. Although the continuance of this school was cut short by the untimely death of its master, the interest it awakened lived on and has brought forth a fairly rich crop of seaside laboratories.

About ten years after the abandonment of the Penikese School, Prof. Baird established, under the auspices of the United States Fish Commission, a marine laboratory at Woods Holl, and succeeded in getting a number of colleges interested in its support. For various reasons—beyond the control of Prof. Baird—the laboratory failed to attract the younger morphologists of the country. There was no lack of facilities, for these were superior to any that had ever before been offered in this country; and there was little lack of means, with the United States Government behind it, supplying money and a fleet of vessels such as no other station in the world has ever had at its command. Of late years, since the station passed into the hands of Colonel Marshall McDonald, its facilities for work have been increased, and a much larger number of morphologists take advantage of them every summer. The main functions of the station, however, continue, and must ever continue, to be devoted to the work of a great fish commission. No other like commission in the world has been able to

* Read before the American Society of Naturalists, December 28, 1892.

work on so grand a scale and with such immense effect. The results obtained each year reflect the highest credit on the management of the work and on the development of the vast field of economical interests charged to its care. The presence of such a powerful plant as this at Woods Holl adds very materially to the advantages of the situation.

The fact remains, however—and this is now conceded on all sides—that a marine biological observatory, devoted exclusively to research, must be independent of any control or interference on the part of the General Government, and rest on an endowment furnished by private initiative. This point has been strongly urged by Huxley, Carl Vogt, Herbert Spencer, and many others, and it may be put down as a settled fact. Of course, it does not follow that such an observatory may not receive support from the Government. Such support is, in fact, as important as it is fitting, as has been seen in the history of the station at Naples. The essential thing is that the observatory have an independent organization, and be able to direct its work to the ends of science, regardless of whether they coincide with those pursued by a commission of fish and fisheries. Although all biological investigation may, in fact must, minister directly or indirectly to the higher interests of humanity, its course must not be dominated or handicapped by utilitarian considerations. As I have said on another occasion: "A biological station should be a purely scientific affair from beginning to end. It should have no other aim than to advance science, and its whole organization should be directed to this one great end. We are urged by every consideration of the present, and every regard for the future of biological science in America, to keep this object steadily in view, and to allow nothing to block the way to its attainment" (first Report). Our course at Woods Holl in providing for instruction, as I hope time will demonstrate, is consistent with the end we are seeking.

The history of efforts to make Woods Holl a center for marine research, and the location there of the National Fish Commission, with resources that make it an ally of the greatest importance, are so much in favor of the place. Woods Holl is not, of course, the only available locality for our purpose, but it offers many natural advantages, and every summer's work has strengthened the conviction that we have been fortunate in our choice of position. Our experience simply confirms the opinion of the late Prof. Baird, that Woods Holl is *the* place of all the places on our coast for a marine station. It is easily reached by rail or by boat from New York, Boston, Providence, Fall River, or New Bedford. With Vineyard Sound in front, Buzzard's Bay behind, the beautiful Elizabeth Islands extending to the southwest, Martha's Vineyard in full sight a few miles away, Cottage City, Gay Head, and Nantucket in neighborly proximity, the environment is certainly not without attractive features. In the "gutters," "holes," and tidal currents; in the stretches of shore, varied and multiplied by "necks," rocky points, bays, flats, and adjacent islands; in a multitude of fresh-water basins and lakes completely isolated and inviting to experimental studies—in all these the naturalist finds a combination of natural advantages that is assuredly rare. One of the indispensable conditions to our work is *pure* sea-water, and that we find at Woods Holl, for there is no muddy river or city sewerage to vitiate it and drive away shore forms of life. The climate is cool and invigorating throughout the summer, and in the winter it is moderated by ocean temperatures. The fauna and flora are exceptionally rich for this latitude, and every year adds to the wealth of material which we can control for embryological purposes. The tropical seas, of course, offer greater riches in this respect; but the question we have to consider is this: *Where can an observatory best be placed to meet the needs of the greater number of biologists for summer work, and at the same time to best serve the ends of a permanent staff of investigators?* Accessibility and a stimulating climate outweigh all the advantages of a rich fauna and flora, when these must be accepted with a climate which, if not dangerous, is at least enervating, and when the locality is not within convenient reach. In fact, all such advantages can be added without neglecting the paramount considerations of health and availability. They can not only be added, but also multiplied almost without limit, by simply equipping a station with such means as will enable it to carry its research to any part of the Atlantic or Pacific coast, or even to the more remote seas of the earth. Such an equipment would be expensive, but is it not precisely what a biological observatory demands? No single locality, be it never so rich in life, can furnish more than an infinitesimal part of the wealth of the seas. *The only effective means of commanding extensive advantages in the way of select material is that of itinerary research.* This fact has been recognized and emphasized by those who have given most attention to marine work. Any plan for a great central station which does not include this all-important feature may be pronounced a failure in advance. Such provision must be equally necessary and equally expensive, whether the location be in the tropical or the temperate zone. If special material is required, it must be sought where it abides, be this one mile or twelve thousand from the center. Center there must be, and the more you limit the radius, the more local and the less satisfactory your facilities. Let the center be where the investigator can afford to spend his life, where his vitality is highest, and his energy most productive. If desirable material calls him to a climate that induces lassitude and exposes him to infectious diseases, let his salary or the funds at his disposal for research be sufficient to enable him to choose his time and limit his stay to the necessities of the case.

Having said this much on the principles that must guide us to a wise choice of location, I must add a word on the tendency to scatter forces. On this point the words of Lacaze-Duthiers (Archives de Zoologie expérimentale et générale, tome ix, 1891, page 258), the distinguished director of the Marine Laboratory of Roscoff and Banyuls, are of interest. Speaking of the tendency to multiply seaside laboratories in France, he says: "We have been able to count as many as seventeen or eighteen stations on our coasts in the course of 1891. Are they all born to live? Will they all endure as long as the pompous announcements that have accompanied or preceded them would have us believe? Have not some discounted too quickly the future? . . . *Is this not also an exaggeration and a dissipation of precious energies, which, if concentrated into a single strong organization, might render very great service?*"

The survival of the fittest will in time answer these questions for us. But there is something to be said in favor of multiplying stations, if their creation be well considered, and determined with a view to *extend* rather than *duplicate* the facilities of a central station. Obviously a central station organized on a foundation that would permit of supplementing local by itinerary research would profit immensely by stations at favorable points, standing in auxiliary relations. Of such stations let us have all that we can possibly have without diverting either forces or funds that should go to make a strong common center. The danger lies, not in the possession of auxiliaries, but in the tendency to build up isolated laboratories in antagonistic rather than co-operative relations. In union there is strength, in division impotence. The advantages of a strong central station are so immeasurably superior to those of many weak local ones, that we are bound to encourage the former and discourage the latter. Our first effort should be to secure *one* foundation in the interest of *all*, rather than a multitude of isolated ones in the interest of individual colleges or universities. No university in this country can undertake to found a biological observatory for the whole country; but all can well afford to unite in the support of one founded by private munificence and open to all on equal terms. This is the only basis on which we can expect to secure an observatory of national importance. No scheme that ignores this simple, common-sense fact can ever lead to anything more than a small local success at the best. Now, I think every prominent naturalist in the country will indorse the opinion that American biology would profit immensely more on the basis I have suggested than it could through any plan that would divide forces and build up weak college dependencies. Moreover, the individual interests of every institution in the country that maintains a biological department would be most economically and efficiently provided for in the same way. The interests of biologists, biological schools, and the science at large, all coincide in this matter, and each emphasizes and re-enforces the same verdict. Here we stand on principles that are too obvious, as it seems to me, to fail of commanding general assent.

This point dismissed, the task of finding a plan acceptable to all remains. Does any one of the marine laboratories now in existence afford a suitable vantage-ground for united action? This is a delicate matter to handle while rival schemes are afloat. But the question may at once be stripped of most of its difficulties by simply ruling out all schemes proposed in the interest of any particular institution and based on *local* organization. No disapprobation is intended for any one of these; they may all be useful and worthy of encouragement; but if they declare themselves organized under the auspices of some university or college, as most of them do, they certainly can make no just pretension to being national in aim and scope, and hence do not appeal to our highest need. And so, while wishing them all every possible success, we invite them to co-operate in a broader undertaking which will in no way encroach upon their private ground, but which, on the contrary, may extend and supplement their work, while sustaining facilities that are beyond their reach. Some of these laboratories, perhaps all of them, have offered their privileges to investigators from the outside, and it is to be hoped that they will continue to do so, for this forms an important part of the co-operation which a general observatory would invite and profit by.

The proposal recently made for the establishment of a biological observatory at Jamaica under the auspices of the British Government, aided by private subscription, is one to be strongly commended. Such an observatory would bring many important advantages to American as well as English biologists, and it might well be an international establishment. A national observatory on our coast, such as we have looked forward to, would find in a station at Jamaica an invaluable adjunct to its facilities, and might be expected not only to avail itself of its advantages, but also to lend it such support as its means might permit. The plan is in no way a rival or a substitute for the one already under way at Woods Holl. It would make no provision for instruction either for students or for beginners in investigation; its work would be limited to research, and its workers would be few and for the most part transients in search of material to be taken away and worked up elsewhere. Its function, however, would be none the less important in subserving interests that could not otherwise be so conveniently and efficiently provided for. It ought, therefore, to receive the heartiest support from all who are interested in the advancement of biology.

Of the marine laboratories now in existence on our coast, the Marine Biological Laboratory holds a somewhat exceptional position, both in its organization and in its general aims. It owes its inception to some members of the Boston Society of Natural History acting in co-operation with the Woman's Educational Association of that city. It is controlled by a board of some twenty trustees, representing the following institutions: Harvard, Yale, Columbia, Princeton, Harvard Medical School, Massachusetts Institute of Technology, Williams College, University of Cincinnati, Bowdoin College, Boston Society of Natural History, the Missouri Botanical Garden of St. Louis, Philadelphia Academy of Science, University of Chicago, and the University of Toronto. This representative board has been extended every year until it may now be said to have a national character, including the majority of our leading biologists who are interested in marine work. Its officers of instruction have been taken from Harvard, Brown, Princeton, Clark, Chicago, Massachusetts Institute of Technology, Bryn Mawr, Cornell, Massachusetts Experiment Station, University of Nebraska, Boston Society of Natural History, University of Cincinnati, Ohio Wesleyan University, and the Allis Lake Laboratory. Its membership has extended to nearly all the more important educational institutions of the country. It represents the third attempt that has been made to unite our universities and colleges in the support of a marine laboratory. Mr. Alexander Agassiz made the first attempt as early as 1874, at the close of the last season at Penikese; and ten years later a second attempt was made by Prof. Baird. Although these efforts failed of their immediate object, they certainly prepared the way for whatever has been accomplished since. The aim from the outset has been to provide for both investigation and instruction, but for the latter as subsidiary to the former. The problem has been to combine the two in such relations that each would contribute most to the same end—the advancement of science. We have always kept in view the necessity of providing as early as possible a separate building for the exclusive use of investigators. Our effort from the beginning, as declared in every annual report, and as shown in every step thus far taken, has been to uphold a plan of national breadth; and it is on this basis that we have asked and received the support of the colleges and the co-operation of investigators, and on the same ground we have rested every appeal for pecuniary assistance.

In certain respects of fundamental importance, then, the Marine Biological Laboratory stands alone among the seaside laboratories now in existence. Its general policy has been national in scope; the organization of its governing board and its staff of instructors is entirely non-sectional in character; it is an independent establishment, free from the control of any other institution, and owes its existence to private initiative; its record of five years has been such as to win the desired support of many of our leading colleges, and thus to place it on a vantage-ground that insures its development along the line of its choice.

Its growth in numbers and prosperity has far outrun expectation. Starting in 1888 with an attendance of seventeen, representing thirteen different institutions, it increased that number to forty-four in 1889, forty-seven in 1890, seventy-one in 1891, and one hundred and ten in 1892, representing fifty-two of our higher educational centers. The number of colleges, universities, seminaries, academies, schools, etc., represented during the five seasons is one hundred and ten. We now have thirty private rooms for the use of investigators, and five general laboratories for the use of students and beginners in investigation. Every room and every laboratory has been filled the past summer to overflowing, so that the library room had to be again occupied, notwithstanding the addition of new buildings more than doubling the capacity of the original laboratory. During the summer we have had no less than fifty investigators, over thirty of whom occupied rooms as independent workers. We can now point to scientific results that secure for the laboratory a reputation of which many a richer foundation might be envious.

With so encouraging a beginning already made, what option have we but to go on and build up on this basis, trusting that friends of our science will be found who will appreciate its work and its need and give it an adequate foundation ?

Biology in America has many needs, but not one that rises to the importance of a marine observatory. In that its highest interests now center, and I am sure that I only express the conviction of my scientific colleagues, both in this country and abroad, when I say that the establishment of such an observatory is an object worthy of the most splendid gift that private munificence has ever bestowed on any branch of science. It costs many millions nowadays to create a first-class university; and not a few low-grade affairs might better have never been planted. Instead of multiplying such institutions, it would be wise to create scientific institutes for the larger and more important branches of science. In this direction the benefactors of education and science have still almost everything to do. It is, in fact, the field that promises the greatest returns and the greatest blessings to mankind. As examples of what such institutes signify, may be mentioned the Pasteur Institute in Paris, the Zoölogical Station at Naples, the Lick Observatory, and the Smithsonian Institution. In what way could money bring swifter, surer, more magnificent, or more lasting rewards than when invested in such foundations? Our country suffers from the lack of these, while it is burdened with a plethora of impotent colleges. For this pathological overplus of colleges, secreting a sort of purulent education, with little or none of the saving basic properties of scientific culture, the best antitoxine would be the creation of research laboratories. There is no antagonism between scientific and literary education; but no one will now venture to deny that culture implies something more than a knowledge of words. Mr. Arnold's definition of culture—"to know the best that has been thought and said in the world"—needs the supplement furnished by Huxley: "Culture implies the possession of an ideal, and the habit of critically estimating the value of things by comparison with a theoretic standard. *Perfect culture should supply a complete theory of life, based upon a clear knowledge alike of its possibilities and of its limitations.*" "Observation and reflection"—the significant words with which Carl Ernst von Baer closed his Embryology of Animals—connote mental attributes that are the fundamentals of culture. They imply powers and habits best nurtured by scientific, but best polished and adorned by literary, training. Both means of culture are to be combined, but duly balanced. My plea is not against any source of culture, but against exaggerating one out of proportion with another. At present we are in desperate need of more science, and my appeal is in behalf of science in general, and biology in particular. I rejoice in the splendid gifts to astronomy, physics, and chemistry, but I feel impelled to urge that that great division of sciences, comprising the whole animate world, has claims upon the enlightened generosity of this country which have not yet been fairly met. The claim which I would place foremost at the present moment is the urgent need of an American marine biological observatory. What grander commemoration of the labors of Louis Agassiz at Penikese or of the efforts of Spencer F. Baird at Woods Holl, or what higher and more fitting tribute to the memory of the discoverer of this hemisphere, could this centennial year bring than the foundation of such an observatory? My humble plea is but the echo of a chorus of voices a thousand times more potent from the leading biologists of America and Europe. This weighty consensus of opinion shows so well how the scientific world regards this subject, and how broadly and deeply the interests of science would be affected, that further remarks on my part would be superfluous.

THE OPINIONS OF VARIOUS AUTHORITIES IN SCIENCE ON THE PROPOSED MARINE OBSERVATORY.—Carl Vogt, the veteran biologist of Geneva, the friend and scientific colleague of the late Prof. Louis Agassiz, and the pioneer advocate of marine observatories in Europe, sets forth the aims and the importance of marine biology in the following letter:

UNIVERSITY OF GENEVA, *January 25, 1892.*

DEAR SIR: You ask my opinion concerning the utility of a marine biological laboratory with a view to enlarging and perfecting the one already established, on a plan too modest and limited, at Woods Holl.

I will not begin my letter with a word-quibble. But I believe that, in the actual state of science, institutions like the one you contemplate are not only of great and undoubted utility, but *absolutely necessary*. Neither theoretical and abstract science, nor the application of science to highly important practical ends, can achieve results of value without seriously and systematically supporting marine biological stations.

As you very truly remark in your letter, my convictions on this subject are not of recent date. I have entertained them for more than forty years—in fact, ever since the days when I devoted myself, alone and without other resources than my own activity, to biology, and carried on my studies for several consecutive years on the shores of the Atlantic and Mediterranean. For many years I vainly attempted to get the governments of maritime countries and trained biologists to carry out my ideas and projects. Some could not comprehend them, and to others they seemed eccentric. After years of fruitless attempts on my own part, I was happy to see the efforts of my friends who shared my views meet with success, and I continue to feel a pleasant satisfaction when I hear of the establishment of new stations whenever it is seriously undertaken. And I maintain that you are very fortunate in living in a country where the citizens are accustomed through their own private initiative to found institutions of interest to the public, where they know how to endow their institutions liberally, and often magnificently; whereas in our old continental Europe we can do nothing without the good will of the governments, which interest themselves in every undertaking, and lavish the better part of their revenues in sterile bounties on an unproductive military class.

But let us come down to facts. I maintain that marine stations are necessary for biological science, since nowhere but in the sea can there be found a host of types whose study is indispensable if one desires to form a clear and concise idea of the *ensemble* of the organic world, of which we ourselves are members. Now, the greater part of these organisms, vegetable as well as animal, are so delicate that, notwithstanding our improved methods of preservation, we can not acquire even an approximately correct idea of their characters unless they can be studied in their natural medium—the sea. We now enumerate along the coast of continental Europe almost as many laboratories as universities. Would these have been founded, often at great trouble and expense, if the need of them had not been urgently felt? And to mention only one branch of biological science—*morphology*—would this have reached the position which it occupies to-day were we not in possession of marine biological laboratories, where most remarkable investigations have been and are still being carried on? To mention only the more important of these laboratories, where would morphology be without the works that have been produced in Naples, Roscoff, Banyuls, Wimereux, Marseilles, Villefranche, and so many other stations? In truth, those who would pretend that morphological science can advance and develop without the aid of these marine laboratories could equally well defend the paradox that astronomy can advance without the aid of observatories.

I need hardly say that I do not limit the term "morphology" to investigations in the structure and organization of the various organisms to be found in the sea; I would also include under it the most lofty questions and most abstract generalizations to which we are led by morphological research. Researches in organic evolution, to which Darwin has given so powerful and fruitful an impetus, can not be undertaken without due consideration of the marine fauna. The sea is really the source of organic life in its *ensemble;* researches on the relationships of different animals, on their origin, on their individual development, from the first visible germ to the completion of their life-cycle, are continually and necessarily leading us back to marine organisms. In order to form a conception of the development of the organic horizons as they extend through the successive periods of the history of our planet, we are obliged continually to recur to the comparative study of marine forms.

But the researches of present and future science are not limited to morphology and its conclusions. We demand a knowledge of the functions of the various organs whose structure has been studied, in order to understand the *rôle* which they played in the elaboration of life; we are desirous of knowing how the varied functions over which the organs preside are exercised. This is the aim of *physiological* investigation, which up to the present has been carried on only on man and a few animals predestined to experiment, such as the dog, the rabbit, and the frog.

I do not hesitate to say, if there were no marine laboratories in existence, they should be created for the prosecution of physiological investigation. In every case existing and future laboratories should be constructed in such a way as to admit of the carrying out of physiological experiments on a grand scale. The field is almost new; it has hardly been touched as yet, but the few works which have been produced in this line prove that most magnificent results await us in the future, and that general physiology will be quite as much enriched and even improved by means of such laboratories as has been the case with morphology. Many of my friends, themselves directors of marine laboratories, have felt the need of physiological equipment; many of them have expressed themselves to this effect in articles and other publications. In Naples they have taken a step in advance in this direction; but, to render these studies productive, delicate instruments are needed, apparatus costly beyond the means of existing laboratories. Will your fellow-countrymen furnish such means? It would be a glory to the United States could these projects there be realized, which have to be abandoned in other countries on account of insufficient resources.

You justly call your prospective laboratory "biological." I ardently wish that your countrymen, so nobly generous when it comes to founding scientific institutions, would saturate themselves with the meaning of the word "biological." *Biology* includes much more than morphology and physiology, which treat only of the mainsprings of individual life; it includes also the life of organisms in its totality; it should study the reciprocal relations which animals living in a common medium bear to one another; their relations with their surroundings, and without which they would be unable to sustain the struggle for existence. Here, again, lies a field, little explored as yet, open to researches which have not only great scientific interest but immediate and undeniable practical value. I should perhaps surprise the public, who are in the habit of attributing to us *savants* a much greater fund of scientific knowledge than we really possess—I should perhaps surprise the public by maintaining that, with the exception of the herring and the sole, which have been studied of late years, we have only very fragmentary, incomplete, and insufficient knowledge of the life conditions of a host of marine animals, the fishery of which enriches so many industries and supplies us with so valuable a store of food. Our laws and regulations respecting marine fisheries (I speak only of continental Europe) are based on the vaguest notions—to a great extent only on suppositions or on analogies drawn from fresh-water fisheries. I am well aware of the fact that the settling of these questions, on the solution of which so largely depends the future of our fisheries, and with these the nourishment of our posterity—I am well aware of the fact, I say, that here also considerable resources are necessary: extensive aquaria, steam launches for long excursions—in short, all sorts of paraphernalia. But more requisite than all these are patient observers, indefatigable workers, who will not hesitate to devote years of labor to the solution of problems that may be summed up in a few words or even prove insoluble. I am convinced, however, that when once the utility—yes, the necessity—of such researches is generally recognized, citizens interested in the welfare and progress of their country will be found to furnish, some the financial resources, others the sustained intellectual labor.

Such are, to my mind, the aims of a marine biological laboratory. Has the utility, the necessity of such institutions been demonstrated? I trust that it has. I do not deny that the pursuit of these aims will require very considerable sums. I may add that the expense will be still further increased by the purchase and maintenance of an appropriate *library*. A neighboring library, to which access can not be had without some trouble, will not be sufficient. The investigators should be able while their work is in progress, to put their hands on all the books that can give them any information on the subject of their study. It is the possession of just such a library that assigns so important a rank to the station at Naples.

You have my best wishes, my dear sir, for the success of your enterprise. I sincerely hope that you will be assisted by your countrymen in every way, munificently, abundantly. You will pardon the length of my letter. If it contributes to the desired result, I shall be more than delighted. It will be a great joy to me in my old age to see arising on the other side of the Atlantic, through the free initiative of your fellow-countrymen, an institution destined to render great service to science, to the country, and to the people. With this wish I remain,

Yours sincerely, C. VOGT.

Prof. Huxley writes:

[LONDON,] *October 30, 1891.*

DEAR SIR: At this time of day, I do not think that a project for the establishment of a biological laboratory should need much advocacy. Biological problems are certainly before the public, and I hope that it is beginning to dawn upon the veriest Gigadibs of a *littérateur*, that the solutions of them are to be obtained by no book learned speculation however ingenious, but by patient appeal to Nature in the way of observation and experiment. I do not venture to say that

America needs to be reminded of this really fundamental truth more than England does; but, certainly, the greater proportion of new theories of the universe—gloriously unfettered by any acquaintance with realities—which periodically reach me, come from your side of the water; and I mourn over the waste of power and of ingenuity which might have been prevented by three months' work in a laboratory. I shall be very glad to hear of the success of your project; and all the more, that you propose to have it carried it out by private enterprise. I am yours very truly, T. H. Huxley.

Naples Zoölogical Station, *January, 1892.*

Dear Prof. Whitman: You want my opinion on your plans regarding a large zoölogical station. I think my opinion has found long since an expression in a far more emphatic way than by ink on paper. Twenty and more years of life I have bestowed on creating and organizing such a station, and you know yourself how far I have met with success, part of which may even be recognized in your plan.

Two things concur to make a station flourishing: *money and good organization.* I have no authority to speak on your chance of finding money enough in your country for your plans; I only lay stress on the fact that money and a good deal of money is necessary to make a zoölogical station successful. It has been for many years my constant preoccupation to raise the income of the Naples station in order to satisfy all the wants science could wish for. I must leave to your appreciation, whether the organization, which I have given to my establishment recommends itself to others as satisfactory. I know myself well enough where it is defective, and how it might be improved; but I know also that there are circumstances in the way that can not be easily removed. As it is, however, it works tolerably well and has done in nineteen years of life some good service to science.

Should you succeed in raising money enough, I think you will be able to establish something so complete and so strong as to rival any existing establishment of the kind. I for one do wish you all possible success in your enterprise. Believe me, dear Prof. Whitman, yours most sincerely, Anton Dohrn.

"Your project interests me greatly. Certainly such a station as you contemplate founding will be of the greatest importance to science."—August Weismann, *Freiburg.*

"An appeal to the 'upper ten thousand,' to the men who generously consider not only the needs of the commonwealth, but also those of intellectual progress, will not die away unheeded."—Rud. Leuckart, *Leipsic.*

"Your communication concerning the erection on the North American coast of a large national marine laboratory as a common center for zoölogical and botanical, morphological and physiological investigations on marine organisms, has excited my keenest interest, and I hope that the considerable pecuniary support so necessary for such an undertaking will be forthcoming."—Ernst Haeckel, *Jena.*

"I heartily sympathize with your desire to bring about the foundation of a laboratory on the United States coast for the use of skilled investigators in biology. . . . You ought to have at a favorable point on the American coast as complete and well-organized an institution as that established by our friend Dohrn at Naples."—E. Ray Lankester, *London.*

"I am convinced that such a station erected at a suitable point on the coast and fully equipped, but, above all things, under judicious management, will greatly further advancing biological science."—C. Gegenbaur, *Heidelberg.*

"I fully believe that your countrymen, with their accustomed enterprise, will meet your present request."—G. B. Howes, *London.*

"If you succeed in founding in the United States a biological institution in which the processes of life may be studied in all their magnitude and extent, you will indeed perform a lasting service to humanity."—C. Ludwig, *Leipsic.*

"Speaking as a physiologist, I can hardly say anything too strong on behalf of marine laboratories such as the one you wish to establish."—M. Foster, *Cambridge, England.*

"I am glad to learn that your plans for the establishment of a permanent national marine laboratory are taking definite shape, and I hope their importance will be generally recognized. It would be strange if support could not be found for an American laboratory that will bear comparison with those of England, France, Germany, and Italy."—E. B. Wilson, *Columbia.*

"The need of a biological experiment station is even greater in this country than in Europe, where its importance has been recognized for a good many years, as shown in the numerous stations already established."—W. G. Farlow, *Harvard.*

"I wish to be put down as one who favors the plan most emphatically. . . . I hope that steps will be taken to make the place a summer gathering ground for the biologists of this country in the broadest sense of the word—i. e., let us have investigations in zoölogy, physiology, botany, the study of the environment, both physical and chemical as well as experimental. Let it further be a national, not a sectional movement."—William Libbey, Jr., *Princeton.*

"I am glad that the Marine Biological Laboratory is taking steps toward securing a permanent and adequate endowment. I have watched its development with a good deal of interest, and have gladly contributed my mite for its support."—William Trelease, *Missouri Botanical Garden.*

"I need hardly assure you of my deep and cordial interest in the permanent establishment of a seaside laboratory, and of my desire that the University of Illinois may share to the limit of its ability in its burdens and in the benefits to be derived from it."—S. A. Forbes, *Illinois State Laboratory of Natural History.*

"I am very deeply interested in the development of the laboratory at Woods Holl. I believe that it is in itself one of the most important educational institutions in the country, and I shall be glad to do all that I can to advance its interests."—David S. Jordan, *Menlo Park, Cal.*

In the description of his journey into the interior of Iceland, published in Petermann's Mitteilungen, Th. Thoraddsen refers to the oases in the desert of volcanic sand at the foot of Mount Hecla. These are constantly changing or moving on account of the violent sand-storms which rage there. On the windward side they are encroached upon by the sand, and all vegetation is gradually destroyed, while on the other sides the grasses take root and "in a surprisingly short time barren and unfruitful spots are changed into good pasture."

THE ÆSTHETIC SENSE AND RELIGIOUS SENTIMENT IN ANIMALS.

By Prof. E. P. EVANS.

DR. WILKS reduces the chief difference between man and brute to the "smallness of knowledge of the fine arts possessed by the latter"; and a passing remark made by Prof. Huxley, in one of his essays, would seem to imply a disposition to draw the line of separation between animal and human intelligence at this point. Prantl regards the phrase "die Kunsttriebe der Thiere" as a metaphorical expression involving a confusion of terms, since animals, with all their apparent artistic ability and taste shown in constructing and decorating their habitations, do not seek to embody ideas in material forms—an assumption which begs the very question in dispute. Schiller, in his well-known poem, Die Künstler, makes man's pre-eminence consist solely in his artistic faculty:

> "In Fleiss kann dich die Biene meistern,
> In der Geschicklichkeit ein Wurm dien Lehrer sein,
> Dein Wissen theilest du mit vorgezogenen Geistern,
> Die Kunst, o Mensch, hast du allein."
>
> In diligence the bee can master thee,
> In skillfulness a worm thy teacher be,
> Knowledge thou dost with higher spirits own,
> But art, O man, thou dost possess alone.

Herbart, however, does not recognize this demarcation. "If one asks for a specific characteristic of mankind, which is not physical, but spiritual, original, and universal, and does not resolve itself into a more or less, I confess," he says, "that I do not know of any such distinction and do not think it exists." He then enumerates the advantages possessed by man—namely, hands, speech, and a long and helpless infancy, to the use and influence of which are due the extraordinary growth of the human brain in size and complexity and the corresponding development of intellectual power. In the acuteness of his senses and in many peculiarities of physical structure man is inferior to some of the lower animals. He has not, says Prof. Cope, kept pace with other mammals in the development of his teeth, which are "thoroughly primitive"; his nose is less serviceable than that of the dog; the eagle has a far better eye; the ankle joint of the sheep is, as a piece of mechanism, stronger and less liable to derangement than the corresponding joint in man; the horse's foot consists of a single compact elastic toe, on which the animal runs while its heel is carried in the air and never touches the ground, thus attaining a springiness and swiftness of motion beyond the reach of the human plantigrade. Whatever lightness and elasticity of step man possesses is due less to the perfection of his bodily organism than to the uplifting influence of his intellect. With the decay of his mental powers *Homo sapiens* slouches like a bear, as may be observed in the ungainly and unsteady gait of cretins and idiots, however vigorous they may be physically.

The objection urged by Prof. Kedny against the doctrine of evolution—namely, that man's helpless infancy proves him to be different in kind from other animals—ignores the fact that the soko and many other species of the genus *simia* pass through a period of infant helplessness almost as long as that of some savage tribes. The babyhood of the anthropoid apes is much longer and more helpless than that of the cynopithecoids, the platyrhines, or the lemurs; and the higher the order of the monkeys, the more they resemble man in this respect. Mr. Wallace captured a young orang-outang, which had to be fed and cared for like a human infant, lay rolling on the ground with all fours in the air, and could hardly walk when it was three months old; whereas a macacus of the same age seemed to have already acquired full use of its limbs and mental faculties. The long duration of this complete dependence on parental care in the case of the human infant, so far from disproving the doctrine of evolution, furnishes one of the strongest arguments in its favor, since it helps to explain how man gradually attained his intellectual primacy among the primates. The American platyrhines, marmosets, and other smaller long-tailed monkeys reach maturity in three or four years, whereas the African dog-headed apes require ten or twelve years for their full development, and with the larger anthropoids this period of growth is nearly as long as with human beings.

The fact that quadrumana have flexible organs of prehension, can grasp and handle things and imitate human actions, gives them a great advantage over quadrupeds. A dog may be as intelligent as a chimpanzee, but he is unable to "show off" as well; he can not untie knots with his paws, nor put on clothes, nor eat with knife and fork, nor uncork bottles, nor drink wine by lifting the glass to his lips, nor use a toothpick, nor perform a variety of tricks which make the monkey appear to be relatively far more richly endowed with mental gifts than is actually the case, and throw into the shade the most conspicuous exploits of the poodle and the collie.

Nevertheless, this manual and digital dexterity can scarcely be overestimated as a means of disciplining the mind and increasing the volume of the brain; and if chimpanzees, orang-outangs, and sokos had enjoyed the thousands of years of domestication and thorough breeding and training, from which dogs have so immensely profited, there is no knowing what advances in knowledge and acquisitions of intellectual culture they might not have made. It is wonderful how much they learn through observation and very slight instruction during a few months' intercourse with human beings, discharging with evident pleasure the duties of body servant or waiter, answering the door bell, showing visitors into the parlor, fetching water, kindling the fire, washing dishes, turning the spit, and doing all sorts of chores in and about the house. "Such an ape," said Brehm, "one can not treat as a beast, but must associate with as a man. Notwithstanding all the peculiarities it exhibits, it reveals in its nature and conduct so very much that is human, that one quite forgets the animal. Its body is that of a brute, but its intelligence is almost on a level with that of a common boor. It is absurd to attribute the actions of such a creature to unthinking imitation; it imitates, to be sure, but as a child imitates an adult, with understanding and judgment."

That the plastic and progressive period of the monkey's individual development is short, and that its faculties become set and stationary at a comparatively early age, is undeniable; but the same holds true of the negro, who loses his educability and ceases his mental growth much earlier than the Caucasian. The longer or shorter duration of this formative season in the mental life of man is, to some extent, a matter of race, but in a still greater degree the resultant of civilization.

The hand is also a valuable instrument for the cultivation of the æsthetic sense, and the more flexible and sensitive this instrument becomes, the greater are the results achieved by it in this direction. But there are animals without hands that show an appreciation of the beautiful. Mr. Darwin has proved conclusively that birds take pleasure in sweet sounds and in brilliant colors, and that the sentiment thus awakened and appealed to plays an important part in the preservation and perfection of the species through natural selection. The struggle for existence is not always carried on by fierce combat and the triumph of brute force, but quite as frequently takes the form of competition in beauty, addressing itself either to the ear as alluring song or to the eye as attractive plumage; and the bird that possesses these characteristics in the highest degree carries off the prize in the tournament of love, and propagates its kind.

There is no doubt that birds take delight in the gorgeousness of their own feathers, and the more brilliant their hues the greater the vanity they display. Conspicuous examples of this love of admiration and fondness of parading their finery are the peacock and the bird of paradise.

The decoration of its boudoir by the bower bird, as described by Mr. Gould in his History of the Birds of New South Wales, indicates a decided and discriminative preference for bright and variegated objects, and evinces no small amount of æsthetic feeling and artistic taste in selecting and arranging them. The bower is built of sticks and slender twigs gracefully interwoven, so that the tapering points meet at the top, and adorned with the rose-colored tail feathers of the inca cockatoo and the gay plumes of other parrots, tinted shells, bleached bones, rags of divers hues, and whatever gaudy or glittering trinkets may please the bird's fancy. Sometimes the space in front of the bower is covered with half a bushel of things of this sort, laid out like a parterre with winding walks, in which the happy possessor of the garnered treasures struts about with the pride and pleasure of a connoisseur in a gallery of paintings, or a bibliophile who has his shelves filled with *incunabula* and other rare editions. These objects have often been brought from a great distance, and are of no possible use to the bird except as they gratify its love of the beautiful and appeal to what we call in man the æsthetic sense. Its conduct can be explained in no other way; for the bower is not a nest in which eggs are laid and hatched and young ones reared; it is a *salon* or place of social entertainment, and thus serves a distinctly ideal purpose.

The singing of birds, as a means of sexual attraction, implies a certain appreciation of melody. Indeed, many of them do not confine themselves to the songs of their species, but learn notes from other birds and snatches of tunes from musical instruments. Canaries can be taught a variety of airs by playing them repeatedly on a piano or on a hurdy-gurdy. They listen with attention and imitate the strains which take their fancy. If harmony or the concord of sweet sounds, as distinguished from melody or the simple succession of sweet sounds, does not enter into bird music, the same may be said of the music of primitive man and of all early nations. Savages, like feathered songsters, sing in unison, but not in accord.

Not only do some species of monkeys, like the chimpanzees and sokos, get up concerts of their own in the depths of the forest, but dogs, which are generally supposed to be decidedly unmusical, also discriminate between tunes and express their preferences or aversions in an unmistakable manner. A friend of mine, who had a magnificent St. Bernard dog, was fond of playing the violoncello. The dog used to lie quietly in the room with closed eyes, and appeared to pay no attention to the music until his master struck up a certain tune, when the dog immediately and invariably sat up on his haunches and began to howl. If the tune which called forth such emotions had been written on a very high key, or characterized by shrill tones or harsh dissonances, the conduct of the dog might be easily explained. But such was not the case. There was nothing in this piece more than in any other, so far as any one could observe, that ought to grate the canine ear. Many incidents of this kind might be cited to prove that even dogs are not indifferent to musical compositions, and show a nice discrimination between them, having their likes and dislikes, as well as human beings.

The fertilization and propagation of many plants depend upon the existence of a sense of color in insects, and the exercise of choice in the selection of flowers. This preference implies a pleasure in certain hues, and consequently the possession of a rudimentary perception of beauty. Plants whose fecundation depends upon the action of the wind do not develop such a variety of colors as those in which this depends upon the agency of insects. Nature can trust her ill-favored daughters to the wooing of the wind, but if she wishes to attract a nicer class of suitors she must endow her children with brilliant qualities.

The power of distinguishing between colors has been denied not only to the lower animals, but also to the lower races of mankind. But a more extended and accurate knowledge shows that the conclusion is incorrect in both cases. We know that the American aborigines discriminate between the seven primary colors, and it is absurd to infer that this faculty was wanting to the Homeric men merely because we do not find all these colors mentioned in the Homeric poems. It has also been asserted that the ancient Assyrians could not distinguish green from blue or yellow, because no word was found for it in the remains of their language. But the tiles discovered at Nineveh prove that they had a very clear conception and æsthetic appreciation of the distinction between yellow, green, and blue, and probably did not confound any colors of the solar spectrum. The evidence of language on this point is purely negative and necessarily defective.

Even the religious sentiment, which has been assumed to be the peculiar possession of man, is faintly foreshadowed in the lower animals. The unanimity of opinion among those who have made the most careful study of this subject, and whose views are therefore entitled to the greatest consideration, is quite remarkable. M. A. de Quatrefages, in his *Rapport sur le Progrès de l'Anthropologie* (Paris, 1867, p. 85), maintains that "domestic animals are religious, since they readily obey those who appeal to them with the rod or with sugar." In other words, they are amenable to rewards and punishments, doing the will and seeking to win the favor of superior beings, on whom they are dependent, propitiating and fawning upon them, creeping and groveling on the ground in abject adoration, in order to assuage their anger or to secure their kind regard. "There is no difference," adds the same author, "between the negro who worships a dangerous animal, and the dog who crouches at his master's feet to obtain pardon for a fault. . . . Animals fly to man for protection as a believer does to his god."

This is precisely the feeling of the savage in respect to the superior skill and power of the civilized man. *Taguta kipini te Atua*—doctor all the same as God—are the words in which the Morioris, or aborigines of the Chatham Islands, expressed their sense of dependence on a higher agency, whose beneficent workings they perceived but could not comprehend. Among rude tribes the sentiment of devotion to a chief does not differ essentially from that of devotion to a god; the Romans, at the height of their civilization, paid divine honors to their emperors; and in modern monarchies kings are officially addressed in terms of reverential awe and superlative adulation as all-wise and all-powerful beings, whose favor one can not sufficiently implore with servile words and suppliant knee.

"The feeling of religious devotion," says Darwin, "is a highly complex one, consisting of love, complete submission to an exalted and mysterious superior, a strong sense of dependence, fear, reverence, gratitude, hope for the future, and perhaps other elements. No being could experience so complex an emotion until advanced in his intellectual and moral faculties to at least a moderately high level. Nevertheless, we see some distinct approach to this state of mind in the deep love of a dog for his master, associated with complete submission, some fear, and perhaps other feelings."*

Comte held that the higher animals are capable of forming fetichistic conceptions, and of being strongly influenced by them. Herbert Spencer denies the truth of this statement in its absolute form, because it does not fit into his theory of the origin and evolution of religious ideas, but admits, what is essentially the same thing so far as the present discussion is concerned, that "the behavior of intelligent animals elucidates the genesis" of fetichism, and gives two illustrations of it. "One of these actions was that of a formidable beast, half mastiff, half bloodhound, belonging to friends of mine. While playing with a walking-stick, which had been given to him and which he had seized by the lower end, it happened that in his gambols he thrust the handle against the ground, the result being that the end he had in his mouth was forced against his palate. Giving a yelp, he dropped the stick,

* The Descent of Man. London, 1874, p. 95.

rushed to some distance from it, and betrayed a consternation which was particularly laughable in so large and ferocious-looking a creature. Only after cautious approaches and much hesitation was he induced again to lay hold of the stick. This behavior showed very clearly that the stick, while displaying none but the properties he was familiar with, was not regarded by him as an active agent, but that when it suddenly inflicted a pain in a way never before experienced from an inanimate object, he was led for the moment to class it with animate objects, and to regard it as capable of again doing him injury. Similarly, in the mind of the primitive man, knowing scarcely more of natural causation than a dog, the anomalous behavior of an object previously classed as inanimate suggests animation. The idea of voluntary action is made nascent, and there arises a tendency to regard the object with alarm, lest it should act in some other unexpected and perhaps mischievous way. The vague notion of animation thus aroused will obviously become a more definite notion as fast as the development of the ghost theory furnishes a specific agency to which the anomalous behavior can be ascribed."

This conduct of the dog, which every one must have observed under similar circumstances, corresponds to that of the savage who worshiped an anchor which had been cast ashore, and on which he had hurt himself when he first came in contact with it. Superstitious fear of this sort prevails most among men of the lowest order of intelligence, or in that stage of society in which human beings are psychically least removed from beasts. In proportion as they rise in the scale of existence and unfold their mental faculties, the more they free themselves from the tyranny of the supernatural. The terror of the dog hurt by the stick was out of all proportion to the pain inflicted, and arose solely from the fact that it was produced by a mysterious cause; it was fear intensified by the intervention of a ghostly element, and thus working upon the imagination it assumed the nature of religious awe. The case is analogous to that of a big, burly, brutal savage trembling before a rude stock or stone, or a Neapolitan bandit cowering before an image of the Virgin or kissing devoutly the feet of a crucifix.

The other illustration given by Herbert Spencer is that of a retriever, who, associating the fetching of game with the pleasure of the person to whom she brought it, would often fetch various objects and lay them at her master's feet; and "this had become in her mind an act of propitiation."

Still more interesting and instructive are Mr. Romanes's experiments with a Skye terrier. This dog, which was exceedingly intelligent and therefore an excellent subject for psychological study, "used to play with dry bones, by tossing them in the air, throwing them to a distance, and generally giving them the appearance of animation, in order to give himself the ideal pleasure of worrying them. On one occasion, therefore, I tied a long and fine thread to a dry bone and gave him the latter to play with. After he had tossed it about for a short time I took the opportunity, when it had fallen at a distance from him and while he was following it up, of gently drawing it away from him by means of the long, invisible thread. Instantly his whole demeanor changed. The bone, which he had previously pretended to be alive, began to look as if it were really alive, and his astonishment knew no bounds. He first approached it with nervous caution, but, as the slow receding motion continued and he became quite certain that the movement could not be accounted for by any residuum of force which he had himself communicated, his astonishment developed into dread, and he ran to conceal himself under some articles of furniture, there to behold at a distance the 'uncanny' spectacle of a dry bone coming to life." In this instance we have the exercise of close observation, judgment, reason, and imagination culminating in the exhibition of superstitious fear—all the elements, in short, which constitute religious sentiment in its crudest form.

Animals are afraid of darkness for the same reason that children are. Thunder, lightning, and other violent meteorological phenomena, which inspire the primitive man with awe and therefore play a prominent part in the evolution of early mythology, produce a similar impression upon many of the lower animals, simply because they are mysterious noises which appeal to the imagination and stimulate the mythopœic faculty. Mr. Romanes states that "on one occasion, when a number of apples were being shot out of bags upon the wooden floor of an apple-room, the sound in the house as each bag was shot closely resembled that of distant thunder." A setter was greatly alarmed at the noise until he was taken to the apple-room and shown the cause of it, after which "his dread entirely left him, and on again returning to the house he listened to the rumbling with all cheerfulness." Dogs and horses can be completely cured of their fear of thunder by being present at artillery practice; they imagine that they now know what produces the dreadful roar, and are henceforth free from all apprehension concerning it.

To some extent this sense of the supernatural seems to enter into the sphere of pure imagination and to excite in the minds of animals those vague feelings of anxiety and alarm arising from mere figments of the brain and characterized as superstition. The following incident, "illustrating the instinctive fear of death and consciousness of its presence manifested by birds," is related by Buist: "A hen canary died, was buried, the nesting establishment broken up, the surviving cock bird removed to a new cage, and the hatching cage itself thoroughly cleansed and purified, and put aside till the following spring. Never, however, could any bird afterward endure being placed in that cage. They fought and struggled to get out, and, if all in vain their efforts, they moped, huddling close together, thoroughly unhappy, refusing to be comforted by any amount of sunshine, companionship, or dainty food." The experiment was tried with foreign birds, that had not been in the house when the death of the hen occurred, and could not, therefore, have known anything of the melancholy event by observation. The result, however, was always the same. "For the future that cage to them was haunted."

It is a common belief that many animals can see ghosts and future events. Justinus Kerner declares (Die Seherin von Prevorst, i, 125) that they are endowed with second sight, and that numerous facts can be adduced in proof of it. This uncanny faculty is supposed to be especially strong in dogs and horses. Storks, too, are known to have foreseen the burning of houses on which they had been wont to build their nests, and to have abandoned them, taking up their abode on other buildings or on trees in the vicinity. No sooner had the anticipated conflagration taken place, and a new house been erected on the same site, than they returned and built their nests on it as heretofore. That Balaam's ass perceived the angel, which was beyond the ken of the prophet, ought to suffice to convince every believer in the plenary inspiration of the Bible of the specter-seeing powers of the lower animals. The ghost stories told of dogs and horses are quite as numerous and well authenticated as those which have been told of men. There is no psychological theory of apparitions that does not explain these strange phenomena as satisfactorily in beasts as in human beings. The night side of Nature casts its gloom over both.

Of course, if religion is a direct and special revelation to man, then no sentient creature prior and inferior to him could have any share in it. The hypothesis of a pure primitive monotheism, of which all polytheistic systems of belief are mere distortions and degradations, would also tend to exclude the lower animals from the possession of religious sentiment by showing that the religious history of the race has been a downward instead of an upward movement, a corruption instead of an evolution. Its growth would not correspond to the growth of intelligence, and it could no longer be studied as a psychological phenomenon, but would be removed at once from the province of scientific investigation. There can be no science of the supernatural, since science recognizes only the operation of natural laws. A miracle that can be explained, as the rationalistic school of theology has attempted to do, ceases thereby to be a miracle. The essence of religion is mystery; the sole aim of science is to clear up and thus do away with mysteries—a goal which it is always tending toward but will never reach, for the same reason that an asymptotic line never meets the curve which it is constantly approaching.

SCIENCE AS A FACTOR IN AGRICULTURE.*

By M. BERTHELOT,
OF THE INSTITUTE OF FRANCE.

GULLIVER relates that in the course of his travels he found a curious country which was governed entirely by academies, according to the most exact rules of science and reason. These bodies had attempted to reform the whole social organization. For the superannuated principles of the old and good agriculture, especially, they had substituted ingenious inventions based on modern discoveries. This was a hundred and fifty years ago, when, instead of digging the ground by the old-fashioned processes, machines had been introduced by the aid of which one man could do the work of several. The cultivation of the soil was carried on by new methods, and the history of English agriculture in the eighteenth century shows that the author intended in the romance to criticise by his fable the first attempts at chemical cultivation. Fair weather and rain, according to the satire, did not escape the innovators. The flying island of Laputa, held suspended above any particular point, permitted it to be withdrawn or submitted at will to the action of the sun. In short, the people of this ideal country had everywhere suppressed or corrected the action of Nature. The effects of this conduct, says Swift, were not long in making themselves felt. The land was miserably devastated. The people, in rags, lived in ruined huts and were dying of hunger, while they were kept in obedience by terror.

Such is the view under which the writers of the day regarded the first preludes of scientific agriculture; and I do not know that there is any need of going very far to find well-informed persons still infected with similar prejudices. But the general opinion has changed; the benefits derived from science have been such, and they have so transformed society in the nineteenth century, that no enlightened mind would dare to-day to use the ironical language of the author of Gulliver.

In truth, I am not sure that our great-nephews may not suc-

* Presidential address before the National Agricultural Society of France, July 6, 1892.

ceed some day in finding a way of regulating the seasons; some Americans already profess to be able to produce rain at will by means of dynamite. But their hypotheses, resuscitated from the notions of the Romans concerning the influence of great battles on the atmosphere, do not seem to have as yet been confirmed by experiment. But, on the other hand, the innovations that were criticised so sharply by the English humorist are in our days becoming the bases of field labors.

Scientific agriculture is gradually becoming more fully substituted for the agriculture of tradition, and it is adding in an unanticipated degree to the wealth of nations.

To the progress of this art, which is more manifest every day, our society has never ceased to lend the most active aid, both through the individual labors of its members and by prizes and incentives offered by it to inventors. It has zealously given its assistance to all the great innovations foreseen in the last century by some advanced minds, which the literary critics of the time turned into derision, but which have been especially developed during the past fifty years.

The advance of material science has, in fact, served as the basis of this surprising metamorphosis of agricultural practices which we witness and admire; and the mental and moral advance of the human mind has likewise transformed under our very eyes the education of the peasant, now raised to the dignity of a citizen. Every day he is gaining a closer acquaintance with science; he is learning to take advantage of its teachings for the increase of his production and for the amelioration of the conditions of his formerly so miserable existence. Three sciences in particular have contributed to this evolution of agriculture—mechanics, chemistry, and physiology. The endlessly various agricultural machines permit us to sow, till, and harvest over large surfaces, and with a small expenditure of human manipulation. The productive force of Nature has thereby been wonderfully increased.

But the machines of themselves create nothing; they are only applied to products already elaborated under the operation of natural forces. The processes which preside at this elaboration, the manner in which the plants are fed at the expense of the air, water, and soil, to serve afterward as food for animals, have long been mysteries. It has hardly been a century since they began to be revealed to us by chemistry, which they could not have been earlier, so long as we were not acquainted with the real chemical elements common to plants and animals, and had not discovered the secret of their passage through living organisms. Chemistry exposed this secret when it disclosed the existence of the elements themselves; it has taught us to recognize them and to measure their proportions in plants and animals; it has established, first, the fundamental and unforeseen truth that the combination of the elements under the form of organic compounds takes place only in plants to the exclusion of animals, for which plants are ultimately destined to serve as food. The mysteries of the production of useful plants and of the feeding of domestic animals have been unveiled by it; and these truths, so simple in our view, have been fruitful in applications.

Without enlarging upon a subject that would demand the most ample development, it will suffice to recollect that the constituent elements of plants have been divided into two groups: in one, such substances as oxygen, the carbon of carbonic acid, the hydrogen of water, and in a certain proportion the nitrogen of the air, are borrowed from the atmosphere, which can furnish them in unlimited quantities. Others, like the alkalies, lime, silica, iron, and a part of the nitrogen, are drawn from the soil. Removed with the crops, they should be restored to it, under penalty of a more or less rapid exhaustion. Each plant requires special elements; and it is necessary in its cultivation to be assured that the soil already has them, or to furnish them to it. Hence the long-disputed utility of chemical fertilizers; in them resides the whole secret of the indefinite maintenance of the land and the entire art of intensive cultivation.

But, while mechanics is a useful auxiliary to agriculture, and while the co-operation of chemistry is continually required, there is another science of still higher importance, because it presides over life itself in the animal as well as in the vegetable kingdom. You have named it *physiology*. You all know to what extent a knowledge of it is indispensable in order to define the conditions of animal and vegetable production, and to assure the normal development of living beings. You all know the importance of hygiene in society for securing the health of men and then of animals, and even of plants. Its function, long misconceived, is conspicuous now in all eyes; and it is one of the triumphs of science that it has been able to prolong the duration of human life, to secure immunity of our domestic animals against epidemics, and to extend its protection against the diseases which are destroying our field products and are threatening the annihilation of agricultural crops.

But the preservation of the products is not all. We need also to learn how to multiply productive beings; and in this field, too, science has, by the application of methods of selection, realized most marvelous progress in agriculture. Not only has intensive cultivation taught us how to draw a larger return than formerly from a particular soil and a given surface, but by the selection of seeds, we have doubled and tripled the formation of sugar in beet roots; by like selections, the production of the potato has been augmented; and we are seeking, with certainty of success, yet more considerable increase in the production of wheat. No less progress is reached in the production of fruits and vegetables, and of cattle, to the daily amelioration of the general condition of the human race.

This advance has been promoted, partly by close acquaintance with the general laws of living Nature, as revealed by disinterested science—laws which are the essential foundation of every application; and equally, and in a way no less worthy of admiration, by the efforts of inventors, those men of practical ingenuity who labor at the same time for the increase of their own fortunes and for the good and profit of mankind.

But,besides discovering important scientific truths and devising profitable applications of them, the inventor needs to have a popular support; and it is, above all, important that the application of his inventions shall be made seriously by educated and intelligent populations, ready to receive and to propagate all useful ideas. To this end the sphere of public instruction has been enlarged; and, besides the elementary knowledge hitherto required, and the moral and civic precepts fitted to make intelligent voters, our educational schemes of the present time include fundamental scientific principles, the knowledge of which is indispensable for hygiene, industry, and agriculture. All civilized peoples have recognized the importance of such teaching, and democracies, more than any other governments, have thus expanded the courses of popular instruction.

The good old times of ignorance raised to a principle have passed away. Science can not be reserved for a narrow oligarchy; all should be associated in it to the greatest possible extent, because knowledge of that kind is necessary for the advancement of the applications, an advancement which is hindered by ignorance. It is so because it is important that all the citizens of a free country shall share in the highest ideal. No ideal is superior to that of agriculture. Country life is the normal type of human life. In it only can manhood be developed in its plenitude. Country life favors at once material health of the body and moral soundness of mind. The robust, industrious, and intelligent countryman has always constituted the strength of nations, and of France in particular; through him we have survived many trials and catastrophes; and through the countryman, active, intelligent, and instructive, we shall maintain the prosperity and greatness of our country.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

HABITS OF THE GARTER SNAKE.

By ALFRED GOLDSBOROUGH MAYER.

WITH DRAWINGS BY THE AUTHOR.

AMONG those many creatures which know our fields and forests for their homes, is the little garter snake; or, as naturalists would have us dub him, *Eutænia sirtalis.* If one will but overcome a deep-rooted antipathy to crawling things, and will exchange the city's heat and turmoil for a few weeks of outing in the pure air of our sweet-scented fields, and make our little friend's acquaintance, much that the observer will not willingly forget will be his reward. When the snake is full grown, it is usually a little less than three feet long. The color is very variable, the usual body hues being brownish olive, sometimes with darker patches upon the sides, and generally there is a lighter yellowish streak down the middle of the back.

The belly plates are greenish blue or yellow, and the tongue is bright red, tipped with jet black. When angry, the snake spreads out its easily movable ribs, so as to make itself as broad and ugly as possible, and then one sees patches of white flecks between the scales on the sides. The general effect of the markings is so much like that of the ground upon which the reptile is crawling that even an observant naturalist rarely sees anything of his snakeship until he finds him almost under foot. All snakes crawl by side twists, and not by up and down undulations. They move themselves along by taking advantage of the friction between the sharp edges of the abdominal plates and the ground. The numerous ribs which can be moved forward and backward, as well as up and down, aid them greatly in their progress; and all the movements are performed with such gliding grace that one imagines the serpent to be impelled onward by some hidden, mysterious force. Place the snake upon a smooth glass surface, however, and it writhes and squirms in a helpless fashion. The garter snake is an excellent swimmer, making rapid progress through the water by means of a rhythmical sinusoidal movement of the submerged body, the little head being always just above the surface. It is a lazy creature, possessed of little desire to see the world, for it rarely wanders far from the place of its birth, as long as food remains abundant. It loves the sunny borders of swamps and ponds, where frogs and earthworms abound, and where it may bask ex-

Fig. 1.—Head of Garter Snake.

posed to the hot glare of the noonday sun, or seek a safe retreat beneath fallen logs or among the crevices of rocks. Its one idea is to warm up its cold blood by heat borrowed from the sun, and its life is one of apathetic indolence, except when in search of prey. Then the serpent steals stealthily through the grass; every now and again its slender neck elevates, and the cold, stony eyes dart a hasty glance to right and left. The red tongue flashes forth two or three times and it renews the search. And now, down beside the mossy bank of the brook, it espies a luckless frog, unconscious of the gliding foe behind. The snake half coils, then springs, and seizes its victim in a viselike grip. Struggles only serve to drive in the little needlelike teeth deeper and deeper, for they are all pointed backward, as one may see by looking at the picture of the skull (Fig. 2). The serpent recoils, dragging the resisting prey more and more hopelessly away from its watery retreat. The method of swallowing is a very simple one, although, if the frog be large, more than half an hour may be consumed in the process. The two bones of the lower jaw are separate and capable of independent movement; so the reptile loosens its hold upon one side of its jaw, and, pushing that side forward as far as possible, it drives the teeth in again, and then draws the jaw back to its original position. The result is that the prey is drawn down by the movement. The process is then repeated by the other half of the jaw, thus inevitably forcing the victim inward. The snake's skin stretches enormously, and the jaw is, of course, dislocated, but the extensible ligaments hold the bones together. The disproportion between the diameter of the frog and the serpent's slender neck is indeed marvelous, and snakes have been observed to split themselves open by attempting too ambitious a mouthful. After perhaps half an hour of laborious contortions, all that is seen of the poor frog is a great swelling that the contracting muscles are rapidly forcing down the reptile's neck. If one liberates the captured frog before it is too late, the wretched animal often seems so overcome by fear, or perhaps stupefied by the serpent's saliva, that it will not leap, but crawls in a painful manner. We must not allow ourselves to be duped into a mistaken sympathy, however, for such is the poetic justice of the case. Large frogs

Fig. 2.—Skull of Garter Snake.

esteem small snakes a particular delicacy. After such a dinner as the above, the snake seeks some safe retreat and there lapses into a more or less quiescent state for about a week, at the end of which time it is ready to add another victim to its list. Frogs are not, however, the only food of the garter snakes; they will also feed upon newts or toads, they are very partial to earthworms, and in rare instances will resort to cannibalism. They never feed upon insects, and as far as my observation goes will not attack birds or mice. There is a great difference between the arrangement of the teeth in harmless and venomous snakes. The harmless garter snake, for example, possesses four rows of little needlelike teeth upon its upper jaw. All these teeth are of about the same size, and are pointed backward. A bite from such a snake would leave an impression similar to that shown in A, Fig. 3, where the dots represent the perforations made by the teeth. Venomous snakes, on the other hand, possess much fewer teeth, and in the outer rows we find several large fangs. An impression from a snake of this sort is shown in Fig. 3, B. Several times during the summer the garter snake molts. Almost a week before this takes place, the horny layer of the old epidermis begins to separate from the underlying skin. This separation is caused by numerous little hairlike structures, called lifting hairs, which develop uniformly all over the underlying epidermis and push the old skin away from it, so that it hangs loosely all over the body. The snake becomes torpid and irritable. The eyes lose their luster and become milky in appearance, for the cuticula over the eyes is shed also. Finally, the skin breaks around the lips and the serpent proceeds to cast it off, which it usually accomplishes in about an hour by writhing slowly through the grass, so that the whole skin is turned inside out, and pulled off backward like the finger of a glove.

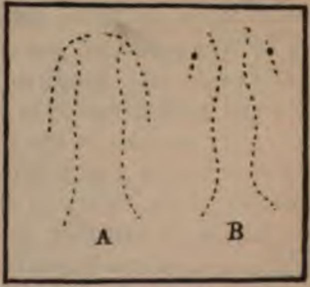

Fig. 3.—Forms of Snake-bites.

The mating season of the garter snake comes about the middle of April, very soon after it awakens from the winter's hibernation. The males possess the mysterious power of tracking the females through the grass, and will follow after all the sinuosities of their paths with the greatest certainty. At this season both sexes emit a very rank and disgusting odor, especially when irritated.

During the months of June and July the females may be observed basking themselves in the hottest sun. They are very easily angered at this time, and generally make a bold front, snapping viciously at the intruder. They refuse to eat in captivity for about a month before the birth of the young, which usually occurs during the latter half of August. The young snakes are born alive, or rather break through their egg membranes immediately upon being born. The number of young produced by a single full-grown snake is usually about fifty, although, according to the observations of Mr. C. Few Seiss, it may vary from thirteen to eighty. To give an idea of the enormous dangers which threaten the lives of the little snakes, it is easily calculated that if the garter snake arrive at maturity at the end of three years, and then produce an average of forty young at a birth, a single pair of mature snakes will have become the progenitors of over one hundred and seventy thousand at the end of the eighth year.

Fig. 4.—Young Garter Snake, One Day Old. Natural size.

The young serpents are usually about five and a half inches long; they are lively, active little fellows, colored very much like their parents, and have large, bright eyes, which give them a staring, surprised look, for snakes have no eyelids and can, therefore, never vary their expression. At the end of two or three days they grow hungry enough to eat, and will pounce upon and devour earthworms with much avidity. Very amusing indeed is it when two little snakes seize upon opposite ends of the same worm, for the fight only ends when one of the serpents attempts to swallow his brother, worm and all. Earthworms, however, can not be their only food, for the garter snake is exceedingly abundant where earthworms are very rare, as in the Canada woods. I have never observed the mother snake guard her progeny, and believe that the little ones scatter immediately to seek their fortunes.

Early in October the garter snakes huddle together in convenient crevices where they hibernate for the winter. As the food of the garter snake consists very largely of frogs and toads, it is probably an enemy to the agriculturist. If we examine carefully the leaves of our trees in late August it will be found that a perfect leaf is indeed rare; very few have escaped the ravages of numerous insect enemies. In this fact we find but another example of the great law of interdependence of organisms. The greatest enemies of the leaves are the insects; frogs and toads depend upon insects for their food, and snakes, in their turn, feed upon frogs and toads. So that we see that the more snakes the more insects, and the fewer perfect leaves will we find in late summer.

GHOST WORSHIP AND TREE WORSHIP.*

By GRANT ALLEN.

I.

FROM the myth of Attis itself, with its strange old-world implications, let us turn our attention next to the more general subject of plant and tree worship, of which the special case of the Phrygian god would appear to be only a particular example.

It will be evident at once from what has gone before that I accept on the whole, without reservation of any kind, Mr. Frazer's main view as to the importance of tree spirits and the soul of vegetation in early religions. But, then, I also accept as proved almost beyond the possibility of doubt Mr. Herbert Spencer's luminous theory of the origin of polytheism from ghost worship and ancestor worship. Not only do I believe that Mr. Spencer has adequately made good his main thesis of the derivation of gods from heroic ancestors, but I have also received considerable encouragement in my faith to this effect from Mr. William Simpson's brilliant and admirable paper on The Worship of Death, a paper much less widely known among thinkers on this subject than it deserves to be. Mr. Simpson, who is the well-known special artist of the Illustrated London News, has been led by his direct observations in the many lands he has visited in the performance of his duties to form independently a theory identical in every essential respect with Mr. Herbert Spencer's. Examination of temples, or their equivalents, in endless lands, from China to Peru, has convinced him at last that in almost every case the temple begins as a tomb or shrine of a dead person, and the worship is primarily offered to the actual ghost of the man or woman interred within it.

Now, between these two views—Mr. Spencer's and Mr. Frazer's—I am aware there would appear at first sight to be an immense discrepancy. I believe Mr. Frazer himself, in particular, would regard them as nothing short of absolutely irreconcilable. To judge from one pregnant passage in The Golden Bough (vol. i, p. 253), Mr. Frazer would appear to hold that the earliest gods of mankind in the hunting and pastoral stage of society took the form of animals, and that, in the agricultural stage, gods were envisaged rather as corn or fruit trees, or assumed the shape of a human being representing the corn or fruit spirit. I can find no-

* From The Attis of Caius Valerius Catullus. Translated into English Verse, with Dissertations on the Myth of Attis, on the Origin of Tree Worship, and on the Galliambic Metre, by Grant Allen, B. A., formerly Postmaster of Merton College, Oxford. London: David Nutt. 1892.

where in any part of his epoch-making work a single phrase which would lead me to suppose he would willingly accept the theory of the affiliation of tree gods and spirits generally upon the ghosts of dead ancestors. Nevertheless, I believe such an affiliation to be not only possible, but natural and provable. It is the object of the present Excursus, indeed, to show in brief outline that the tree spirit and the corn spirit, like most other deities, originate in the ghost of the deified ancestor.

Let us begin by examining and endeavoring to understand a few cases of tree spirits in various mythologies. Virgil tells us in the Third Æneid how, on a certain occasion, Æneas was offering a sacrifice on a tumulus crowned with dogwood and myrtle bushes. He endeavored to pluck up some of these by the roots, in order to cover the altar, as was customary, with leaf-clad branches. As he did so, the first bush which he tore up astounded him by exuding drops of liquid blood, which trickled and fell upon the soil beneath. He tried again, and again the tree bled human gore. On the third trial, a groan was heard proceeding from the tumulus, and a voice assured Æneas that the barrow on which he stood covered the murdered remains of his friend Polydorus.

Now, in this typical and highly illustrative myth—no doubt an ancient and well-known story incorporated by Virgil in his great poem—we see that the tree which grows upon a barrow is itself regarded as the representative and embodiment of the dead man's soul, just as elsewhere the snake which glides from the tomb of Anchises is regarded as the embodied spirit of the hero, and just as the owls and bats which haunt sepulchral caves are often identified in all parts of the world with the souls of the departed.

Similar stories of bleeding or speaking trees or bushes occur abundantly elsewhere. "When the oak is being felled," says Aubrey, in his Remaines of Gentilisme, page 247, "it gives a kind of shriekes and groanes that may be heard a mile off, as if it were the genius of the oak lamenting. E. Wyld, Esqr., hath heard it severall times." Certain Indians, says Bastian, dare not cut a particular plant, because there comes out of it a red juice which they take for its blood. I myself remember hearing as a boy in Canada that wherever *Sanguinaria canadensis*, the common American bloodroot, grew in the woods, an Indian had once been buried, and that the red drops of juice which exuded from the stem when one picked the flowers were the dead man's blood. In Samoa, says Mr. Turner,* the special abode of Tuifiti, King of Fiji, was a grove of large and durable afzelia trees. "No one

* Turner's Samoa, p. 63.

dared to cut that timber. A story is told of a party from Upolu who once attempted it, and the consequence was that blood flowed from the tree, and that the sacrilegious strangers all took ill and died." Till 1855, says Mannhardt, there was a sacred larch tree at Nauders in the Tyrol, which was thought to bleed whenever it was cut. In some of these cases, it is true, we do not know that the trees grew on tumuli, but this point is specially noticed about Polydorus's dogwood, and is probably implied in the Samoan case, as I gather from the title given to the spirit as King of Fiji.

In other instances, however, this doubt does not exist; we are expressly told it is the souls of the dead which are believed to animate the bleeding or speaking trees. "The Dieyerie tribe of South Australia," says Mr. Frazer, "regard as very sacred certain trees which are supposed to be their fathers transformed; hence they will not cut the trees down, and protest against settlers doing so."

Again, we must remember that most early worship is offered directly to the spirits of ancestors in the expectation of definite benefits to be derived from their aid. In New Guinea, for example, where religion has hardly progressed at all beyond the most primitive stage of direct ancestor worship, Mr. Chalmers tells us "when the natives begin planting, they first take a bunch of bananas and sugar cane, and go to the center of the plantation and call over the names of the dead belonging to their family, adding, 'There is your food, your bananas and sugar cane; let our food grow well and let it be plentiful. If it does not grow well and plentifully you all will be full of shame, and so shall we.'" *

Abundant other evidence could be forthcoming, were it necessary, to show that the ancestral spirits are regarded by the most primitive types of men as causing the earth to bring forth fruit in due season. But I hardly think further formal proof of this proposition necessary.

But how did the ancestral ghosts acquire in the first instance this peculiar power of causing growth in vegetation? The explanation, it seems to me, though crude and barbaric, is a very simple and natural one. In the first place, in many of the earlier and more native forms of sepulture, the dead are buried under a tumulus or barrow. Such tumuli, of course, go back in time to a remote antiquity. Now, many circumstances would make vegetation upon the turf of the barrows exceptionally luxuriant. In the first place, the soil there has been largely piled up and labored; it consists for the most part of an accumulation of deep vegetable mold, gathered together from all the surrounding surface; and at an age when cultivation was wholly unknown—for tumuli, we

* Chalmers. Work and Adventure in New Guinea, p. 85.

have reason to know from the example of Ohio, began in the hunting stage of humanity—the burial mound would be almost certainly conspicuous, from this cause alone, for its exceptional greenness. In the second place, again, the body within would add to its fertility, the more so as a great chief was seldom committed to the tomb alone, but was usually accompanied to the grave, whose megalithic stone chamber was to serve as his future palace, by his slaves, his wives, and his other belongings. In the third place, too, animals would be slaughtered, and feasts would take place at the newly made barrow. The blood of the victims on such occasions is habitually poured out on the grave, or on the surface of the altar stone; offerings of meat, of fruit, of milk, of oil, are made there in abundance by trembling worshipers. These offerings would act, of course, as rich manures, and would encourage on the barrows an unusual wealth and luxuriance of vegetation. But primitive man knows nothing of the nature and action of manure. To him, the fact that grass grew greener and bushes spread faster on the tumulus of the dead would almost inevitably appear as an effect immediately due to the supernatural power of the ghost or spirit who dwelt within it. In all probability, the savage would envisage to himself the actual herbs and shrubs which so sprang upon the tumulus as the direct embodiment of the soul of his ancestor, or his departed chieftain.

Now, it could hardly be expected that any direct evidence of so abstruse a point as this would be forthcoming from books or the accounts of travelers. Yet, fortunately, however, I have been lucky enough to hit in an unexpected place upon one curious little bit of actual confirmation of this *a priori* suggestion. In his excellent work on Nether Lochaber, the Rev. Alexander Stewart, of Ballachulish, quotes and translates a Gaelic MSS. poem, collected by Mr. Macdonald, the minister of the parish of Fortingall, in Perthshire, one stanza of which runs as follows:

"And ever he saw that his maidens paid
 To the fairies their due on the *Fairy Knowe*,
Till the emerald sward was under the tread
 As velvet soft and all aglow
With wild flowers such as fairies cull,
Weaving their garlands and wreaths for the dance when the moon is full!"

Upon this suggestive verse Mr. Stewart makes a curious and important comment.

"The allusion to paying—

'The fairies their due on the fairy knowe,'

has reference to the custom, common enough on the western mainland and in some of the Hebrides some fifty years ago, and not altogether unknown perhaps even at the present day, of each maiden's pouring from her *cumanbleoghain*, or milking pail, evening and morning, on the fairy knowe, a little of the new-drawn milk from the cow, by way of propitiating the favor of the good people, and as a tribute the wisest, it was deemed, and most acceptable that could be rendered, and sooner or later sure to be repaid a thousandfold. The consequence was that these fairy knolls were clothed with a richer and more beautiful verdure than any other spot, howe or knowe, in the country, and the lacteal riches imbibed by the soil through this custom is even now visible in the vivid emerald green of a *shian* or fairy knoll whenever it is pointed out to you. This custom of pouring lacteal libations to the fairies on a particular spot deemed sacred to them, was known and practiced at some of the summer shielings in Lochaber within the memory of the people now living." *

Fully to appreciate the importance of this evidence we must remember that in almost every case, all over Britain, the "fairy knowe" is a chambered barrow, and that the fairies who emerge from it are the last fading relics in popular memory of the ghosts of stone age chiefs and chieftainesses. This idea, which I long ago put forward in an article in the Cornhill Magazine, entitled Who are the Fairies? has been proved to demonstration by Mr. Joseph Jacobs in the notes on the story of Childe Roland in his valuable collection of English Fairy Tales.

There is yet another way, however, in which the idea of special fertility must become necessarily connected in the savage mind with the graves of his ancestors. For we must remember that early worship almost invariably takes the form of offerings in kind at the tombs of dead chiefs or other revered persons. On this subject the Rev. Duff Macdonald, of Blantyre, in Central Africa (one of the ablest and most unprejudiced of missionary observers), says very significantly: "The ordinary offerings to the gods were just the ordinary food of the people.† The spirit of the deceased man is called Mulungu, and all the prayers and offerings of the living are presented to such spirits of the dead. It is here that we find the great center of native religion. The spirits of the dead are the gods of the living. It is the great tree at the veranda of the dead man's house that is their temple, and if no tree grow here they erect a little shade, and there perform their simple rites. If this spot become too public the offerings may be defiled, and the sanctuary will be removed to some carefully selected spot under some beautiful tree." In this we get some first hint of the origin of tree worship.

* Rev. A. Stewart. Nether Lochaber, pp. 20, 21.

† Africana, vol. i, p. 89.

Now, the ordinary food of the living would of course include grains, seeds, such fruits as bananas, plantains, or melons, and many other vegetable objects. Mr. Macdonald adds the significant note: "It is not considered necessary that these offerings be taken away by the spirits. It is sufficient that they are placed there, that the spirits may come and lick them." * He further mentions that on these same graves fowls may be offered by cutting the throat, and making the blood flow down. "When the fowl is killed," says he, "they simply lay it down at the prayer tree." A goat may be offered in the same way, or milk may be poured out at the foot of the sacred banyan. What is the implication? Why, naturally, seeds placed in newly turned soil over a dead body, and richly manured with constant supplies of blood and milk, would germinate freely and produce unusually fine crops of grain or fruit. Is it suggesting too much to hint that, in this almost universal rite, we may even see the ultimate origin of cultivation? Primitive man, careless of the future as he is, would scarcely be likely deliberately to retain seeds from one year to the next for the purpose of sowing them. It is his habit rather to eat and destroy with lavish prodigality whatever he possesses in the pure recklessness of the moment. Something must first show him that seeds produce an increase before he can think of keeping them and deliberately planting them.

It has usually been held, to be sure, that cultivation must have taken its rise from the accident of chance seeds being scattered about in the neighborhood of the hut or of the domestic manure-heap—the barbaric kitchen midden. This may be so, of course; but it seems to me at least equally probable that cultivation should have begun through the offerings of grains and fruits and seeds at the graves or barrows of departed ancestors. Certainly we see that fruits and seeds are constantly so offered by existing savages. We know that they are deposited under conditions most favorable to their growth and productivity. And we can hardly doubt that the luxuriance of the vegetation so produced would greatly strike the mind of the early savage, and would be implicitly assigned to the productive power of his dead ancestors. I shall show in the sequel that the presence of an informing ghost or spirit of vegetation is even considered essential to the growth of crops by existing savages, and that human victims are slain by them for the mere purpose of providing such indwelling deities. The ghost in fact plays in the ideas of early man the same part that guano and phosphates play to-day in the ideas of the educated scientific farmer.

Nor is this all; I will even venture to go one step further. Is

* Africana, vol. i, p. 95.

it not at least possible that in the minds of early men the fruitfulness of the sown crop may seem to depend upon the presence beneath the soil of the deified ancestor? I do not mean physically, as manure, for that idea is, of course, quite beyond the savage, but magically and supernaturally, as ghost and spirit. At first sight, to be sure, this seems a somewhat large and uncertain postulate. But if we reflect upon the nature of the evidence collected by Mr. Frazer, we shall see, I think, that the transition is a sufficiently simple and natural one. Primitive man may well have begun by scattering seeds as offerings on the graves of his relations. If these seeds germinated and grew successfully, as they would be pretty certain to do, he would at once, as if by instinct, accept the increase as the immediate gift of the dead ancestor. For he knows nothing beforehand about the nature of seeds or the laws of their germination. He doesn't even know, to start with, that seeds are necessary for the production of food plants. From this first step, however, it would be but a slight advance deliberately to produce and bury a god for the express purpose of fertilizing a sown crop. That gods were so produced, slain, and buried in fields, to insure fertility, we know now for certain. "The Kandhs," says Sir William Hunter,* "have many deities—race gods, tribe gods, family gods, and a multitude of malignant spirits—each one of whom must be appeased with blood. But their great divinity is the earth god, who represents the productive energy of Nature. Twice each year, at sowing time and at harvest, and in all special seasons of distress, the earth god required a human sacrifice. The duty of providing the victims rested with the lower race of outcasts attached to the Kandh village. Brahmans and Kandhs were the only two classes exempted from being sacrificed; and an ancient rule ordained that the offering must be bought with a price. Men of the lower race, attached to the villages, kidnapped victims from the plains; and it was a mark of respectability for a Kandh hamlet to keep a small stock in reserve, as they said, 'to meet sudden demands for atonement.' The victim, on being brought to the hamlet, was welcomed at every threshold, daintily fed, and kindly treated, till the fatal day arrived. He was then solemnly sacrificed to the earth god; the Kandhs shouting in his dying ear: 'We bought you with a price; no sin rests with us.' His flesh and blood were distributed among the village lands, a fragment being solemnly buried in each field in the newly turned furrows."

This passage is sufficiently striking in itself as evidence for our purpose; but Mr. Frazer has further shown good grounds for believing that the *meriah*, or victim selected for this purpose,

* Imperial Gazetteer of India, vol. vii, p. 207.

was not merely "daintily fed and kindly treated," but was also regarded by the Kandhs themselves in the light of a god or divine personage. Indeed, Kandhs in distress often sold their own children for victims, "considering the beatification of their souls certain, and their death for the benefit of mankind the most honorable possible." "The victims," says Mr. Frazer, "being regarded as consecrated beings, were treated with extreme affection mingled with deference, and were welcomed wherever they went. A meriah youth, on attaining maturity, was generally given a wife who was herself usually a meriah or victim, and with her he received a portion of land and farm stock. . . . The periodical sacrifices were generally arranged by tribes and divisions of tribes, so that each head of a family was enabled once a year to procure a shred of flesh for his fields, generally about the time when his chief crop was laid down." *

Still more striking is the account of the way in which bits of the body were disposed of after the sacrifice. "Flesh cut from the victim was instantly taken home by the persons who had been deputed by each village to bring it. To secure its rapid arrival it was sometimes forwarded by relays of men, and conveyed with postal fleetness fifty or sixty miles. In each village, all who stayed at home fasted rigidly until the flesh arrived. The bearer deposited it in the place of public assembly, where it was received by the priest and the heads of families. The priest divided it into two portions, one of which he offered to the earth goddess by burying it in a hole in the ground, with his back turned, and without looking; then each man added a little earth to bury it, and the priest poured water on the spot from a full gourd." (Notice here the simulation of burial, the formation of a tumulus, and the pouring of libations.) "The other portion of flesh he divided into as many shares as there were heads of houses present. Each head of a house rolled his shred of flesh in leaves and buried it in his favorite field, placing it in the earth behind his back, and without looking." † The remainder of the body—head, bones, and bowels—was afterward burned on a funeral pile. The ashes were scattered over the fields, laid as paste over the houses and granaries, or mixed with the new corn to preserve it from insects. Here we would seem to have the superposition of a custom derived from cremation on a still earlier rite derived from burial and the formation of the barrow.

Of all these ceremonies, Mr. Frazer rightly remarks that they can not be explained as merely parts of a propitiatory sacrifice. The burial of the flesh by each householder in his own fields im-

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* Frazer, *ubi supra*, vol. i, p. 385, quoting Macpherson, Memorials of Service in India, p. 115.

† The Golden Bough, vol. i, p. 385.

plies that to the body of the meriah there was rather ascribed "a direct or intrinsic power of making the crops to grow." In other words, the flesh and ashes of the victim were believed to be endowed with a magical or physical power of fertilizing the land. Again, intrinsic supernatural power as an attribute of the meriah appears in the sovereign virtue believed to reside in anything that came from his person, as his hair or spittle. The ascription of such power to the meriah indicates that he was much more than a mere man sacrificed to propitiate an angry deity. Once more, the extreme reverence paid him would point to the same conclusion. Major Campbell speaks of the meriah as "being regarded as something more than mortal"; and Major Macpherson says that "a species of reverence which it is not easy to distinguish from adoration is paid to him." In short, by common consent of our authorities, the meriah appears to have been regarded as himself divine.

To a certain extent, then, I would venture to differ, with all deference and humility, as of a scholar toward his master, from Mr. Frazer, in the explanation which he gives of this and sundry kindred ceremonies. To him the human god, who is so frequently sacrified for the benefit of the crops, is envisaged as primarily the embodiment of vegetation; I would make bold to suggest, on the contrary, that the corn or other crop is rather itself regarded as the embodiment or ghost of the divine personage.

Here are some more very striking cases that look that way, extracted once more from Mr. Frazer's vast repertory: "A West African queen used to sacrifice a man and woman in the month of March. They were killed with spades and hoes, and their bodies buried in the middle of a field which had just been tilled. At Lagos, in Guinea, it was the custom annually to impale a young girl alive, soon after the spring equinox, in order to secure good crops. Along with her were sacrificed sheep and goats, which with yams, heads of maize, and plantains, were hung on stakes on each side of her. The victims were bred up for the purpose in the king's seraglio, and their minds had been so powerfully wrought upon by the fetich men that they went cheerfully to their fate. A similar sacrifice is still annually offered at Benin, Guinea. The Marimos, a Bechuana tribe, sacrifice a human being for the crops. The victim chosen is generally a short, stout man. He is seized by violence, or intoxicated, and taken to the fields, where he is killed among the wheat to serve as 'seed' (so they phrase it). After his blood has coagulated in the sun, it is burned along with the frontal bone, the flesh attached to it, and the brain; the ashes are then scattered over the ground to fertilize it. The rest of the body is eaten."*

* The Golden Bough, vol. i, p. 383.

Now, it is true that in any case the identification of ghost and crop is very complete, for, as Mr. Frazer remarks, the Mexicans killed young victims for the young corn and old ones for the ripe corn. The Marimos thus sacrificed as "seed" a short fat man, the shortness of his stature corresponding to that of the young corn, his fatness to the condition which it is desired that the crops may attain. Again, says the same high authority, the identification of the victim with the corn comes out in the African custom of killing him with spades and hoes, and the Mexican custom of grinding him like corn between two stones. Still the point which I wish here particularly to suggest as important is, that cultivation may have begun on the actual tumuli of the dead, and that the annual god who was sacrificed for the fertility of the crops may have been, as it were, a deliberately designed and artificially produced deity, who replaced the ancestral spirit of early ages. Early man said to himself: "Food plants grew best where they grow on the grave of a divine chieftain: let us make such a grave in every field, and the spirit we put in it will insure fertility." Just as cultivation itself is a substitution of artificial for natural growth, so the annual slain god is, I believe, an artificial substitute for the natural dead chieftain in his sacrificial barrow.

As bearing once more on the supposed connection between ghosts and crops, which we shall presently see resolves itself later on into a connection between trees and crops, we might bring up the curious ceremony of the gardens of Adonis, which would seem to be a survival of the same idea that vegetation springs directly from the body of the divine person. The death of the Syrian god was annually lamented with bitter wailing by the women of the country. Images of Adonis, dressed to resemble corpses, and, no doubt, replacing the actual corpse of the original annual Adonis victim, as the Attis effigies replaced the original slain Attis, were carried out to burial, and then thrown into the sea or into springs of water. What is more noteworthy, however, is the fact that baskets or pots were filled with earth in which wheat, barley, lettuces, and various flowers—presumably anemones among the number—were sown and tended for eight days, chiefly by women. Fostered by the sun's heat, the plants shot up rapidly, but, having no depth of root, withered as rapidly away, and at the end of eight days were carried out with the images of the dead Adonis, and flung with them into the sea or into springs. We do not know whether these gardens were actually grown on the top of the effigies, but this would seem probable, says Mr. Frazer, from analogies elsewhere; for in Sicily the women, at the approach of Easter, sow wheat, lentils, and canary seed in plates, which are kept in the dark, and watered every second day. The plants shoot up quickly. The stalks are then tied together with red ribbons, and the plates containing them are placed on the sepulchres, which with effigies of the dead Christ are made up in Roman Catholic and Greek churches on Good Friday. In both these cases the plants would seem to be envisaged as springing from the actual body of the dead god. Indeed, Eustathius speaks of the gardens of Adonis as being placed on the grave of the hero.*

Furthermore, another connection may be shown to exist between plants or trees and ghosts. We know that it is a frequent practice deliberately to put in herbs, shrubs, or trees on the graves of the dead. How far back in history or in savage life this practice may extend I am unfortunately not in a position to state. In Roman Catholic countries, however, the planting of flowers on the graves of the dead takes place usually on the *jour des morts,* a custom which would seem to argue for it an immense antiquity; for though it is usual among Catholics to explain the *jour des morts* as a *fête* of comparatively recent origin, definitely introduced by a particular saint at a particular period, its analogy to similar celebrations elsewhere shows that it is really a surviving relic of a very ancient form of Manes worship. In Algeria, again, I observed, the Arab women went on Fridays to plant flowers on the graves of their immediate dead; and the same point is noted about the same place by Miss Seguin.† The *koubbas,* or little dome-shaped tombs of Mohammedan saints, so common throughout North Africa, are almost always inclosed by a low stone wall, which marks off the *temenos,* and are usually overshadowed by palm trees deliberately planted there.

All through southern Europe, indeed, the cypress is the common emblem of the grave and the churchyard, as the yew is in our more northern climates. And this connection brings me more directly into closer contact with our proper subject, the pine tree of Attis. I think there is evidence that from a very early age evergreens of one sort or another were planted upon barrows. Those who have read The Golden Bough will not fail to see the significance of this pregnant association. Evergreens are plants which retain their vegetation—show the life of their tree spirit—through the long sleep of winter. The mistletoe, as Mr. Frazer has ably shown, owes its special sanctity to the fact that it holds, as it were, the soul of the tree in itself, while all the branches around it are bare and lifeless. As soon, then, as primitive men had begun definitely to associate the ghost or god with the idea of vegetation, nothing could be more natural for them than to plant such evergreens on graves or barrows. Now all through southern England we find many examples of round barrows planted with

* The Golden Bough, vol. i, p. 295.

† Walks in Algiers, p. 280.

Scotch firs. This is the more remarkable, as the Scotch fir is not considered by botanists an indigenous tree to southern Britain; nay, more, Mr. Darwin has shown that it can not live on open or exposed situations where deer or cattle graze unless it is protected by a fenced inclosure. Sheep and cows and stags nibble it down to the ground in its earliest ages, so that Scotch firs may be found in open spaces on English heaths, showing many annual rings of growth, but eaten close to the soil by the ever-active herbivores.* Hence we must conclude (since barrows stand for the most part in extremely open, heathy country) that not only were the Scotch firs deliberately planted on the tumuli, but also that they were carefully protected by fences till a relatively late or even historical period. A particularly fine example of a round barrow overgrown with ancient Scotch firs is to be found near St. Martha's Chapel at Guildford. Another, a little less striking, but equally characteristic, stands on the summit of Milton Heath, near Dorking. It is faced on the opposite side of the road by a second and extremely degraded barrow, also marked by a conspicuous clump of pine trees. A group of very ancient and gnarled Scotch firs, known as the Glory, on the hill just behind Dorking to the south, forms another and still more noble example of the same combination. But I need not labor the point. Whoever knows our southern counties knows that barrows and Scotch firs go together almost universally. Indeed, I believe there are no *very* old firs in Surrey, Kent, or Hampshire that do not so stand on antique tumuli.

Now, as these trees are not indigenous to southern England, and as they could only have grown under the protection of a fence, I conclude that the ancestors of the existing firs were planted there when the barrows were first formed, were long secured from harm by a belief in their sanctity, and have kept up their race ever since, either by seeds or shoots, under cover of the old trees, to the present day. The Scotch fir is in England the sacred tree of the barrows.

Have we here, then, I would venture to ask, the origin of the sacred pine tree of Attis? I incline to believe that we have. As the pine tree is planted upon tumuli in many parts of the world, and is often protected by walls or hedges, it would seem to be naturally associated with the ghost, and to become, in the expressive phrase used by Mr. Macdonald, the "prayer tree" of the departed.

This, then, I take it, is the true explanation of the prominent part which the pine tree plays in the myth and ritual of Attis. Nor is it any objection to our view that Attis is also apparently envisaged in an alternative form both as a man or god, and as

* Darwin, Origin of Species, p. 56.

an embodied corn spirit. Such frank inconsistencies, which to us would seem fatal to the success of any theory, appear perfectly natural to the easy-going mind of primitive man. To him, the ghost may reasonably appear in any one of many alternative forms. He recognizes it equally in the snake that glides from under the stones of the tumulus, in the beast or bird that crosses his path after the offering of prayer to his deified ancestor, in the shadowy form that eludes his prying gaze amid the dense shades of the primeval forest, and in the vague human shape that stands beside him in his dreams, and whispers into his ear uncertain warnings or dim promises for the future. So, too, with plants. From one point of view, Attis is the corn that springs directly from the dead god's body; but from another point of view he is the pine tree that grows with waving boughs above the grassy barrow of the self-slain or self-devoted hero. Whatever comes from the dead body, whatever seems to stand in close relation to it, is regarded in the simple philosophy of these *naïf* worshipers as an embodiment or representative of the multiform deity. Thus, in the extant descriptions of the ceremonies of the Attis festival, we get traces or glimpses of every one in turn among these alternative conceptions. Attis is first of all envisaged as a human being—a young man who dies a violent death in a particular fashion. This death by self-mutilation seems to point to a further development of the same idea which lies at the bottom of the Kandh practice of buying the victim and paying for him with a price—namely, it implies a certain obvious element of consent and self-sacrifice—a realization of the principle that "it is expedient that one man should die for the people." So the West African victims, we are told, went gladly to their doom; and so, too, in Phœnician and Carthaginian history we often find that in great crises of the state young men of good family volunteered to devote themselves as victims to Baal on behalf of the fatherland. Once more, after his death, Attis is changed into a pine tree; and his festival is inaugurated by cutting down just such a pine tree in the woods, which is accepted as in a certain sense the embodiment and representative of the dead Attis. But still the human embodiment remains side by side to the end with the vegetable one; for the effigy of a young man is also attached to the middle of the tree, as the young man himself was no doubt attached in still earlier practice. All this is comprehensible enough when we recollect that the original corn and the original pine tree may actually have grown out of the body or barrow of the self-devoted man god in earlier times, and that the ceremonies described for us by late classical writers represent very mitigated and modified forms of extremely ancient and savage rites.

There is also an interesting transitional stage, it seems to me, between tree worship pure and simple and its offspring, grove worship. This transition from the special cult of the single tree to the general cult of the wood or forest, comes about, I take it, through the medium of the *temenos*. And what is the *temenos?* Well, I think, we get the first clew toward an answer to that question in Mr. William Simpson's brilliant identification of the temple and the tomb, already so well foreshadowed by Mr. Herbert Spencer. For if the temple is only a magnified tomb where offerings on a large scale are habitually made to the sainted ghost or the deified ancestor, then clearly the *temenos* is just the representative of the inclosed space surrounded by a wall about the primitive barrow. In the center stands the temple—that is to say, the actual tomb itself; all round it stand the sacred trees planted upon or about the holy grave, and regarded as the actual representatives of the deified hero. These trees form, I think, the great link of transition to the sacred grove. For when once people had grown accustomed to the prime idea that certain trees were to be considered as sacred from their close connection with a deified ancestor, it would be but a slight and natural step to regard other trees as sacred because they stood near a holy site, or even to manufacture an artificial sanctity by planting trees about a cenotaph temple. Thus, when Xenophon, for instance, built a temple to Artemis, and planted around it a grove of many kinds of fruit trees, and placed in it an altar and an image of the goddess, nobody for one moment would pretend to suppose that he erected it over the body of an actual dead Artemis. But the point is, that men would never have begun building temples and consecrating groves at all, if they had not first built houses for the dead god-chief, and planted trees and shrubs and flowers and gardens upon his venerated tumulus.

And this point leads me up to an important qualification. It is not necessarily true—nay, it is demonstrably false—that every individual god was originally a dead man. In late stages of culture, gods are quite unmistakably manufactured out of abstractions, as when the Roman Senate decreed in due form the erection of a temple to the purely factitious goddess Concordia. But nobody could ever have thought of making Concordia or any other like abstraction into a deity, unless they had been first thoroughly familiarized with the idea of many gods, derived originally from the deified ancestor or chief, and unless also these gods had already been envisaged as "departmental"—that is to say, as possessing certain definitely distributed functions and prerogatives over certain particular actions or portions of Nature. The possession of such special prerogatives, however, does not in the least militate against the primitive humanity of such departmental gods; for the Christian saints have often similar prerogatives, and we know with certainty that most at least of the Christian saints were originally ordinary men and women.

To put it briefly, though there are individual gods who need not necessarily once have been individual men, there could be no such thing as the idea of a god except as the reflex of the ghost of man in general.

So, too, with temples. While it is almost certainly true that temples as a whole originate, as Mr. William Simpson has so abundantly proved, from the tomb of the deified chief or hero, it is also undoubtedly true that certain temples exist in later stages of culture which are, to use once more the phrase I employed above, cenotaph shrines. But these cenotaph shrines could never have come into existence at all unless men's minds had already long been habituated to the idea of worship at the actual tomb-shrine.

It is the same, again, with sacred stones. These, as I have endeavored to show elsewhere, owe their sanctity at first to the standing stones erected over the remains and tumuli of the dead. But in course of time prayer offered at the grave comes readily to be regarded as prayer offered to the visible and tangible object then and there present—the stone that crowns and tops the barrow. *Ghee* or oil poured out for the ghost comes readily to be regarded as offered rather to the stone itself than to the person whose grave it marks and commemorates. Especially will this confusion exist in the mind of the worshiper when the worship is of old date, and the personality of the deceased has been long forgotten. It is very early ancestors who become the great gods of later generations. Still no one could ever have dreamed of offering up food or preferring requests to a lifeless stone, unless he and his predecessors had long been accustomed to look upon similar stones as the dwelling places of his ancestors. But nowadays, when the sanctity of certain stones is already a well-established article of belief, the people of southern India—to take a particular instance—artificially manufacture sacred stones by setting them up in their fields, painting them red (a substitute for blood libations), and pouring offerings of oil or *ghee* on top of them. That is to say, they treat certain casual stones, which have no rational connection at all with their ancestral spirits, in exactly the same way in which they or their predecessors have been in the habit of treating the graves of their forefathers.

A like evolution has taken place, I believe, in the case of sacred trees and sacred groves. I do not mean for a moment to assert, or even to suggest, that every individual sacred tree grows or ever grew on the grave of a dead person. But I do mean to say that, so far as I can see, the notion of the sanctity of trees or plants could only have arisen in the first place from the reverence paid to trees or plants which actually sprang from the remains of the dead, and so were regarded, like everything else that came out of the tomb, as embodiments or avatars of the dead man's spirit. Once such sanctity came to be generally recognized, however, it could be readily transferred to other conspicuous or remarkable trees, or even to trees in general, and particularly to the special groves or plantations that surrounded temples, whether mortuary or cenotaphic.

Yet in every case, when we go back far enough in time, or, what comes practically to the same thing, when we go down low enough in culture toward the savage level of primitive man, we find always that we stand nearer face to face with these the earliest naked realities of religion—that the ghost counts for most; that the temple has not progressed beyond the stage of the hut or underground dwelling; that the sacred stone is still the actual tombstone; that the altar is still the actual grave slab; that the sacred tree is still directly and intimately connected with the ghost or the tumulus.

[*To be continued.*]

NUMBER FORMS.

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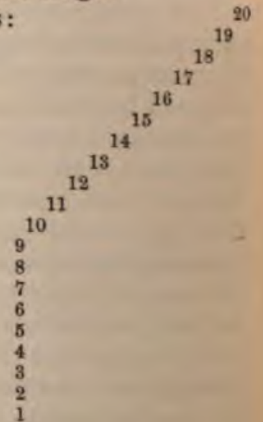
IN the Atlantic Monthly for February, 1873, Miss H. R. Hudson, writing on idiosyncrasies, says, "The nine digits *will* ascend in a straight line before my mind's eye, and the larger numbers *will* slant off at a queer angle" thus:



About twelve years ago Francis Galton, in England, while engaged in an investigation into the visualizing peculiarities of different persons, discovered that the possession of "number forms" was not uncommon. Some of these "forms" were given by him to the public in Nature for January 15, 1880, and afterward a collection of about sixty-five of them was published in his book on Inquiries into Human Faculty. These were accompanied by many descriptive details, but Galton did not attempt any complete explanation of the number form in general.

Neither is it the purpose of this article to attempt such an explanation, but rather to add to Galton's list some thirty-five or forty forms, which I have incidentally collected during the last four years, together with some explanatory remarks and a few suggestions toward a future theory. It is hoped, too, that further attention may be called to the subject, and other contributions made to this curious chapter in psychology.

With about half a dozen exceptions, the accompanying forms have been gathered from college students of both sexes, varying in age from eighteen to twenty-five years. They are taken from drawings made in every case by the "seer" himself, in response to some such question as this: "When you think of the numbers

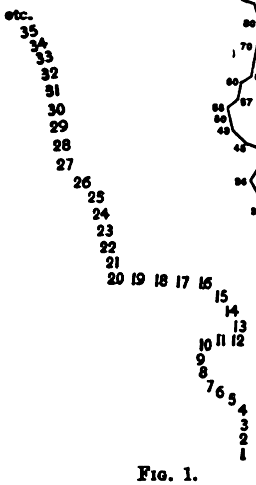


FIG. 1.

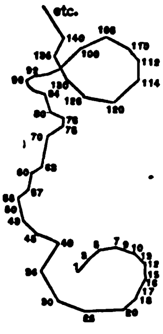


FIG. 2.

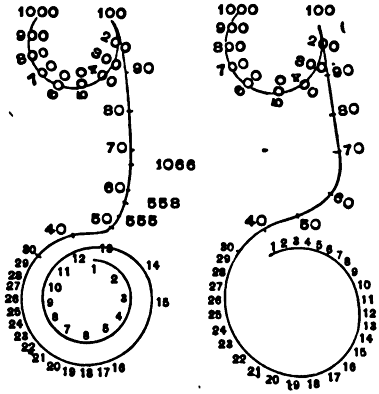


FIG. 3.

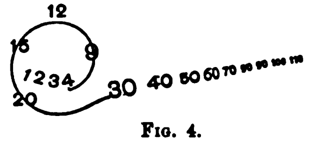


FIG. 4.

from 1 to 100, do you mentally *see* them in any form, or outline? If so, can you draw a representation of it?" At first about seventy-five students, of whom thirty were young women, were thus interrogated. In this examination it was probably understood that only well-defined and perhaps somewhat striking number forms were called for. As a result, only four forms were found, two from young women (Figs. 1 and 2) and two from young men (Figs. 3 and 4). This would correspond roughly with Galton's estimate that one out of every thirty adult males, and one out of every fifteen adult females, has a number form. My own later experience, however, has developed the fact that such a mode of investigation does not discover the full number of persons possessing forms, simple or complex. There are several reasons for this. The subject is not commonly understood when first presented. It would seem that a person having even a complicated number form might live and die without knowing it, or at least without once fixing his attention upon it or speaking of it to his nearest friends, although such a one might use his form in daily computation. It seems to him quite natural to see the numbers in that way, and the thought may never enter his mind that others should see them differently. Again, if one is conscious of a peculiar form, he regards it as an idiosyncrasy and exhibits a certain shyness in revealing it. For this reason it is especially hard to get all the number forms from a company of children. They do not like to be laughed at, and will willingly keep silent about anything which they suspect may be another of those idiosyncrasies causing such mental torment to many children. Finally, those who do not have complicated forms are apt to think that the little curve, twist, or angle in which they see the numbers is quite too trifling a matter to mention. I am inclined to believe that one out of six adults would be a more accurate proportion, that the proportion among children would be still greater, and that it is perhaps a little more common among women than men.

FIG. 5.

The questions one would naturally ask a person having a number form are these: "How long have you seen the numbers in this way? Is the form fixed or is it changeable? What was its origin?" The answers to these questions are almost absolutely invariable. They would be as follows: "I have seen the numbers in this way ever since I can remember. The form is fixed and unchangeable. Its origin I do not know." In a very few cases when the nine digits always appear in mental vision as a mere straight line from left to right, the subject may conjecture that it originated with the printed forms from which they were learned. I have found that certain simple kinds of alphabet forms are very common. If a number of people be asked whether, when they think of the alphabet from *a* to *z*, they see it in a visual picture, and if so in what particular form, it will be found that a considerable number will say that they see the letters in one, two, or three vertical columns reading downward. A simple illustration is seen in Fig. 7. When there are two or three columns, the same letter always appears to a given person at the top of each column, but I have not found two forms alike except when they consist of a single straight line. In these cases the suggestion is often made by the seer that the letters were so arranged in his primer. Obviously this explanation would not apply to any such alphabet

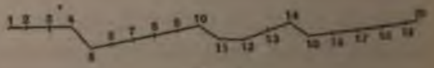


FIG. 6.

forms as are shown in Figs. 13, 15, and 16. Nevertheless, it is probable that all strongly eye-minded people, if they do not visualize the alphabet in any other way, visualize it as they do other things, in the form in which they had usually seen it.

Concerning the stability of number forms, any one may have his doubts removed by a few tests separated by months or years. In almost every case it will be found that, no matter how complicated the form may be, the subject, after one, two, or three years, will draw from his mental picture of it a copy differing in no essential respect from the original copy. The number form represented in Fig. 3 was given to me in 1889. In October, 1892, I requested of the young man by letter a second copy, and in reply received one precisely like the first. Other tests gave similar results. Galton testifies to the unchangeable character of number forms in all cases where they are well defined. It is true, however, that they sometimes disappear entirely. They are found to be more common among children than adults. It is probable that in children who are not naturally vivid visualizers, or in cases where it does not serve any useful purpose, the form fails to survive. One case of such a lapse I have found in an adult.

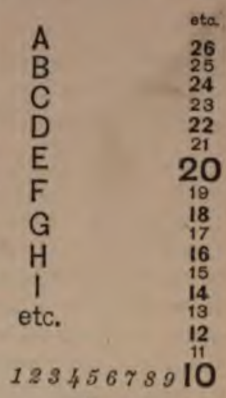


FIG. 7.

The general character of number form is such that a person having one can not think of the related numbers without *seeing* them in a definite visual picture. A form or outline rises involuntarily before his mind. In some cases the seer can describe it as definitely located in space in relation to his own body. It is two feet long or six inches long. It stares him in the face or lies at his feet. It recedes to the right or left, or into the distance. Others can not answer the question as to the location. In most cases, though not in all, no individual number can be thought of without seeing it in its appropriate place in the usual outline. Sometimes the form seems to be useful to its possessor in computations, particularly in addition and subtraction. In other cases it seems to have no use at all further than that of all mental imagery, which will be considered below. It has been suggested that it is by means of a number form, or at least by a clear visualization of numbers, that the arithmetical prodigies accomplish their remarkable computations. Though it has been shown that many of them do visualize the numbers, and mentally *see* the different steps of their problem, yet this alone offers

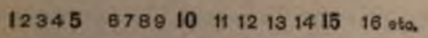


FIG. 8.

no adequate explanation of their mathematical agility. This hypothesis is further weakened by the recently developed fact that Inaudi, the ruling French mathematical wonder, is not a *visionnaire* at all, but a distinct *auditaire* who *hears* all his numbers.

Referring now to the accompanying forms, Figs. 1, 2, and 4 demand no further explanation. In Fig. 3 we have an interesting double form, the one to the left showing how the numbers from 1 to 15 appear when thought of by themselves or in connection with one another. But when any number below 15 is thought of in connection with any number above 15, it is seen as shown in the form to the right. Above 15 the numbers are unalterably fixed. The possessor of this form writes me as follows:

I do not believe I can think of a number apart from this outline. I refer all numbers to it, however large. One million is located where 1,000 is, and so of 1,000,000,000; 550 would be at 55 on the circle; 1,235 is at 35. You will notice that of the last two numbers I mention, the first is located at the point indicated by the first two figures, viz., 55; but the last number, 1,235, is located at 35, the last two figures. I can not explain this, but simply state it as a fact. I think possibly in large uneven numbers, I really, though almost unconsciously, separate the number into parts, in 1,235 the 1,200 either being ignored and my mind directed to 35, or else I in some manner connect the two locations but direct my attention more to one than the other. I stated above that I did not believe I could think of a number apart from this outline, and that is true when I think of some one number by itself and in adding and subtracting small numbers. If any one should ask me how many hours intervened from 3 to 11 o'clock, I would say 8, because I *see* that many on my number form, which immediately appears before my mind's eye, but I could not subtract 37 from 89 in that way. I would immediately locate the two numbers but I could not determine how many numbers intervened, and I find that in adding, subtracting, and multiplying odd numbers, and numbers beyond 15 say, I do it abstractly without referring to my form; but as I said, in thinking of any one number by itself, it is always connected with some point along that outline. This number form, by the way, stands upright and is about two feet in height—that is, the number 100 is two feet above 18 and about six inches to the right.

Among the seventy-five young men and women interrogated in the first experiment, was a rather diffident young woman who communicated to a classmate that while, she had no number form, there were certain associations that she always made with the nine digitis. Learning this, I questioned her, and she consented to write out the associations, which I reproduce here exactly as given:

1 = a child about two years old.

2 = a boy, ten or twelve years old, brown hair and eyes, frank, active, noisy, always ready to help.

3 = a girl, short hair, black, curly; sharp features, not pretty; slight; awful temper; shrill voice; bangs and slams around generally.

4 = a young lady, same characteristics as 2, but is calm, more quiet, studious, a home girl.

5 = a society girl, a policy girl, is always favored, has everything she wants; selfish; does not care how much trouble she makes other people; not always truthful.

6 = a young man, plain, matter-of-fact person, slow, good; will never amount to more than the average.

7 = a sort of villain; a schemer; dresses well, has polished manners, a good talker, bad habits; has a certain sense of honor; is able, but does not use his ability in the right direction; clear-cut features, tall, dark.

8 = a lecturer or clergyman; good, solemn, careful, very pious.

9 = a lady, hair rather gray, tall, soft low voice, sweet face, very well educated, dresses in soft colors; a truly refined woman.

No explanation of these peculiar associations could be offered. Each person arose in a distinct mental image whenever the corresponding digit was thought of. One notices, of course, that we have here the prevailing types of mankind as seen by a young girl. I have recently found another case quite similar. Here, also, the subject is a young woman, and she can give no explanation of the origin of her associations. In hearing or reading long numbers rapidly, she says that she does not have time to see the mental pictures, but single numbers, especially if written by herself, instantly call them up. The associations are as follows:

1 is without definite character, as is also 8, with the exception that the former reminds me of a short person, and the latter of a very stout person, but neither has sex or other characteristics.

2 is always a graceful woman, beautifully dressed. She is slender, with a beautiful delicate face.

3 is a chubby little girl, with dark eyes and bright quiet ways.

4 is a plain woman, rather tall, with pale hair brushed tightly back from a severe face. She is dressed very plainly, and the lines of her figure are angular. She is abstinent, intolerant, and hard to get along with.

5 is a man, dark, medium height, dressed in gray clothes. He is a business or professional man, successful and not particularly intellectual. 5 is always associated with the color gray.

6 is a pleasant-faced woman, medium height and stature, with hair brushed back plainly, and with quick, quiet ways. She is dressed plainly and neatly, and always looks pretty. She is an excellent housekeeper, and I think of her as engaged in household duties. I do not know the color of her hair.

7 is a man of quite opposite type from 5. He is very tall and dark, of musical or poetic temperament. I don't know how he is dressed, except that his whole figure is dark as I imagine him.

9 is another man, more like 7 than 5, also dark and dressed in black clothes. He is fine looking and a professional man.

To a class of twenty-nine students, of whom eight were young women, the following questions were recently given:

1. When you think of the numbers from 1 to 100, do you see them in any particular form? If so, will you write or draw it on paper?
2. When you think of the alphabet from *a* to *z*, do you see the letters in any particular form?
3. Have you any associations of color with the numbers or letters?

To these questions twenty-nine written answers were received, disclosing four number forms and a few simple alphabet forms. Immediately afterward, however, two others of the class told me privately that they thought they did have forms, although they had not reported them in writing. These were found, indeed, to be perfectly well defined, and are shown in Figs. 6 and 7. The other four are shown in Figs. 5, 8, 9, and 10 (*a*). One curious alphabet form was found (Fig. 10, *a*), but no color associations. This method of inquiry revealed in this case, at least, a much larger percentage of number forms than that given by Galton. These six forms present also some new types. Fig. 5 is from a young man, who sees only the numbers 5, 6, 7, 8, and 9. Of these, 7 is by far the most conspicuous, and is described as a black figure, fine and perfectly formed, standing on a reddish background. 6 and 8 are less distinct; 5 and 9 still less. Fig. 7 shows the number form of a young man, who sees the numbers from 1 to 9 in Italics on a horizontal line. The others are straight and form a right angle with the first. All the odd numbers appear to him as weak, affording in counting unsatisfactory places to stop. The

1	2	3	4	5	6	7	8	9	10
10	20	30	40	50	60	70	80	90	100
11	21	31	41	51	61	71	81	91	1000
12	22	32	42	52	62	72	82	92	10000
13	23	33	43	53	63	73	83	93	100000
14	24	34	44	54	64	74	84	94	1000000
15	25	35	45	55	65	75	85	95	10000000
16	26	36	46	56	66	76	86	96	100000000
17	27	37	47	57	67	77	87	97	1000000000
18	28	38	48	58	68	78	88	98	10000000000
19	29	39	49	59	69	79	89	99	100000000000

Fig. 9.

even numbers are firm and strong, while 10 and its multiples are much larger and more prominent.

Fig. 8 is from a young woman who sees the numbers in a straight line; 1, 5, 10, 15, etc., appearing more distinct than the others, with wider spaces after 5 and its multiples.

One of the most interesting forms in this collection is that shown in Fig. 10 (*a*). This young man sees only 1 and 0 distinctly; 2 and 9 stand in their proper places, but are less distinct;

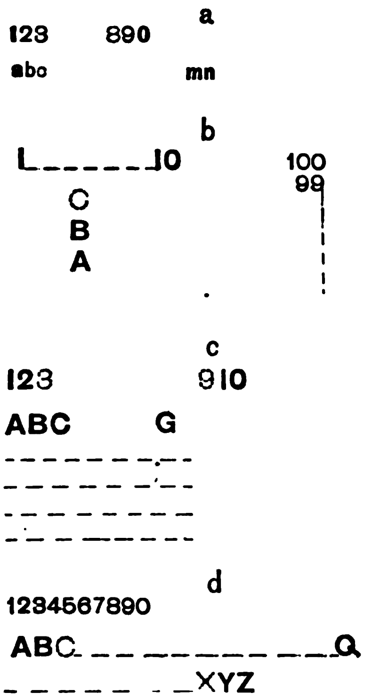


FIG. 10.

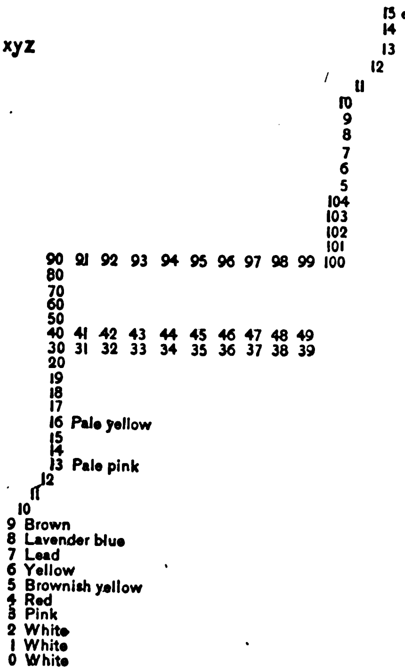


FIG. 11.

while 3 and 8 are seen but faintly in a shadowy form. The intervening figures are not seen at all, but the appropriate *space* for them is there. His alphabet form accompanying discloses the

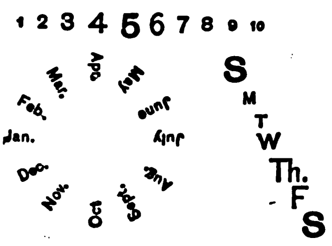


FIG. 12.

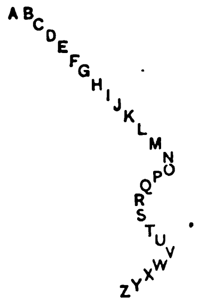


FIG. 13.

same principle. *A, m, n,* and *s* are very distinct; *b* and *y* are fainter; *c* and *x* are shadowy; a blank space intervenes, sufficient for the other letters. This young man has a brother and two sisters, whom he severally asked concerning their views of the letters and figures, without mentioning his own. The forms shown in Fig. 10 (*b*), (*c*), and (*d*) are the results. The brothers and sisters differ widely in age, did not learn their letters or figures from the

Fig. 14.

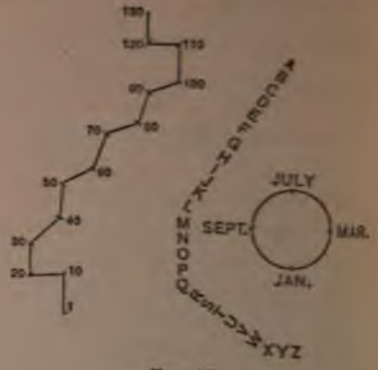


Fig. 15.

same books, and had never, until this time, spoken of their forms to one another. The very striking similarity, together with the odd character of the forms, shows strong hereditary tendencies in this case. There are other instances of family likeness in number forms. It is not, however, invariable. Figs. 2, 12, 14, 15, and 16 are forms from members of one family. There are some similarities, but they are not striking.

Fig. 11 shows the number form of a girl of nine years. This is a colored form, its peculiarity consisting in the fact that the numbers containing two or more figures maintain their individuality and appear in a color formed by mixing the colors of its constituent digits. Thus 13 is not white and pink but pale pink. Other colored or partly colored forms appear in Figs. 17 and 18. In the former, 5 is scarlet, while the other numbers are not seen in colors. This form, like that in Fig. 4, lies in space of three dimensions, and like that of Fig. 10 has some faint and some missing numbers. Other peculiarities of this form are best presented in the words of the seer herself :

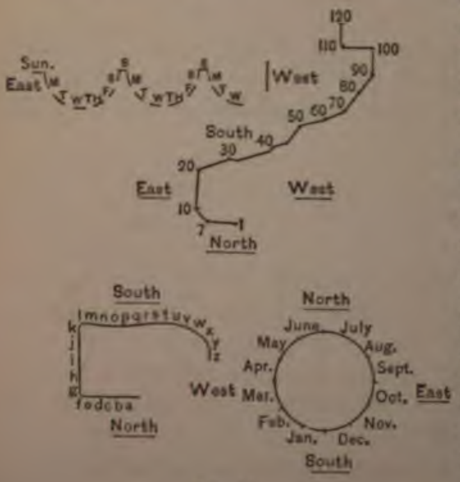


Fig. 16.

In all these forms the figures and letters appear to me in my own handwriting, except in the divisions of the day. In these, I have the abstract idea of morning, etc., in mind, but with the distinct divisions as in the diagram. All the plans are very much larger than here represented. The figures begin at my left and cross to my right before me, curving at 8; and 1,000 seems about my finger-tips when my arm is extended straight before me. The circle of the seasons is about as large as would lie between my arms extended straight before me. The days of the week occupy a line at my left, about a yard long. The divisions of the day are perpendicular, as though hung on a wall, and morning begins at a level with my hand.

The number form in Fig. 18 is peculiar in this respect, that it reads from right to left. The seer is an artist, and it may be worth mentioning that she is not left-handed. Other features of her form she describes as follows:

Fig. 17.

The line of the figures runs down to 8, 18, 28, 38, 48. They turn and ascend to the multiples of 10, but after 40 I see only the numbers found in the multiplication table—42, 48, etc. The numbers 18 and 19 form a very dark corner; 20 is quite light; 24 again is dark, the darkness continuing to 30; 30 is again light, and the numbers following are all quite light. The source of light seems to be 60, which is much higher than the rest, the light touching those on either side; 75 is very distinct.

Number forms being all unlike, adequate explanation of them becomes practically impossible. Speaking very generally, however, their origin may be traced to one great cause—namely, the attempt or necessities of children to give a concrete form to the abstract. Now, numbers are among the first abstractions that children have to wrestle with. Our earliest abstract ideas, perhaps also our later ones, are, as it is now well known, either mere samples of individual things, or else a kind of composite picture of them. The child's concept of boy, girl, dog, horse, are nothing more than visual pictures of some particular boy, girl, dog, horse, or else a composite picture of a limited number of individuals. Now, numbers do not admit of such composite pictures. They are bald abstractions that the poor child must manage in some way. In most cases, if he be an eye-minded child, he merely visualizes the Arabic numeral. He may give it individuality further by clothing it in a particular color, or even personifying it outright as in the two cases given. Color audition and association of color with written characters are explained by many as due to physiological conditions, especially to the contiguity of the cortical center involved. Dr. Krohn, in a recent review of the subject in the American Journal of Psychology, adopts this explanation in part. It is doubtful whether this hypothesis is necessary to explain the comparatively rare cases of color associations; it certainly is not necessary for explaining number forms. In any case, physiological association would be due, either in its origin or as a justification of its survival, to useful psychic associations. Now, in the matter of number forms, sup-

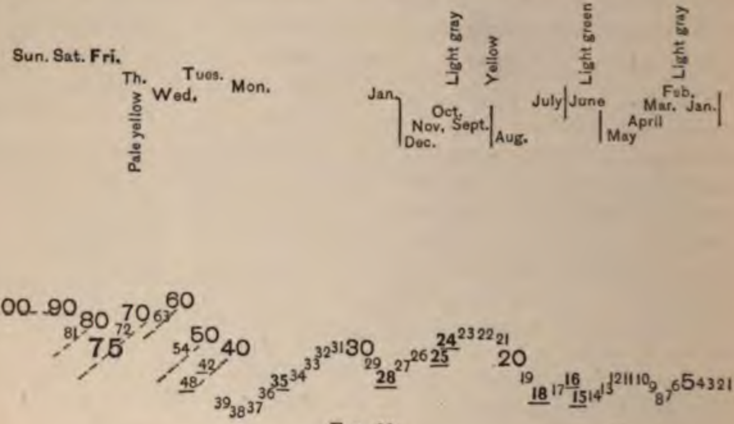


Fig. 18.

pose that the child is required, as is very early the case in counting, to think of the numbers not separately, but in relation to each other. He has then the problem of arranging abstractions in a series, and, if he is naturally an ear-minded child, will arrange them as a mere series of associated sounds. If, however, he is eye-minded, he may consciously or unconsciously hit upon the device of a visual spatial image, and thus enable himself to comprehend and remember the numbers as he does other things by a mental picture. A number form thus becomes a little system of topical mnemonics. Its continuance, either in the individual or, in cases of inherited forms, in the family, is of course due to physiological conditions. In every case, however, its origin is probably to be traced to useful psychic associations.

M. Stanislas Meunier has been able to produce artificially, by a process of reflection, an appearance like that of the gemination or doubling of the canals of Mars, and suggests hypothetically that the phenomenon in question may be one of that character.

THE TREPANG.

By WILLIAM MARSHALL.

THE variety of food substances that men have obtained from the animal and vegetable kingdoms is really wonderful. One might say, "There are many men on the earth, and every one will eat what he can get the most of and at the cheapest rate, and so they have tried and tasted them all." We may grant this, but the most curious fact in the matter is, that the strangest dishes are not foods of the masses of the people, but are rather the costly dainties of the wealthy classes. Nowhere have such rare tastes in food been developed as among the Romans in ancient times and the Chinese. There may be found in the bills of fare of the latter people addled eggs, fat grubs, caterpillars, sharks' fins, rats, dogs, Indian birds' nests, and—the finest of all their delicacies—trepang. What is trepang?

Trepang or tripang is a collective name by which a considerable number of species of most curious sea animals are designated; they are also known as sea rollers, sea cucumbers, in French as *cornichons de mer*, and scientifically as holothurias. They are among the most sluggish of animals. Only the fixed or stationary animals are slower than the holothurias. They lie like gray, brown, or black leather pipes or cylinders on the bottom of the sea. One might watch them half a day long, if he had nothing better to do, and hardly see them change their position; and they rarely move more than a foot or two in several hours. Their class relatives, the other spiny-skinned animals or echinoderms, are much more active. A sea urchin or a starfish is able to get away from a spot quite nimbly, and the serpent-stars, the most active members of the whole order, are capable of using their long, slender, many-jointed arms as legs, and are as quick and alert as crabs.

Fig. 1.—Serpent, or Brittle Starfish.

One would not suppose, at the first glance, that the sea cucumbers are relatives of the sea urchins and starfishes; for while the skin of the latter is thickly armed with scales of limestone, and they possess a radial structure that is easily distinguished, the appearance of the others is very different. The skin of most of them, including the trepang, is always leathery, compact, and closely adherent to the muscular system.

Still, the chalky deposits are not wanting in them, but they are microscopically small, are scattered, and rarely exhibit patterns or knobs. The radial structure is easy to recognize in many of them, but not in others, especially in the deep-sea forms which have only recently become known. But this is a modern variation. The ancient typical structure of all the spiny-skins is radial, and the number of rays is five or a multiple of five. When rays appear in other numerical relations (based on 3, 4, or 6), it may be traced back to a recent variation. While the mouth in the sea urchins and starfishes is on one of the broad sides of the somewhat flattened body—which for this reason is designated as the buccal, or, not very accurately, ventral region—in the sea cucumbers the body extends from the mouth to the other pole, and the animals are not flat, like their relatives, but lengthened out like worms. They, therefore, do not move on the mouth-surface. Thus they are transformed from a radial symmetrical structure into an apparently bilaterally symmetrical, right-and-left structure, but really equally lateral, and, superficially regarded, look like thick, plump worms. Around the mouth is a fringe of tentacles, shield-formed or greatly branched, which serve as organs of touch and groping, or perhaps for breathing. The size of the animals varies greatly; there are forms in the depths of the northern seas which measure but little more than a few centimetres, while tropical species living near the surface are two feet long and more. Their stupidity and slowness of motion correspond with the kind of food they live on. They fill themselves with sand and the detritus of crumbled corals; and, as they do not hunt for food, they need no eyes or organs for rapid motion. In those sediments of the sea are enough organic substances—products of decay, algæ, animals of the lowest species—to keep the slow metabolism in action by their motion. Such inert animals would soon fall a prey to the always hungry robbers of the sea if they had to depend on their skill and dexterity. But they seem to have other means of keeping their enemies away; possibly they have a bad taste to them, or their tough, leatherish skin causes them to appear undesirable morsels

Fig. 2.—Sea Cucumbers.

to their meat-hunting fellow-denizens of the sea. They have an exceedingly rare peculiarity. When one excites them, handles them roughly, or takes them out of the water, they contract their musculous body convulsively, and vomit themselves out—not only the contents of their stomach or intestines, but the intestines with the contents. But this self-mutilation, apparently so terrible, is not as bad as it seems to be. The intestine is capable of replacing itself, and, after a short season of fasting, our sea cucumber is again restored to its former condition. This is a remarkable phenomenon of a regeneration or restitution process, not yet sufficiently investigated. The holothurias are, like all the spiny-skinned animals, exclusively inhabitants of the sea; at least no fresh-water form is known. In the sea itself, however, they are of universal occurrence. Their representatives are found from pole to pole, and in all depths, from those of only a few metres to those of a thousand metres and more.

A former officer of the Dutch East Indies, M. Lion, who is thoroughly acquainted with the characteristics of that remarkable region, says that there is not an island in the Indian Archipelago near which the trepang is not found; and this is confirmed by the Englishman Jamieson, who marks as the home of the animal all the seas from Sumatra to New Guinea. The trepang can be found everywhere in this region when the surf is not too strong, chiefly at depths of from six to nine metres, on flats covered with coral sand, but not on muddy bottoms. Here they feed, as the English author Guppy has described them to us. An individual of any of the species of trepang from twelve to fifteen inches long will eat half a pound of weathered coral sand a day, loosening it from the surface of the reef. The term eat, however, is hardly the proper one. The animal lets the mass, which contains only a trifling fraction of nutritive matter, pass through its intestines. Fifteen or sixteen of these animals would thus dispose of a ton, or about eighteen cubic feet, of sand in a year. Mr. Guppy speaks of an "organic denudation," of a process of weathering of the coral reef, in course of accomplishment through living causes.

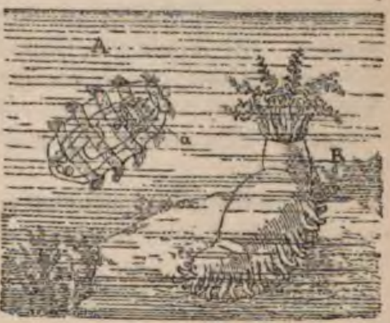


FIG. 3.—INFANCY OF A SEA CUCUMBER. A, a jelly animal swimming and feeding; *a*, small sea cucumber forming inside. B, the young sea cucumber with the leaf-like tentacles round its mouth, walking on its tube feet.

"The Celestial Empire," says Mr. Jamieson, "could not exist without trepang and East Indian birds' nests; and the inquiry for these articles is therefore so brisk that the danger of a glut in the market can hardly be feared. Holothurias are even fished in the Bermudas and the West Indies, and exported, chiefly from Boston, to China. They are probably not sold there as products of the Atlantic ports of the New World, but mixed with real Indian trepangs. For about eighty years also trepangs caught near Ceylon and the Isle of France have been marketed in China, and have sold well; but are ranked—not being well enough prepared for the most delicate Chinese tastes—among the most inferior qualities of the Moluccan supply.

The principal trepang fishers are the Buginese and the inhabitants of the island of Goram. There go out together flotillas of from thirty to forty small, apparently fragile, but really quite seaworthy boats—called *proas* in the East Indies—with a complement of about a thousand men. The fishermen receive no wages, but are supplied with all the necessaries for the expedition—provisions, etc.—by Dutch and Chinese traders; these then have the right to the whole catch, for a previously determined price, to be paid on delivery, of which each participant in the voyage is entitled to his share. The dangers connected with such an expedition appear not to be small. But the business is a lucrative one. While we can not examine the accounts of the Malays and Chinese, we have evidence of this from another source. An American, Captain Eagleston, sent out five successive expeditions, which brought him 4,467 pikols (a pikol is 61·5 kilogrammes) of trepang, or, at 1,100 to the pikol, 4,913,700 individuals. The enterprise cost $10,337, and returned a clear profit of $67,924.

This fishing is conducted in a rather primitive manner. The most of the "fish" are caught, in shallow water, by spearing the larger ones and diving for the smaller ones; in deeper water an extremely simple drag-net is used, which is fastened to a long handle of bamboo.

A suitable number of trepang having been caught, the fishermen repair to the nearest island to put them up. The trepang are first opened and disemboweled; then the water is pressed out, and they are rubbed within and without with dry lime, which the Malays call *tsilumam*. They are next dried, either in the sun—which gives an inferior product—or in special crates, beneath which a smoking fire is kept burning; and, lastly, they are packed in bags. According to Mr. Wallace's description, they look like sausages that have been rolled in mud and dragged through a sooty chimney. The kind which I have occasionally tried at our *delicatessen* shops does not present quite so bad an appearance as that, but it is probably not one of the best qualities.

The dressed trepang are next taken to an appointed place where a kind of fair is held at certain times. The Buginese, who are the most enterprising trepang fishers, have such a place in the little island of Kilwaru, between Ceramlaut and Gessir. It is really only a sand bank, fifty ells long and broad, rising three or four feet above the level of the sea, and surrounded by coral reefs. Other such places are situated on the Aru Islands and at different spots here and there in the Australasian Archipelago. Very many are taken to the chief mart at Macassar; and Java has recently begun to compete actively with this island for the trade.

The market price of this costly dainty depends not on the size of the individuals, but on other qualities which are mysteries to all but connoisseurs. The Chinese dealers and sorters understand them, but the native fishermen pay no attention to them. Crawford mentions thirty different qualities, the best of which, called *takker itam*, costs about eighty dollars a pikol, while the least valuable, the *kuasser*, or *peku goreng*, can be got for a little more than five dollars a pikol. A very good sort comes from the Marianne Islands, and is called *guam*.

About 1,510 pikols a year of trepangs are sent to China from the Aru Islands, 6,000 from Java, and 8,000 or 9,000 from Macassar. The whole quantity brought to the Celestial Empire every year amounts to 90,000 pikols, but the demand is always ahead of the supply; and yet the trepang is not a people's food in China; for, while the number of individual sea cucumbers consumed there annually rises to 99,000,000, the empire has 380,000,000 inhabitants; so that only every fourth Chinaman could possibly get a trepang a year. The market price in China ranges from about $23 to $135 a pikol. Averaging it at $54 a pikol, we find that the frugal Mongolian sons of heaven yearly spend nearly $9,000,000 for this sea worm.

Not being versed in Chinese cook-books, we can not give directions for serving up the trepang; but, according to Jamieson, the Chinese make strong and palatable soups and various fricassees from them.—*Translated for The Popular Science Monthly from Daheim.*

Of the influence of the recent earthquakes in northern Italy, M. Goiran has observed that they were apparently followed by a speedier germination of seeds, a more rapid growth of the young plants, a more luxuriant vegetation in the pastures, tillable lands, vineyards, and copses, and a more distinct greenness of foliage. He ascribes these results, not to the earthquakes directly, but to the augmented production of carbonic acid, a more complete distribution of fertilizing matters in the soil which suffered a sort of trituration from them, and to an increased electrical development. Under some conditions earthquakes seemed to have an unfavorable influence on veg tation, but this, M. Goiran believes, was the result of long droughts that accompanied them.

SCIENCE TEACHING.*

By Prof. FREDERICK GUTHRIE, F. R. S.

AT the outset of our inquiry into science teaching, we are, of course, met by the old question as to the purpose of education. There are those who regard education as an intellectual arming and equipment for the battle of life. Others look upon it rather as an end than as a means. The first would supply to the individual only those weapons which he is likely to require in making his way in the world. The second advise a wider, and therefore more dilute, education (the time given to education being the same), and would relegate the acquirement of specialties to the exigencies of the career. I suppose that it need scarcely be insisted on, nowadays, that both of these views are fallacious on account of their partiality. The most favorable product of the first is the "successful" specialist, who is for the most part a burden to himself. The second gives us the shallow "prig," who is for the most part a burden to his fellow-creatures.

A good citizen—and by citizen I mean, of course, a citizen of the world—must be a man of large sympathies. Though color-blind, he must have common feeling with painters, and, if tone-deaf, the works of musical composers must not be without interest to him. And through all it must not be forgotten that distinction is a noun of limited number. The time may come when they who know as much mathematics as Newton shall be counted by scores. The time has come when they who know as much geometry as "Euclid" are to be counted by thousands; and they who know as much chemistry as Dalton, by tens of thousands. But we are as badly in want of Newtons, Euclids, and Daltons as ever.

Here, as elsewhere, it appears that an apparently insuperable difficulty is half surmounted when fairly confronted. It is, without doubt, the conviction of those whose opinions of to-day will count as truisms to-morrow, that, up to a certain stage, and as far as the presenting of opportunities is concerned, the education of one should be the education of all. Liberal variations should be recognized in accordance with the tastes, and especially with the distastes, of the individual; yet there is a certain nucleus of somewhat indefinite boundary which should be offered habitually to each. When I say "somewhat indefinite," do not, I pray, imagine that I want to shirk a difficulty; on the contrary, my purpose is to accentuate and try to deal with it.

It is perhaps in matters of taste which, in their developments,

* Abridged from the Journal of the Society of Arts.

become fine arts, that the greatest eagerness to learn, and the greatest antipathy against learning, are manifested by the individual. And it is for this that I should relegate such matters to the later stages of a general education.

When, accordingly, I shall have to advocate the introduction of drawing into the very earliest stages of education, it will be understood that I am not considering it then and there as a fine art, but as a mere record of the perception of things. It is in regard to subjects which involve taste that the course should be least rigid. If the arithmetical course, for instance, were less rigid, the parent might, indeed, be spared the ignominy of having to confess to his child that he (the parent) does not know how many pennyweights there are in a kilogramme. Think how we parents have to shuffle, and how we scarcely recover our dignity after we have, more or less clandestinely, referred to books. This is bad. But, to my mind, it is far worse to have to listen to some poor little mortal trying to acquire some one or two set pieces on the piano, for hours daily, and for months yearly. And the excess of pain in the second case over that in the first is due not to the fact that our own physical agony is greater than our moral ignominy, but that in the second we see a long vista of hopeless effort before the little victim.

It is the legitimate boast of this country that the highest offices of the state, excepting of course those pertaining to the throne, are open to the child of the lowest birth or the deepest poverty. It is as certainly one of the greatest scandals of the country that such offices are open to and have often been held by persons of the very lowest culture and ability. As long as this is so, as long as a man may aspire to become, and actually become, a judge, a bishop, an ambassador, a colonial governor, and yet be and remain on the whole an ignorant fellow, so long will the educational establishments, whether schools or colleges, in which such persons have received their so-called educations, remain much as they have been.

Is it not rare to find an artist, either literary, pictorial, musical, or other, whose conversation does not bore you on account of its narrowness? Unquestionably this is so, and unquestionably the best in each profession are the first to admit it. Even in a profession such as that of medicine, where we have a right to expect to find at all events scientific culture, we find rarely anything of the kind. Owing to the fact that the medical profession has had for centuries our healths in its hand, the ignorant naturally have recourse to the doctor in matters of health; nay, are in a manner compelled to do so. Accordingly, and for instance, you find our vestrymen appointing as public analysts any kind of broken-down medical man, who does not know one end of a test tube from the other, although he may know on which side his bread is buttered.

Even the surgeon, whose profession is eminently scientific, is too often shamefully ignorant of the very elements of chemistry, physics, and mechanics, the three general sciences which, together with the trivial science of anatomy, make up the whole of the science of his profession.

On the bench the want of scientific culture is painfully conspicuous. Speaking under correction, I suppose I may go so far as to say that, theoretically, law is founded upon justice; that it is, at all events, a more or less crude effort toward that rather illusive ideal. As a matter of fact, lawyers will tell you, with beaming countenances, that English law is an inchoate hotch-potch of enactments and precedents, obsolete, imaginary, supplementary, and contradictory. In fact, the idea of right is replaced by an indefinite number of rules of an arbitrary character. It is here to be well noted that the study of such arbitrary information—I will not call it knowledge—has and must have a narrowing influence; it deadens the mind, as it must deaden it, to the perception of principles. Now, the laws of Nature are not parliamentary enactments, and a judge, in his questions to witnesses, and in his remarks and summings-up, when scientific matters are before him, often appears at great and painful disadvantage through his efforts to codify Nature. Frequently, indeed, his remarks, as reported, are the funniest things in a daily paper. Of course, the efforts of the judge are greatly aided by counsel, who are supposed to be able to master any question in any science in twenty minutes. I am ashamed to say how justice is aided by the "scientific experts," generally of third or fourth rate standing in their professions—well, this is also an unpleasant subject. As to the final outcome of the suit, as a court generally reverses the decision of the one below, a great deal depends upon whether there is an odd or even number of courts between the first and the last. But I for one do not want either to ridicule or pity that which should be sober and majestic. And if it is not possible that every judge should have scientific training, it would be surely advisable that one or two should have it, and that causes involving scientific questions should be brought before such alone.

As it is from the universities that the so-called liberal professions are to a great extent recruited, I am bound to speak a word or two as to the position of science in them.

Of the teaching of science at the Universities of Oxford and Cambridge I need say but little. The weighty list of names illustrious in mathematics and astronomy which the latter of these can show, might be considered sufficient to redeem it from the reproach of neglect of scientific culture. But in such an estimation we are justly to consider the boundlessness of the opportunities, the vastness of the means, and stringency of the duties. Regarded under this light, and in spite of many notable examples to the contrary both in the past and in the present, it does not admit of a shadow of doubt but that on the whole these opportunities have been greatly wasted, these means wrongfully applied, and these duties wantonly neglected.

These universities were primarily intended for the teaching of those branches of knowledge which have since developed into science. I imagine that education as understood for instance by the Greek was mainly athletic, scientific, æsthetic, literary, and political; literature in its widest, politics in its narrowest sense. Their philosophers looked around, as all philosophers are bound to do, as most have done excepting Kant and Comte, whose philosophy, based upon insufficient scientific knowledge, crumbles to pieces when touched. The Greek philosopher got much of his honey from abroad; but the comb he built for it was geometric, universal.

It was for the purpose of understanding such scientific writers as Aristotle, Euclid, Archimedes, that the "schools" were founded and supported. Then we have Plato, who seems to me to be forever hanging on to the hem of the garment of the Great Master. Much of this of course came through the Latin language. But shortly the means became the end. The language was found to contain a literature. Then a curious but not unnatural event happened. The means of acquiring knowledge in a foreign language degenerated—I will use no other word—into the study of that language, redeemed by the simultaneous acquirement of its marvelous literary treasures. Hence arose the dreadful school of dogmatic grammarians and pseudophilologists. Their day is passing, because grammar and philology are becoming sciences as exact at least as geology or biology.

It is, I think, hopefully to be expected that we shall soon lose sight of those dreadful creatures who used to wobble their heads over what they in their ignorance conceived to be a false quantity, often mistaking accent for quantity, partly through want of scientific training, partly through ignorance of the knowledge acquired by other nations. Such creatures were, perhaps, the natural outgrowth of the state of transition between Aristotle and Darwin, between Archimedes and Joule.

The really frightful outcome of all this was that, for a time, information took the place of knowledge; and the culture of the university was little beyond that of the cabman, the postman, or at best that of the librarian.

Perhaps the very greatest revelations made to man in the historical past took place in the last quarter of the last century and in the first half of the present. It was then that chemistry led us to understand the composition of matter. It was then that physics developed the co-ordination of the known forces and showed the existence of a new one. It has been during this time that biology has been changed from the chaos of natural history into a hopeful cosmic science.

In the matter of chemistry, the record of what we owe to these universities is shamefully short. While the intellectual world was ringing with the discoveries of Priestley, Black, and Lavoisier, the universities were concerned with the insignificant squabbles of philologists. While Faraday and Dumas, Liebig and Darwin were at work, what was, say, Oxford doing? Future generations will scarcely credit it. The leading lights in that university had nothing better to do apparently than to issue and discuss tracts on the difference between "tweedle-dum and tweedle-dee."

And even now, in spite of many vigorous efforts and encouraging successes, in spite of the notable men who have filled and are filling the posts of teachers, the universities under consideration can not be considered as centers of science. The very best men connected with the universities are the first to admit this. For such centers those who wish to become masters of the craft have had to look abroad, or to the metropolis, or to our provinces.

In regard to the teaching of science in the most widely known of our English public schools, we must regard it as being for the most part abortive. This has, without doubt, been brought about chiefly by the narrowness of culture of the head masters and their subordinates.

In such a school the unhappy science teacher is the worst off. If he be also a teacher of classics, who undertakes to teach science by reason of some smattering of it which he may have picked up in a desultory manner, his task is distasteful to him, and we may be sure he is not slow to contaminate his scholars with such distaste. He detests his duties partly because his ignorance is a disagreeable revelation to himself, but mainly because he feels that quick-witted lads soon discover his incompetence.

If, on the other hand, a highly qualified scientific man is employed, he finds himself out of sympathy, almost out of touch, with the rest of the school. The absolute necessities for teaching his science are denied to him or grudgingly dribbled out. His colleagues regard him without any feeling of comradeship, and so again the boys get to look on him as a sort of pariah, and on his occupation with contempt.

Observe the vicious circle. With ignorances and prejudices such as those I have mentioned the scholars from such schools go up to the universities, and give to them in the main their own uncultured tone. As it is from the universities that public schoolmasters are for the most part drawn, the bar to improvement seems strong indeed. One obvious way to break this vicious circle lies, it is true, at hand. I can not consider it conveniently here, and I am loath to touch upon it. But this much must be said: it can not be for the welfare of any religious body that its highest offices should be filled as often as they are from a class—the class of head masters—which persistently and almost professionally sets its face against natural knowledge. For it is thus a premium is placed on one-sided and therefore imperfect culture at the very fountain-head of education. Still more rarely can it be for the advantage of a public school to be under the guidance of a member of a class which has, speaking generally, consistently shown both fear and dislike of Nature and her interpreters. Whatever hope there may be in the future for relief in this matter, it is probable that such relief will rather be effected from the outside than from the inside.

As to this influence from the outside, where shall we look for it? Clearly in the aspirations, ambitions, and discontents of the better classes. The better classes are the more intelligent classes, and these are, without any doubt whatever, formed from the ranks of the artisan or handicraftsman—whether of our cities or our fields—and especially from the ranks of those who have been artisans or handicraftsmen, but whose ability has advanced them, say, from the laborer to the farmer, from the carpenter to the builder, from the nail-maker to the engineer, from the apprentice on a barge to the captain of a "liner." It is here or hereabouts that the very marrow of our nation lies. The aspirations of these classes are opposed directly and indirectly by the more ignorant classes both above and below them. The dangerous classes are the idle classes of all ranks. He would do a far greater service to the commonwealth who should give useful employment to the idle rich than he who should sweep away a thousand slums.

It is disastrous folly to fight against the inevitable. Science will take, and is taking, its proper place in our system of education. Men may bury themselves in the darkest crypts of ignorance; they may raise the densest smoke of prejudice or spread most diligently their little umbrellas of effeminacy, and fancy they have shut out the sun from the whole earth. The contest, if contest it can be called, which is waged against science, consists of hysterical vituperation on the one hand, and mainly pity on the other. Such a contest is only of passing interest, for the issue admits of no doubt. On the side of our opponents there are, it is true, the prejudices and ignorances of the half-cultured; but on the other there is the whole universe. They who oppose the introduction of science into even elementary schools do so at their proper peril and that of the commonwealth.

Having discussed briefly the positions which science has held, is holding, and should hold in general education, I shall now consider what I conceive to be the proper way of introducing the child to a knowledge of the material world. In a little book which I published some years ago, called The First Book of Knowledge, I drew up a systematic course of object lessons of the kind which I should like to see generally adopted, because I think that, however defective it may be in many respects, it is perhaps the first attempt to direct this kind of education; and I insist that, on this account, it or its method will have to be considered by educationalists. For, after all, it must be conceded that matter, and the properties of matter, play a not unimportant part in the universe in which we happen—at the present moment at least—to be living. And so my task will consist mainly in considering the purpose and use of such a book.

In the first place, it should not be a book of reference; it should not be written and used on the principle of a directory or of a dictionary, or even of a manual of household recipes, which we consult to-day to find out how to make egg sauce; and to-morrow, how to remove ink stains from the fingers.

It must be progressive in order to be educational; it must deal with familiar stuffs and things in such a fashion, and after such an order, that the understanding of one may help in the understanding of those afterward to be considered.

On the table before you is a series of familiar "stuffs and things." The total cost, including the packing box and bottles, may be three or four pounds. This collection was made to illustrate the book of which I have spoken, and it contains, I believe, all the stuffs and things required in the building of a house and used by its indweller.

Now let us build the house. The first stuff is concrete. This is made of lime and pebbles or gravel. To make lime, again, limestone or chalk is required. And to quicken or burn either, fuel is necessary. I find it therefore convenient to describe the formation of coal, and to defer the description of the formation of wood and the growth of plants, and also of the process of combustion, to a later chapter.

After coal, the description of the formation of coke, ashes, cinders, and breeze follows at once; but the complete description of the manufacture of coke is deferred until that of gas is considered.

The pupil is now prepared to understand the action of fire on limestone—the quenching or slacking of quicklime, and the formation of concrete and mortar. A description of the natural formaion of clay is followed by an account of the manufacture of bricks, tiles, drain pipes, chimney pots, etc. Slate finds its proper place hereabouts.

Such stuffs as marble, granite, sandstone, and plaster (stucco) may be now described.

The chief metals used in house construction or in house furniture are iron, lead, zinc, copper, tin, and mercury, and their derivatives, such as brass, zinc plate, tin plate, and so on. And, perhaps, the only stuffs still demanding consideration are glass, glue, whitewash, litharge, and putty.

Now, all these stuffs should not only be seen, they should be handled by the pupils, and such processes as the slacking of lime, the setting of mortar and of plaster, the baking of clay, and the reduction of some of the metals from their ores, should be shown, as can easily be done by means of the materials and a few pieces of apparatus before you.

It is thus seen that I adopt the plan, which I think is the soundest one, of not attempting to generalize or philosophize until the child has got something to generalize from. But such generalization must not be delayed too long; for it is of incalculable help to the pupil in his further studies.

Accordingly, I would here or hereabouts introduce him to that truly awful revelation that there are on the earth, as far as we can search; in the earth, as far as we can dig; ay, and throughout the universe as far as we can see, but a limited number of prime stuffs—the elements. To my mind two men are in no sense on the same intellectual level whereof the one can and the other can not tell you of what elements familiar things consist. The latter may be intelligent, possibly he is well-meaning; intellectually he is a savage. Such savages abound in all strata of our commonwealth. Such savages are dangerous. We must not kill them; we are not even permitted to teach them. Let us at least catch and civilize their children, both for their own sakes and ours.

The conception of the elements leads at once to air and that type of chemical uniting called burning. Much time spent in a careful study of fire, flame, and water would be well spent indeed. Practically, and returning to our scheme, I find it far best for educational purposes to secure such generalization at about this point. The pupil can now understand something about wood, the last of the stuffs considered in the building of a house.

Such knowledge brings us at once to the heating and lighting of the house, and so to the manufacture of charcoal, the formation of peat, and the making of coal gas. The methods of obtaining a light lead to the interesting and instructive subject of matches, and the stuffs of which they are made.

Our next chapter might properly include the finishing and furnishing of the house. By finishing I mean such processes as papering, painting, glazing, and varnishing. Furnishing would embrace the origin and manufacture of cotton thread, flax, linen, hemp, canvas, cane, wool, carpets, oilcloth, cocoanut fiber, mirrors, German silver, silver; the processes of lacquering, plating, and the manufacture of pottery, porcelain, and earthenware.

The next division would concern the person, and would include chapters on clothing, food, washing, writing, and reading.

In clothing would have to be described the textile fabrics, skins, tanning, with such adjuncts as pins, needles, combs, and brushes.

Concerning food I should be inclined to confine the instruction to such things as the five B's of food—bread, butter, beef, beer, and bacon—and such as milk, cheese, eggs.

The description of the manufacture of bread should be in a manner an intellectual epic poem. The growing of the wheat, its thrashing, winnowing, grinding, bolting; the nature and effect of yeast; the effect of baking; the relationship between the constituents of the wheat and the body. All this, I say, constitutes an epic of infinitely greater beauty, strength, and significance than can be furnished by the sulks of Achilles, the wanderings of the pious Æneas (I wish he had been drowned), the tortures of the Inferno, the ravings of Orlando, the childish imagery of Milton, or the dreary paraphrase of Klopstock.

The epic of bread is, and must be, as far above the epic of the poet as is the mere external beauty of a living flower above that of the most elaborate and gorgeous design on the back of a playing card. And I suppose the study of the construction and life of the flower is more elevating than the most subtle game of whist which was ever played.

In the matter of food, again, we have to guard carefully against the dogmatism of the smatterers who talk so glibly of flesh-formers, fat-formers, bone-formers, and so on, as though you had only to eat fat in order to become fat; bone, to become bony; flesh, to become muscular. There are people whom one may, without offense, call the "prigs" of this particular branch of science, who fancy that Liebig's extract of meat, for instance, is concentrated meat, and that a few grains of it are of the same nutritive value as an ounce of meat. This, I need scarcely say, was not the view of the illustrious author of the extract. He justly looked upon it as a condiment or stimulant. There are those who, by quoting chemical formulæ, would fondly persuade us that there is as much nourishment in an egg as in a chop. I need scarcely say I do not believe them, for I don't suppose you do. Such people compare the analysis of grain with that of the human body, and tell us to eat pumpernickel, or rye bread, or brown bread, or whole-meal bread, or white bread, according to their schools. In order to be consistent they should recommend cannibalism, and preach that—

"The proper nourishment of man is man."

The people of whom I am speaking usually write to the papers. One shows how the condition of the workingman may be made one of affluence and comfort by living chiefly on dandelions, nettles, and sorrel (with perhaps a pinch of pepper). Another shows how the weight of a pound of steak may be doubled by cutting it up fine and stewing it with sixteen ounces of water. A third demonstrates how essential to the human frame is a certain amount of lime, and deplores the wastefulness of throwing away the shells of oysters, lobsters, and eggs. Yet another, of a more synthetic turn of mind, is familiar with heat-producers and flesh-formers, with carbon, nitrogen, and phosphorus compounds. His knowledge of chemistry enables him to recommend a cheap dish consisting of charcoal, saltpeter, tallow, and glue, flavored with singed feathers and stirred up with a few matches.

I need not apologize for speaking at some length on this subject. Food is as important to the human being as fuel is to the steam engine. It was once made a subject of reproach or banter against our nation that we had a hundred religions and only one sauce, while the nation of our critic had only one religion and a hundred sauces. I suppose if this epigram were fairly analyzed it might be found to be based upon the fact that our meats had a hundred different flavors, and our hundred religions only one; while the one religion of our critic's countrymen had a hundred different flavors and their hundred meats a single one. For I need not remind you that when and where the cooking has become most elaborate the feeding is at its worst; for, instead of depending upon the exquisite flavors of the simply cooked constituents of a meal, a sort of "Ur-wurst," or universal sausage, containing a thousand flavors, and therefore none, is the result. As good wine needs no bush, so good food needs little cookery and less sauce.

In the next place should be considered materials used in cleaning, such as soap, soda, hearthstone, sponge, vitriol, emery. And finally the materials used in writing and in books—the manufacture of paper and of pens, of inks, of pencils, of type, and the rest.

I can not but think that some such system as I have laid before you will be—will have to be—introduced into elementary education, into the education of our school boards. Not only that the lads on leaving school may be more useful citizens, but that they may have that knowledge which alone gives happiness, and which never turns to bitterness, or proves to be vain, the knowledge of the ways and the beauties of almighty Nature.

SERVILITY IN DRESS.

By HERBERT MAXWELL.

THE further we travel from the origin of our species the less concern does male humanity show to enhance what share of beauty it may lay claim to, or to screen the ugliness it is generally heir to, by grace of garments. Among civilized and well-to-do men, gala costume has no keynote now but respectability—at weddings as at funerals, at garden parties as in Parliament, costume is attuned to harmonize with the hurtful cylinder of sable which the supineness of our great-grandfathers allowed the hatters to impose on them as a headdress, and a hundred hopeless years have but served to bind more tightly on our aching brows. If the chimney-pot hat were comfortable wear—were it sunproof or rainproof, or easily carried when not in use—our allegiance to it might be monotonous, but at least it would be intelligible. But, in plain sooth, it is intolerable in sunshine; it is so sensitive of rain-drops that an umbrella must be carried for its special shelter; and when we travel, it is as difficult to dispose of as a murdered corpse. It can not be concealed; the accursed thing will fit in with no other portion of our raiment, and must be provided with a special case of grotesque and impracticable shape. In wear or out of wear, we can not forget its existence nor neglect to make provision for its protection. Cephalalgic humanity has tried every means to be quit of it, but in vain. The creature has not even a serious name, for no one, except the fiend who frames it, knows it as a silk hat; schoolboys, with the contempt born of familiarity, call it a "buster" or a "topper"; soldiers, scornfully, a "stovepipe"; civilians, realistically, a "chimney-pot." In vain has bountiful Nature provided straw, and human ingenuity fashioned felt: two more perfect substances for head-covering could not have been devised; but, perversely, littering our horses with the one, and roofing our barns with the other, we thrust our thinking organs into unyielding towers of pasteboard. In a simpler age we should have made a god of It—prayed to It, sung to It, bowed to It, propitiated It; but, having adopted monotheism, we are outwardly consistent, and are content to insist on taking it to church with us. The first inhabitant of Mars who visits the earth, and publishes a volume of travels on his return, will probably describe how, in western Europe, the possession of a chimney-pot hat is held to be essential to salvation.

And now let us dismiss the Hat from consideration (would that it could be as easily dismissed from wear!) with a passing speculation as to the tenacity with which, in its present form, it has fixed itself in our scheme of costume. This probably has its origin in the jealousy felt by those under middle height toward others of more commanding stature. The desire to level humanity down to one standard has undoubtedly given rise to many of our fashions. A small man may *look* no bigger with a tall hat on, but he *feels* so. A hat which adds four inches to the height of each of two men—one, A, being five feet high, the other, B, being six feet high—reduces the advantage possessed by B. For although he will still be twelve inches taller than A, A will no longer be shorter than B by one fifth of his (A's) own height, for 64 inches is to 76 as 16 to 19, whereas 60 inches is to 72 only as 15 to 18. £999 is much nearer £1,000 than £9 is to £10, though between each pair there is the same difference of 20*s.* So it looks as if in this matter of hats the small men are the chief culprits.

The same jealousy of superior physical advantage has brought about many of our ugliest fashions. Sculptors and painters sigh with vain *Weltschmer* for the small-clothes of eighteenth-century Macaronis and the trunk-hose of the Elizabethans, but so long as some men continue to be born with spindle or crooked shanks and doubtful ankles, so long will well-turned limbs be doomed to the obscurity of trousers. The excuse that trousers are more convenient and comfortable than breeches and hose is groundless and insincere.

In like degree, as graceful shapes have ceased to be sought for in designing men's garments, beauty of color has also been rejected, and a preference shown for black, white, or neutral tints. In no article of clothing is this more rigidly prescribed than in leg covering; and this is the more remarkable because the word "breeches" is supposed to be derived through the Roman form *braccæ*, from the Celtic *breac*, which means variegated, of many colors. This marked preference for somber hues arises, in part, from the same desire to neutralize the effect of physical superiority which has spoiled the shape of modern clothes.

It is part of the same plan which, as is well known to ethnographers, takes the form of tooth-breaking among primitive people in different parts of the world. Just as an influential Batoka of East Africa, or a Penong of Burmah, whose teeth happened to be defective, feels happier when he has persuaded other young men of his tribe to deface their faultless ivory; so a European grandee, of bilious or dyspeptic habit, would look with prejudice on one whose clear complexion and ruddy cheeks gained brilliancy by contrast with pale-blue satin or carnation silk; he might at least have the sense to eschew such combinations in his own attire, and, by showing preference for somber tints, tend, in virtue of his position and influence, to set the fashion flowing that way.

It is difficult to decide whether the gradual suppression of magnificence in male attire and the development of feminine finery among civilized races, is more interesting to the zoölogist, the anthropologist, or the moral philosopher.

To the first of these it is a perplexing departure from the scheme of Nature, where it is a rule that any marked difference between the sexes confers greater splendor upon the male. The peacock and peahen, the lion and lioness, the stag and the hind, are common examples of a principle which, among the higher animals, finds its only exception among certain falcons.

As for our moral philosopher, his opinion does not count for much in matters of dress, or its substitute—tattooing. He probably wears a shocking bad hat, with marks of ancient rain-drops, which, like those on the Corncockle flags in the New Red Sandstone, having once been allowed to dry, are practically indelible. His umbrella is robust enough to shelter three abreast, but, honest man, he had left it in the stand at the British Museum, or his mind was too busy with a complicated train of thought to allow him to put it up at the right moment. His theory of feminine dress finds no favor with the wife of his bosom or his daughters; they bewilder him by the mutability of their fashions, for no sooner has he found a parallel in dress-improvers to the worship of Venus Callipyge, than lo! they have melted away, and an unaccountable protuberance appears somewhere else. He prepares unanswerable arguments against the cruelty of adorning hats with feathers and the bodies of little birds, but, before he can produce them, ribbons and flowers are all the mode.

Perhaps women devote themselves to the details of millinery all the more because we men have allotted to them more than a fair share of the dull things of this life. We have left them comparatively little on which they can occupy themselves agreeably. They have books, of course, but books only serve as a whet to active employment. The daily round of household duties, the weekly discharge of bills, the tedious routine of morning calls, visitation of the sick—everything, in short, that bores a man is cast upon his wife; no wonder if her thoughts attach themselves to matters of toilet, which we despise as being beneath our dignity. And thereby we, who are the oppressors, derive unmerited advantage, for we are free to feast our eyes on the pretty things in which the fair sex go pranked.

Not that our enjoyment is without alloy. Feminine costume is subject to the most sudden and excruciating variations. No sooner have we learned to delight in a simple, becoming fashion, than instantly the Evil One, whose dwelling-place is in Paris, contrives some mock deformity, and every woman of spirit hastens to adopt it. There is nothing in the human frame more pleasing to the eye than the sweet lines of a woman's shoulder; yet this is precisely the part which, during the last year or two, the malice of *modistes* has concealed with every ingenuity of structure. Vertical humps have been placed there, contrived so as to make the chest look as narrow, the shoulders as high, and the neck as short as possible.

The serious part of this is, that the immense cost of women's dress leaves nothing of value behind it. Sables are positively the only purchase that can be looked on as a safe investment. The most thoughtful selection and design of other materials is sure to be soon stultified by the imperious caprice of Monsieur Worth. By no means can the sorrowful folly of this thralldom be brought home to one more forcibly than by a visit to the cases in the British Museum, containing the little funebral figures from the tombs of Tanagra. The exquisite grace of raiment, the delicate hair-dressing, varied to suit each different cast of features, the care with which beauty of form is accentuated instead of being wrapped up or distorted—all convince one of the cruelty of the modern system which robs our eyes of legitimate delight. How would it be with us were it the custom to lay in the tombs of our departed ones little statuettes, representing them in their best clothes? Should we not shrink from the criticism of posterity? It must be confessed that women would stand this ordeal better than men: still, a modern ball-dress, with corsage cutting horizontally across the bust, is a terrible violation of the natural lines of the figure, especially when, by means of long stays, the cincture is thrust away down where no sculptor would dream of placing it. In the name of common honesty, whence comes the mock delicacy of forbidding the form of a woman's legs to be seen? Are they more suggestive of unlawful thoughts than arms and shoulders? Shall Diana be accounted less than chaste because her statue in the Vatican shows her with tunic girt well above her bare knees? The Spartan virgins were not the less reverently regarded because the graceful *chiton*, being open on one side to allow freedom of movement, flew open as they walked, and got them the name of φαινομηρίδες. It is utterly unjust that, because some women have indifferent legs, all should be compelled to wear long skirts on all occasions. If it is desired to see which is most becoming, compare an Ayrshire dairymaid in work-a-day attire of short pleated petticoat and the linen jacket called a bedgown, snooded hair, woolen hose, and serviceable shoes, with the same girl figged out on Sunday with a flyaway bonnet on her head, a travesty of Paris fashions on her back, trailing skirts, and high-heeled Balmorals. Of the two, the first is not only the more pleasing, but infinitely the more modest in appearance.

Marie Bashkirtseff, in composing the most self-conscious journal ever penned, was in the habit of subjecting her own actions and those of others to frank analysis. She came to the conclusion that the sentiment of physical modesty was one arising from a sense of one's own imperfection; that if one could be quite conscious of perfect proportion and beauty, there would cease to be any motive or impulse to conceal the body and limbs. Perhaps it is as well that misgivings on this point are pretty universal; but, seeing that it is fixed by an utterly arbitrary rule what portions of the body may be displayed and what may be concealed, it may be permitted to enter a protest against the tyranny which forbids one young lady to show her ankles because another one finds it expedient to conceal hers.

One longs for redemption from the barbarities of feminine fashions. One sighs to exchange the long, wasp-like waists and tight-lacing for the simple, easy gowns of our grandmothers, to replace the girdle where the Grecian zone was bound, just clear of the ribs. But one has an uneasy foreboding that the simplicity of classical toilets might be interfered with by the diabolical devices of milliners. At the close of last century, before small waists came, in the inscrutable movement of the female mind, to be counted a beauty, there was an atrocious fashion of wearing pads below the girdle, so that the drapery should fall in unbroken sweep from the bosom to the ground. Many were the shafts aimed by ribald writers against this extraordinary device; many the unjust imputations to which it gave rise:

> "Some say Nature's rights 'tis invading
> This sham swelling garb to put on:
> For how, with these false bills of lading,
> Can ships by their rigging be known?"

It passed away, and the last ninety years have seen the beginning and end of many other modes more unsightly and not less absurd. Is it hoping too much that, seeing how fast the fashions fly, all the ludicrous, hideous, and hurtful ones will, in the fullness of time, have been discarded, and a return be made to the only faultless model the world has ever seen?—*Abridged from an article entitled Clothes in Blackwood's Magazine.*

Réaumur is quoted as having written, in 1720, of Bernard Palissy, the potter and one of the procreators of geology, that "it was a hundred and fifty years ago that a French author who seemed to glory in his ignorance of Latin and Greek pointed out a large number of places in the kingdom where shells are buried. I mean Bernard Palissy, all of whose ideas I would not adopt, but whose spirit of observation and clearness of style I admire extremely. I am little concerned about his lack of literary knowledge, but I can not repress a regret that he had to make pots and follow the art of *faïence* to make a living for himself and his family." Réaumur, says a French journal, would be consoled if he knew the price the pots he despised so heartily would bring now.

PREHISTORIC TREPANNING.

ONE of the most remarkable revelations made of late years by prehistoric archæology relative to primitive man has been that of the extent to which trepanning was practiced by the men of the polished stone age—the men who erected the rude stone monuments of which Stonehenge and Carnac are the highest expressions.

In 1872 Dr. Prunières first called attention to the fact that among the interments of the neolithic age in the limestone caverns of Lozère, and under the so-called dolmens, a certain number of skulls found had been surgically treated. Portions of the skull had been removed, in many cases during life; whereas others had been trepanned after death. There could be no question but that in many cases those who had been operated upon had survived the operation, as the reparative efforts of Nature were marked.

The matter was taken up by Dr. Broca, who published an essay on the subject, which he had communicated to the Anthropological Congress at Buda-Pesth in 1876. It has since been investigated by M. Nadaillac, and has been recently referred to by Count d'Alviella in his Hibbert Lectures for 1891.

A word first upon the race which practiced trepanning. As far as can be ascertained, it entered Europe by the shores of the Baltic from the Caucasus and Crimea, strewing the plains of Pomerania, Hanover, and Gröningen with their monuments, erected out of the stones left by the rafts of ice that floated over these submerged plains in the Glacial period. This race occupied Denmark and Sweden, crossed into Great Britain, and has left its remains in Scotland, Ireland, Wales, the west of England, Dorset, Wiltshire, and Kent. It entered France, made Brittany its stronghold, traced up the rivers to the central plateau of France, but never occupied the upper waters of the Elbe, the Rhine, or the Meuse, was never on the Danube at all, and, though it descended from the central mountains of France to the Rhone, yet never advanced far east beyond it. On the other hand, it crossed the Pyrenees, erected its rude stone monuments in Spain and Portugal, traversed the strait of Gibraltar, and, after setting up some circles and cromlechs in northern Africa, disappeared altogether.

What this race was we do not know; it was not a pure one, for among the skulls found in its sepulchral monuments some are round and some are long-headed; but in all probability it was a long-headed race that had subjected other peoples, and had brought along with it wives and slaves of alien blood.

The tools and weapons of this remarkable people are of beautifully polished flint, chert, and jade. In the possession of the writer is a granite axe-head from a dolmen in the center of France, on which great pains have been spent to give it a polish. Some of the flint spear-heads worked by them are marvels of labor and ingenuity. A large core of flint has been taken, and out of it a flake has been got which has been not only worked into a flame or tonguelike shape, but has been diagonally grooved throughout on one side for ornamental purposes. One such, over a foot in length, of milk-white translucent flint, was found in a dolmen on the Lot a few years ago. It was scooped out with forty diagonal spiral lines. The labor expended upon it is incredible. This race was acquainted with pottery. It did not burn its dead at first, but very frequently scraped the flesh off the bones before consigning the remains to the sepulchre. The bones preserve the scratches made by the flint scrapers, and they are not always correctly placed to form the skeleton in its tomb, a left arm being sometimes put to a right shoulder; and sometimes important bones are missing. After a while bronze became known to the race of the megalithic monuments. It was introduced from the south; it seems to have traveled up the basin of the Po.

In 1880 the Baron de Baye published the results of some remarkable discoveries made by him in the chalk of the Marne. Here he discovered a number of caves sealed up, and completely untouched, that had been the sepulchres of men of the polished stone age. There was much about them that was extraordinary; one feature was a rude representation of a woman, always on the left side of the entrance into the sepulchral chamber. Along with this woman was figured, carved in the chalk, a flint hatchet; color had been applied to distinguish the flint stone from the horn handle into which it was fixed. In these mortuary caves a great number of remains of human beings was found. Some of the caverns were clearly family sepulchres. Some contained a large number of dead who had obviously been killed in a battle. But what specially concerns us now is the fact that, among the skulls recovered from these caves, a certain number showed that they had been trepanned, precisely as had been the skulls obtained by Dr. Prunières from the caves and dolmens of Lozère. Not only so, but the dolmens of Algeria have given up skulls treated in like manner, so have some found in Denmark. Obviously the very unpleasant custom of cutting slices out of the skulls of some of their members was continued in this race from their first appearance in Europe to their final disappearance in Africa.

M. Cartailhac, in his La France préhistorique, says: "A considerable number of our sepulchres contain perforated human skulls. The openings, without being geometrical in shape, are sufficiently regular; they approach more or less the shape of an ellipse, in length about 1⅝ inch; the sides are gradually reduced in thickness, and are always cut obliquely, at the expense of the outer surface of the bone."

These holes cut in the head occupy different positions; some are at the side, some on the top of the head, but never on the brow or any portion not covered with hair. It is quite impossible to suppose that they have been due to a blow of an axe or sword. That would only be possible where portions of the skull were arched or projecting. Moreover, a blow would have left bruises on the bone, and it must be remembered that steel weapons were then unknown; no flint or bronze axe or sword could make so clean a cut. Besides, an examination of the edges of the wounds reveals the manner in which the trepanning was effected. There remain the scratches, formed by a slip of the tool employed, and the marks of the flint scraper which effected the operation. In the majority of cases the skull was mutilated during life, and it was carried out with such skill as not to injure vitality. Some of the operations took place in childhood, and those who had been trepanned grew to be men and women.

The tool employed seems to have been invariably a flint scraper, with a sharp edge, which was worked round and round the portion of the skull that was to be removed till the bone was cut through, when the disk was taken out whole. It was necessarily a laborious and lengthy process; it could not possibly have taken less than an hour. In the case of children, when the skull is tender, it would, of course, take very much less time.

The first of the trepanned skulls was discovered as early as 1685 in the tomb of Cocherel. Montfaucon mentions it. He says, "One of the heads there found had the skull pierced in two places, and apparently both wounds had healed." A second specimen was found in 1816 in a cave at Nogent-les-Vierges which contained two hundred skeletons. "One of the skulls had in it a great hole three inches long and two inches wide, which seems to have been caused by a wound which had resulted in the loss of a large piece of bone. Nature had repaired the edges of the fracture, and M. Cuvier thinks that the man in question may have lived a dozen years after having received it." Thus this discovery was described at the time and misunderstood. It was not till Dr. Prunières drew attention to the frequency of skulls being thus marked and mutilated that the importance of the matter was realized.

In the Ribeiro Museum at Lisbon is a skull of the neolithic age that shows on it the work of the operator left unfinished; the oval has been nearly, not quite, cut through. In the Musée Broca of the Société d'Anthropologie is a skull from Oise, of a man who apparently died under operation. Other skulls are indeed found that have been submitted to the saw. One was dug [illegible] in the valley of the Petit-Morin with the whole top of the head removed, but these belong to an entirely different category. They are all cases of mutilation after death—mutilation, in all probability, of the heads of enemies.

One of the skulls found by the Baron de Baye was that of a man of advanced age who had been trepanned twice at different periods, and had recovered from both operations.

But this is not all. Not only were skulls of living men systematically trepanned among the men who raised the rude stone circles and dolmens, or, as we call them, cromlechs, but they preserved and used as ornaments or amulets the pieces of skull thus removed. A great number of such cranial disks, pierced with one or two holes for suspension, have also been found in their sepulchres, and these are not infrequently polished or rubbed by the long usage.

It does not appear that this strange custom of removing portions of the skulls of living men and women was confined to the [illegible]. Skulls similarly treated have been found elsewhere. If it were a fashion, it spread among other races.

One portion of a skull bored with holes for suspension was found in a tumulus in Thuringia belonging to the bronze age. A trepanned skull was extracted from a covered stone avenue at Borreby, in Denmark; another from a dolmen at Näs, in the isle of Falster; another comes from Karleby, in West Gothland, from a tomb of the transition period from polished stone to bronze, and this, so far, is the sole example from Sweden.

But prehistoric trepanning was practiced in America. In the Peabody Museum is a skull thus treated. Another comes from Peru. A mound on the Devil's River furnished another example. More trepanned skulls have been found near Lake Huron and Grape Mound. A skull in a great tumulus on the river Detroit had two holes cut in it. A sepulchre at Chaclocayo, near Lima, contained a head that had undergone like treatment. A trepanned skull was found in a tomb in the upper basin of the Amazon. But all the American cases are of cranial mutilation after death.

To come to Europe, in addition to those trepanned skulls already mentioned in Sweden, Denmark, and France, they have been found in tombs of the neolithic age in Portugal and in Spain.

Dr. Boulongne, in his work on Montenegro, says that it is a custom of the natives of the Black Mountain to have portions of their skulls removed for the smallest motive, merely if troubled with headache, and not at all solely because of a blow and breakage of the skull and concussion of the brain. He says that he knew of individuals who had themselves trepanned seven or eight times without its affecting their health.

Apparently in all these cases the persons who were trepanned walked about among their fellows with always a soft place in their heads. But sound skulls have also been found with disks from other men's heads securely lodged within their own. These disks must have been introduced after death, and must have had a religious purpose.

The first of those so discovered was in the museum of Grenoble; it was noted in 1867 by M. Chambre, who completely misunderstood it, and supposed that the disk was a sort of bone spoon.

Another very singular discovery among the sepulchral remains of the same epoch and race concerns skulls, though not the trepanning of them. A considerable number of heads have been discovered stuffed with children's bones, and bearing traces of having been polished by friction. The skulls have apparently been carried hung round the neck as a sort of pocket on the breast, and small bones belonging to several children have been packed within them, specimen bones, as it were, taken from several different subjects.

The explanation of this is much easier than that of the trepanned skulls. It is supposed that a widow carried about with her the head of the "late lamented," and that in it she preserved memorials of her children who had died young, for the purpose of keeping by her a couple of bones of each of her pets.

The practice of wearing disks of skull was not confined to the people of the stone age. Two such have been found with holes for suspension in a Gaulish sepulchre at Wargemoulin, in Champagne, suspended to a bronze torque. Another was found with the body of a child of the Gaulish epoch. Others have been found in the cemeteries of Marne appertaining to the same people and to the historic period. In some cases undoubtedly heads were operated upon after death, and portions removed to serve as trophies, much as a North American Indian carried off and gloried in the scalps he obtained. But the evidence is all against this as explaining the greater number of cases of holed heads.

What is more probable is that these cranial disks were employed as amulets. In the exhibition at Milan in 1881, M. Bellucci showed such a portion of a skull that had been actually in use at the present day among the Italian peasantry as a cure for convulsions and epilepsy.

The writer of this article remembers some forty years ago making the acquaintance of a very charming Irish gentleman and lady. One day she thought she observed that his eyes were resting inquiringly on her brooch, which was of gold, inclosing a mass of fractured bone. She laughed and said: "Are you admiring my brooch? I will tell you the story of it. One day, some ten years ago, when I was a young girl, I was staying in the house of a friend who also knew Mr. X., who is now my husband. We were having a game—a romp—and running after each other through the house, which was large, with long galleries and chambers communicating with one another. Mr. X. was close behind me, trying to catch me. I darted through a door and threw the door back behind me. Mr. X. had his head down, and the handle struck his skull and he fell stunned. The skull was fractured, and to save his life he was obliged to have it trepanned. Now he wears a plate of silver over the hole, and I wear the portion cut out of his skull in this brooch. The accident—I suppose my distress and remorse—brought about a *rapprochement*; we became engaged, and are now man and wife."

So the custom of wearing cranial disks need not be regarded as completely done away with, even in our days.

Various explanations have been offered to account for the trepanning of the skulls of the neolithic men; but perhaps, before considering them, it will be as well to notice another series of phenomena, and that connected with the sepulchres of the same people, as it belongs apparently to the same category. This is the perforation of the tombs themselves. It has been observed repeatedly that among the dolmens, covered avenues, and kistvaens of this race there is very generally one stone that has been trepanned—had a hole cut through it; not only so, but that in their circles of stones one gap has been almost invariably left so as to make the circle incomplete. Trevethy Quoit, in Cornwall, has a rectangular hole cut through the cap-stone. La Maison des Fées, at Grammont, in Hérault, has the stone at the head perforated. At Conflans was one of these monuments with not only a round hole in the closing stone at the foot, but also the plug wherewith the hole could at will be closed. It has been moved to the Musée St.-Germain. In the Crimea and in the Caucasus, where the same kind of monuments is found, the hole in one side, laboriously bored through one slab, is a constant feature.

We may, and probably ought to, connect the holed stones in tombs with the holes in the skulls. And the most probable explanation of both is that they were intended as openings whereby the spirits might escape, and trepanning was employed on those who suffered from epilepsy, which was regarded as possession by an evil spirit. Broca says: "The art of trepanning was applied to certain spontaneous maladies, and followed the opinion formed of affections of the head in nervous disorders, as idiocy, convulsions, insanity, epilepsy. Maladies which science regards as natural struck the imagination of the ignorant, and they attributed them to divine causes, to demons, to possession. Who can say that trepanning, now a practice almost abandoned, was not employed among the first men as a means of letting demons escape out of the system, by opening for them a door of exit?"

"I ask," says Broca again, "for what motive these operations were performed, not always, indeed, but usually, on young subjects, often on mere children; and I venture to suggest that they were due to some superstition, and formed part of a ceremony of initiation into some sort of priesthood. This would, indeed, suppose that there existed a sacerdotal caste among the neolithic people, and there can be little doubt that they did possess an organized form of worship. The cranial disk inserted in a skull after death, what can it mean but some vague belief in another life? If it be objected that the cranial mutilations were too grave to be accepted as a religious ceremony, I answer that trepanning is not in itself a very dangerous operation. If it is so often attended by fatal results nowadays, it is because recourse is had to it only in desperate cases. What produces death in so many instances where trepanning is resorted to, is not the trepanning, but the cerebral congestion which one endeavors to relieve by the operation. Besides, religious exaltation knows no limits. If certain divinities were ready to accept a scrap of skull in place of an entire human victim, they may have passed as remarkably indulgent. It is well known that among the negroes of western Africa some individuals will disembowel themselves as an initiation into sanctity, or to prove the efficacy of certain charms. Some of these men perish, but others recover, and such become saints among their tribe."

We are disposed rather to accept Dr. Broca's first suggestion than the last, and to regard trepanning among the prehistoric men as having had a therapeutic motive.

The perforation of the tomb was almost certainly intended as a door of exit for spirits. Even in later times, when the dead were burned, holes were often bored or knocked in the urns that contained the ashes, for the same purpose. Some cinerary urns have been found with little windows, as it were, made in them, and a piece of glass placed over the hole. Macrobius, in his Saturnalia, quotes an Etruscan belief that a door should be opened for the spirits to pass in and out.

The writer remembers a case of a dying woman some few years ago in Sussex. She was gasping, and apparently was undergoing the last struggle in great distress. The nurse went to the window and opened it. At once the dying woman breathed deeply and expired. The writer said to the nurse, "Why did you open the window?" The answer given was, "Surely you wouldn't have her soul go up the chimney?"

One can understand how that, if a piece of skull had been regarded as in contact with a demon or spirit, it would be respected as an amulet, and that so the *rondelles* removed from the heads of men who had been subject to epileptic fits would acquire a virtue in the eyes of the ignorant and superstitious, and be employed as charms. And this seems to be both the simplest and most intelligible explanation of the phenomena of hole-pierced heads, and of the wearing of the portions removed from those heads by men and women who had not themselves been trepanned.—*Cornhill Magazine.*

THE NEW STAR IN THE MILKY WAY.

A "NEW STAR" is a representative of a class of phenomena so rare that the number recorded during the last few centuries may be counted on the fingers. Hence we readily conceive that, since they are very striking in themselves as breaking the monotony of the starry heavens, and since also their nature was considered till quite recently to be shrouded in mystery, a most lively interest has been stirred up by the recent new arrival, not only among astronomers, but among that large class who are always on the *qui vive* for celestial wonders.

When tortured by the many instruments which modern science places at the observer's disposal, a new star is quite a thing *per se*; while at times their brilliancy is extraordinary, some of these "new stars" having rivaled both Mars and Jupiter in brightness, and even sometimes Venus.

The time that they take to wax and to wane varies very considerably; some have lasted at their greatest brightness only for days, others have remained visible for months or occasionally for years. It generally happens that a "new star" when first seen is brightest, and many have thought that this is simply because the star is at the stage most likely to be noticed by us; but this may not be the entire truth, as can be gathered from a consideration of the various views which have been put forward as to their nature.

Among the many hypotheses that have been suggested to explain how it is that these strange bodies make their appearance from time to time, we may first of all mention that which supposed them due to the sudden colliding of a comet with a star; another theory assumed that a star at some period of its existence became enveloped in a kind of crust or slag, which by some cause or other became disrupted, and revealed the glowing mass within.

Both these hypotheses, although they might to a certain degree explain the sudden brightness of the star, would not hold good with regard to the rapid diminution of its light, because, if large bodies are dealt with, the cooling must take a very long time.

The latest view put forward is, that these bodies are produced by the sudden meeting in space of two swarms or streams of meteoritic matter, each traveling with a considerable velocity, the sudden bright light being due to the collisions of the particles composing the swarms; and this hypothesis explains very well not only the sudden outburst, but the rapid decrease in brightness, due to the fact that only small particles are dealt with, and these must cool and dim quickly.

The appearance of the present new star, or "Nova," in the constellation of Auriga, was first announced by an anonymous post-card received at the Royal Observatory, Edinburgh. Why the post-card was sent anonymously remains a mystery; but the extraordinary reticence of the writer does not make any difference to the immortality of the discoverer; for while, on the one hand, newly discovered comets, which are also of an apparently temporary nature, are always associated with the names of those who first observe them, new stars, on the other hand, are always referred to by the name of the constellation in which they appear.

The instrument now used to obtain observations of these strange visitors consists of a combination of an object-glass; a prism, which is placed outside the object-glass, and a camera. The function of the prism is to separate the million strands of colored light which go to make white light; that of the object-glass is to collect each color, concentrating it at the same time, so that finally we get a fine line of rainbow color.

This method of obtaining a spectrum is by no means modern, but was suggested and used by the German optician Fraunhofer about the year 1814. He placed a prism before the object-glass of a theodolite, and in this way was the first to observe the spectra of some of the stars. By the use of this method, whether the eye or the photographic plate is used, the so-called "spectrum" of the body under observation can be studied without any difficulty. The length of the exposures required when photography is employed for stars of different magnitude varies very considerably; for the brightest a few minutes are generally ample, but for those of much smaller magnitude a space of two or three hours is by no means too long.

The spectra that are thus obtained are of various kinds, as various classes of so-called stars are observed. Some consist of bright lines on a dark background, others of dark lines on a bright background while a mixture of both these is met with. These variations in spectra depend upon the fact that any substance that is heated sufficiently to emit light whether in the heavens or on the earth, will give a spectrum. If it be a solid or liquid body, we shall have what is called a continuous spectrum—that is, a colored band bright from end to end, with no sign of any dark or bright lines about it. By continuing to heat this body until it becomes a mass of incandescent gas, the spectrum will become entirely changed, and will consist of a series of bright lines on a dark background, the number and position of the lines depending on the substance heated. But suppose, now, that the light from an incandescent solid or liquid body passes through a gas, what kind of a spectrum should we have? Experiment shows that in this case we get a continuous spectrum crossed by *dark* lines, these dark lines being produced by the peculiar power that a gas possesses of absorbing those particular rays of light which it emits. Thus we see that if we are dealing with incandescent solid or liquid bodies, we obtain continuous spectra; if with incandescent gases, bright-line spectra; and if with absorption, dark-line spectra; the position of the lines in all cases revealing the chemical nature of the substances.

So much, then, for the general idea of the nature of a spectrum. There are some additional points to be considered when we are dealing with stars. If we observe the spectrum of a star at rest, we shall obtain lines, whether bright or dark, in their normal place in the spectrum. These lines will be peculiar to certain substances, and, in fact, their presence in the star is determined simply by them. If we deal with the light from a body which is not an apparent *point*, the lines will still keep the same positions, for the same reason, but each one of them will be broadened equally.

Let us now suppose the star no longer stationary, but moving with a considerable velocity. In this case the wave-length of each line will be no longer the same; but the line will have altered its position in the spectrum to an extent depending on the movement of the star toward or from the earth. The result produced in the spectrum will be the same with regard to the number of lines as was the case when the star was assumed to be motionless, but the lines will all have received a slight shift, either to one side or the other of their initial positions, according as the star is approaching or receding. If instead of one we now deal with two stars of the same chemical and physical structure, traveling with different velocities, either toward or away from us, the spectrum would show each line doubled, and the more rapid the relative motion the coarser will be the doubling. If the stars were so physically constituted that the same chemical substances were present in both, but giving bright lines in one and dark lines in the other, the spectrum would present a series of bright lines, each accompanied by a dark one, on one side or the other, according as the body which contained dark lines in its spectrum was approaching the earth or receding from it.

After this very brief statement of general principles, we can now refer to the observations that have already been made with regard to the spectrum of the present new star, observations unique in astronomical history, and of the highest importance and interest. It has been found to consist of both light and dark lines. The fact that pairs of bright and dark lines are seen proves that two bodies are in question. If we suppose two swarms of meteors colliding in space, the spectrum can be easily explained on this assumption in the light of the general principles referred to above. Further, the thickness of the lines tends to show that each one is produced by a large number of small incandescent masses moving at different velocities, rather than by one large one. The motion necessary to produce the doubling of these lines has been estimated, and the relative velocity of the two swarms has been put down as more than five hundred miles per second!

If the photographs should continue to show the same relative positions of the bright and dark lines, the observations would prove that this relative motion is not produced by the revolution of one body round another, but that a dense swarm of meteorites is moving toward the earth with a high velocity, and passing through another receding one of less density.

It will be seen that the observations harmonize well with the hypothesis that has been advanced on much less definite evidence; but this is not the only instance we can give of the grip that modern science has on large classes of phenomena which were supposed to be beyond the reach of man. The lines that have been photographed in the spectrum of this star are all such as could have been predicted with our knowledge of new stars.

As an instance of the advanced stage at which astro-physical science has arrived, we may say that, if we had no observations of new stars other than those already recorded of the present one, their whole theory could be obtained by induction. This may seem a "sweeping statement," but it is nevertheless true, for since many so-called "stars" are now known not to be "stars" like our sun, but simply clouds of meteoritic bodies clashing together, and since we know approximately the sequence of changes through which the spectra of these stars pass as their temperature is first increased and then reduced, each spectrum indicates the complexity of each swarm.

We have already seen that the doubling of the bright and dark lines indicates that we are dealing with two swarms in the present instance, one approaching and the other receding; we now learn that the condensation at which each of these swarms exists can be approximately determined; that which gives us the dark lines is denser than the one which gives us the bright ones.

In conclusion, it may be well to point out a difference of some importance between comets and these new stars. A comet, as is generally conceded, consists of a cloud of meteoritic dust *traveling round the sun*, sometimes in elliptic but more often in a parabolic or hyperbolic orbit; in other words, those traveling in elliptic orbits have been captured by the sun and return to it periodically, while those pursuing a parabolic or hyperbolic orbit after one passage near the sun are forever lost to us.

Thus a comet with an elliptic orbit may be said to be a member of the solar system, and on this account can approach very near to our earth; and in fact our earth has even passed *through* one, giving rise to the phenomena of a great number of shooting-stars.

A new star, on the other hand, *never* approaches our system, but is formed at very great distances from us, distances probably as great as that of the nearest star, so that light, which travels one hundred and eighty-six thousand miles per *second*, takes about thirty years to complete its journey to us. Our new star, then, is already old.—*Saturday Review.*

THE DISCOVERY OF THE SEXUALITY OF PLANTS.

ATTENTION was called, at one of the late meetings of the Brandenburg Society of Botanists, to the fact that the two hundredth anniversary of the discovery of sexuality in plants had recently occurred. It was in fact two hundred years since the doctor and botanist Rudolf Jakob Camerarius, professor at Tübingen, separated two feminine types of the annual mercury from a group of plants of the same kind growing in a garden, and remarked that they had hollow seeds. His report on this subject, published in the Ephemerides of the Leopoldine Academy, is dated December 28, 1691. Camerarius demonstrated that plants are reproduced like animals by means of sexual organs. Till then confused notions had been entertained on the subject, and no one had thought of submitting it to an experimental test. Camerarius found that the stamens constituted the male organ and the pistils the female organs, and published the fact in his memoir *De Sexu plantarum Epistola.* The thought, like many other great discoveries that are not appreciated at the time, was too remote from current ideas to be accepted, and was comparatively overlooked.

A hundred years after the discovery of Camerarius a book appeared that cast a new and living light on the question of the sexuality of plants. Like the elder one, it also was not appreciated by the students of the time. Although Camerarius had shown, between 1691 and 1698, the necessity of the intervention of the pollen in the act of the fecundation of plants or the production of the seed—or, to use one of Goethe's expressions, that plants gave themselves up, in the bosom of the flower, to the sports of love—the special destination of the different parts of the plant remained a riddle.

But flowers, with their special properties, the richness of their living colors derived visibly from the green of the leaves, the wonderful variety of their forms, and the perfumes with which they made the air fragrant, continued to attract the attention of the learned world. In 1793 a schoolmaster, the regent Christian Conrad Sprengel, of Spandau, again withdrew the veil, and showed with rare penetration, confining himself to the genus, what were the functions of the organs of the flower, and chiefly of the colored petals. The facts he disclosed, and which are now part of the incontestable patrimony of science, appeared so surprising to him that he entitled his book The Mystery of Nature unveiled in the Structure and Fecundation of Plants. He also advised the botanists of his time to study plants *in vivo*, in Nature, instead of contenting themselves with the examination in their studies of dried and withered specimens in a herbarium. His discovery was of so great importance to the scientific explanation of the functions of the different floral organs that it is hard to explain how his book, still remarkable and interesting, could have passed unnoticed. Incredible as it may appear, it is nevertheless true that his ingenious work remained unknown till 1862, when Charles Darwin, being occupied with the same question, found it and made it known.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

Mr. James Ellis Humphrey, in his book on Amherst Trees, Massachusetts, speaks of the Japanese gingko as being very interesting to botanists for representing an extreme type of development in conifers, with much specialized flower and fruit, and for being the survivor down to the present time of this type, which was very abundant and widely distributed over the earth's surface in earlier geologic ages. This plant, whose natural habitat has become restricted to China and Japan, would probably itself have disappeared, like its relatives, but for the peculiarly religious significance which has in some way become attached to it. This has led to its careful preservation in the temple groves by the Chinese and Japanese priests, and it is even stated that it is known only in cultivation, having become extinct in the wild; so that we owe our knowledge of the living tree to a superstition.

SKETCH OF ROBERT BOYLE.

THE services of Robert Boyle to science are described in the National Biography as "unique, notwithstanding occasional failing on the side of credulousness"—a failing which Sir Henry Ackland excuses as due rather to the age than to the person. Boerhaave regarded Boyle as the father of experimental philosophy, "the ornament of his age and country, who succeeded to the genius and talent of the Chancellor of Verulam," and indulged in somewhat extravagant eulogy of his work.

ROBERT BOYLE, the fourteenth child and seventh son of Richard Boyle, Earl of Cork and Orrery, was born at Lismore Castle, Munster, Ireland, January 25, 1627, and died in London, December 30, 1691. He was put into the care of a country nurse, with instructions to bring him up as she would one of her own children, his father saying that he would avoid the excessive tenderness which parents were liable to exercise toward their own children, guarding them as carefully from the sun and the rain "as if they were butter or sugar." Although the nurse carried out these instructions faithfully, her ward grew up of weak constitution and subject to many infirmities. He learned to speak Latin and French in his earliest years, but showed, as he advanced in his studies, a more decided inclination toward the sciences. When eight years old he was sent to Eton to school, leaving Ireland, according to Sir Henry W. Ackland's terse summary of his life, "in a gale of wind, and when the coast was 'infested by the Turkish Gallies'; but, after touching at 'Ilfordcombe and Minehead,' he happily arrived at Bristol. He shortly afterwards went to Eton, where (we are told) 'he lost much of that Latin that he had got; for he was so addicted to the more solid parts of knowledge that he hated the study of bare words naturally.'" The college was then under the charge of his father's friend, Sir Henry Wotton. After spending three years there, he was placed as a private pupil with the rector of Stalbridge, in Dorsetshire. In 1638 he started on his travels, under the care of a "wise and intelligent tutor," passing through Normandy to Paris, thence to Lyons, and thence to Geneva, where he stayed twenty-one months. In the autumn of 1641 he visited Switzerland and Italy, to spend the winter in Florence, where, he himself wrote, he "spent his spare hours in reading . . . the new paradoxes of that great stargazer Galileo, whose ingenious books, perhaps because they could not be so otherwise, were confuted by a decree from Rome; his Highness the Pope, it seems, presuming, and that justly, that the infallibility of his chair extended equally to determine points in philosophy and religion, and loth to have the stability of that earth questioned, in which he had established his kingdom."

"At length," says Sir Henry W. Ackland, "Boyle arrived at Rome, where he passed as a Frenchman. He was shocked by much which he saw and heard of the life and immorality of even the clergy there." He studied unceasingly, reading much on all his journeys. At Marseilles, in 1642, he learned of the breaking out of the rebellion in Ireland, a fact that was more deeply impressed upon his mind by the consequent impossibility of getting any money from home, and he did not return to England till 1644. There he learned of the death of his father, and found himself heir of certain estates in Ireland and of the manor of Stalbridge. In London, the next year, he became a member of the Philosophical College, a society of scientific men, which, in consequence of the political agitation of the times, held its meetings as secretly as possible, first in London and then in Oxford, and was called the "Invisible College." After the Restoration this society was incorporated by Charles II as the Royal Society. "The course of Boyle's life," says Sir H. W. Ackland, "must be considered as now fully determined. He had gradually acquired a keen interest both in science and theology, an interest never to be abated, and henceforth interlaced with all his thoughts and writings." In 1646 he settled at Stalbridge, and devoted himself to study, scientific research and experiments, and authorship. Visiting Ireland in 1652, he made anatomical dissections with Sir William Petty, and verified by actual experiments the circulation of the blood. He removed to Oxford, where he lived fourteen years, enjoying the society of many learned men. Here he made improvements in Otto von Guericke's air pump, and by curious experiments made various discoveries on the properties of air, the propagation of sound, etc., the most important of which was the discovery of the law called Mariotte's in the text-books, but more properly Boyle's, of the intimate relation between the volume of a gas and the pressure. He constantly, say his French biographers, opposed the teaching of Aristotle, which was still current in the schools; and was, like Bacon, convinced that the truth could be discovered only by experiment. He would not even read the works of Descartes, lest, finding in them more imagination than observation, and hypotheses rather than facts, he should be tempted out of his chosen path. None of the scientific systems then in vogue were received by him. In particular he brought experimental demonstrations to bear against the theory that salt, sulphur, and mercury were the essential principles of bodies. He allowed matter no properties but mechanical ones. To him we owe the exact determination of the fact that air is absorbed in calcinations and combustions, and that metallic calces are heavier than the original metals—observations which long afterward served as one of the bases for modern chemistry. By completing the air pump, Sir Henry W. Ackland says, he "revolutionized the instrumentalities by which the atmosphere of the earth, the gases, many phenomena of life, and infinite chemical actions may be forever studied. It led, I doubt not, to the suggestion of rules proposed for the investigation of the Peak of Teneriffe—no small effort in the seventeenth century—and thus attempted to settle one physical problem which was set forth with great detail and precision by the Royal Society of the time." In his essays on this instrument, he "foresaw the far-reaching results through its agency of a more precise knowledge of the physical and the chemical properties of the atmosphere, . . . its relation to all organic life, and to meteorology in the widest cosmical sense. Henceforward he applied himself to experiments with this instrument, combined with his increasing power of chemical investigation, into almost all matter, above, upon, and within the globe; to vapors, to metals and stones of every kind. He studied respiration in the higher animals, investigated the effects of respired air on birds, on reptiles, on snails, and on plants, and the manner of death in each. Though experiments on living animals such as could then be performed were abhorrent to his tender soul, yet the knowledge of Nature was to him a religion; and he had to pierce through the secrets of life, the cause of disease, of suffering, and of death by every means that his ingenuity could devise."

When the Royal Society was incorporated, in 1663, Boyle was named a member of the Council. He was elected president of the society in 1689, but declined to serve in the office on account of his scruples against taking the oath. He was at one time interested in alchemy, and carried on experiments on the transmutation of metals. In the interest of this business he secured the repeal of the statute against multiplying gold and silver.

The religious side of Boyle's character was as prominent as the scientific side. Some experiences that happened to him in early youth gave a tinge of melancholy to his disposition; and he was moved by the reflections to which he was led by this trait to give himself for a considerable time wholly to an inquiry into the principles and the evidences of Christianity. Vital and sincere as was his faith, he was occasionally troubled with doubts, which he spoke of as being to the soul like toothache to the body, not mortal, but very inconvenient. The works of apologetics current in his time did not satisfy his mind, and he went to the original sources, studying Hebrew and the Oriental languages, and calling in the aid of the best theological scholars contemporary with him. The result of this inquiry was a conviction, the intensity of which was manifested by a great activity in religious discussion and religious work. He founded a lectureship on the evidences of Christianity; contributed liberally to projects for the spread of the gospel in India and America; bore the expense of publishing translations of the Gospels and the Acts of the Apostles into Malay, and of publishing an Irish Bible; contributed to the publication of the Welsh Bible and a Turkish New Testament; and aided with money in Pococke's translation of Grotius's De Veritate into Arabic. The learned Sanderson having been deposed from his benefice on account of his loyalty to Charles II, he gave him a pension on condition that he would write a work on questions of conscience. When invited to take orders in the Church, he declined to do so, on the ground that that was not his vocation, and that his writings on religious subjects would have greater weight coming from a layman than from a paid minister.

Boyle left Oxford about 1668 and settled in London, fixing his residence in the house of his sister, Lady Ranelagh. His health began to fail seriously about 1690, and he was obliged to withdraw gradually from all his public engagements. He discontinued his contributions to the Royal Society, resigned his office as governor of the corporation for the propagation of the gospel in New England, and announced publicly that he could no longer receive visits. He devoted his time to chemical investigation, the accounts of which he left "as a kind of hermetic legacy to the studious disciples of that art." His health continued to grow worse, and his death occurred precisely one week after that of his sister, with whom he had lived for twenty years. By his will he founded and endowed the Boyle Lectures for the demonstration of the truth of the Christian religion "against atheists, theists, pagans, Jews, and Mohammedans."

Boyle was never married. In person he was tall, slender, and of a pale countenance. "While his scientific discoveries procured him wide and lasting renown, his private character and virtues, the charm of his social manners, and his wit and conversation endeared him to a large number of personal friends."

Boyle's place in science should be estimated by the relation of his work to his time, not to ours. He was a leader, much in advance. Sir John Herschel says that he "seemed animated by an enthusiasm of ardor, which hurried him from subject to subject, and from experiment to experiment, without a moment's intermission, and with a sort of undistinguishing appetite." Sir Henry W. Ackland suggests that he had so many qualities, and pursued so many lines of thought, that they almost dim one another. From his "quality of prudence, and from his steadfast adherence to the supreme test of experiment, he was led to doubt and to test several opinions in the science of the day, and to overthrow dogmas which had been unquestioned. This skepticism in scientific mat-

[illegible] the Royal Society."

Bishop Burnet, a contemporary and a man of the court, says: "His knowledge was of so vast an extent that, if it were not for the variety of vouchers, in their several sorts, I should be afraid to say all I know." After referring to his knowledge on theological matters, the bishop continues: "He ran the whole compass of the mathematical sciences, and, though he did not set himself to spring new game, yet he knew even the abstrusest parts of geometry; geography, in the several parts of it that related to navigation or travelling; history and books of travel were his diversions. He went, very nearly, through all the parts of physic; only the tenderness of his nature made him less able to endure the exactness of anatomical dissections, especially of living animals, though he knew those to be the most instructing; but, for the history of Nature, ancient and modern, of the productions of all countries, of the virtues and improvements of plants, of ores and minerals, and all the varieties in them, he was by much, by very much, the readiest and the perfectest I ever knew, in the greatest compass, and with the truest exactness. This put him in the way of making all that vast variety of experiments, beyond any man, as far as we know, that ever lived. And in these, as he made a great progress in new discoveries, so he used so nice a strictness, and delivered them with so scrupulous a truth, that all who have examined them have found how safely the world may depend upon them. But his peculiar and favorite study was chemistry, in which he engaged with none of those ravenous and ambitious designs that drew many into them. His design was only to find out Nature; to see into what principles things might be resolved, and of what they were compounded, and to prepare good medicaments for the bodies of men."

Of Boyle's scientific works, the earliest was New Experiments, Physico-mechanical, touching the Spring of Air and its Effects, published in 1660. It was followed, in 1662, by The Sceptical Chemist, which was afterward reprinted, with additions. In 1663 he published the first part, and in 1671 the second part, of Considerations touching the Usefulness of Experimental Philosophy. He also published, in 1663, an important volume of Experiments and Considerations upon Colors, with Observations on a Diamond that Shines in the Dark. Other scientific works are, New Experiments and Observations upon Cold, 1665; Origin of Forms and Qualities according to the Corpuscular Philosophy, 1666; Tracts about the Cosmical Qualities of Things, the Temperature of the Subterraneous Regions, and the Bottom of the Sea, 1669; Origin and Virtues of Gems, 1672; Essays on the Subtilty and Determinate Nature of Effluvia, 1673; tracts on the Saltness of the Sea, the Moisture of the Air, the Natural and Preternatural State of Bodies, Cold, Hidden Qualities of the Air, Celestial Magnates, Hobbes's Problem of a Vacuum, and the Cause of Attraction and Suction, 1674; Experiments and Notes about the Mechanical Origin or Production of Particular Qualities, including a Discourse on Electricity, 1676; the Aërial Noctiluca, or some New Phenomena, and a Process of a Factitious Self-shining Substance, 1680; New Experiments and Notes upon the Icy Noctiluca, to which is added a Chemical Paradox; Memoirs for the History of Human Blood, 1684; Short Memoirs for the Experimental History of Mineral Waters, 1685; Medicina Hydrostatica, 1690; Experimenta et Observationes Physicæ, 1691; and, published after his death, the General History of the Air Designed and Begun; an account of his making the phosphorus, September 30, 1680; and Medicinal Experiments. Most of the volumes of his works, with many manuscripts, exist in the library of the Royal Society. The works were collected in five folio volumes in 1744; a more complete edition, in six large quarto volumes, with a life by the editor, Dr. Birch, published in 1772, contains most of his scientific writings, several theological treatises, and numerous letters from him and to him.

The purpose of a book by Paolo Riccardi on Anthropology and Pedagogy is to show what aid anthropology can bring to the science of education. The school, according to his view, should not be regarded as an assemblage of children of every class, connected with one another only by the four walls of a common inclosure; but as a social organism, a little society in which the child is to be taught to live, and prepared for the future life in the larger society of adults. He asks anthropology to make this preparation. The teacher's first effort should be to determine the relative strength of his pupils, and the possible relations between superior and inferior vigor and intelligence, between the moral and the organic condition of each.

The officers of the Russian vessel Aleut have identified the burial place of Bering, the discoverer of the straits that bear his name, on Bering Island, and have erected upon it a granite monument tipped with an iron cross.

EDITOR'S TABLE.

PRESIDENT ELIOT ON PUBLIC-SCHOOL EDUCATION.

THE article contributed by President Eliot to the December Forum, under the title Wherein Popular Education has Failed, is one of the weightiest utterances on that subject that have fallen under our notice in recent years. It is weighty in its moderation, in the clearness and force of the indictment it formulates, and in the precision with which it indicates the remedial measures to be taken. Need we add that it is weighty also through the recognized eminence of its author in the field of education? It would be hard to mention any voice in this country that speaks with more authority upon any educational question than that of President Eliot.

The opening statement of the article is terse and pointed: "It can not be denied that there is serious and general disappointment at the results of popular education up to this date." During two whole generations State-supported schools have been in full operation. These have been devised and maintained on such a scale as to bring the whole, or nearly the whole, population under their influence; and yet, with elementary education almost universal, we do not seem to have a wiser, a more virtuous, or a happier people. President Eliot admits that some important improvements have taken place during the last two generations: penal codes have been reformed; prisons are better ordered; hospitals, asylums, and reformatories have been provided on a much larger scale than formerly; the general condition of the working classes has improved; the average duration of human life has been increased; and education, he is disposed to believe, has had some share in bringing about these ameliorations. In saying this the writer of the article goes perhaps as far as can be done with safety. Prison reform and the abolition of the slave trade were burning questions before any great movement for popular education had set in, and the same might be said of other humanitarian and socially useful movements. At the same time there is no doubt, as President Eliot suggests, that, where the population in general can read, there is formed a public opinion which renders the retention of abuses more difficult.

Still, notwithstanding all that education and other agencies of an enlightening character have done, the condition of things as regards popular intelligence is far from satisfactory. To quote from the article before us: "In spite of every effort to enlighten the whole body of the people, all sorts of quacks and impostors thrive, and one popular delusion succeeds another, the best-educated classes contributing their full proportion of the deluded. Thus, the astrologer in the middle ages was a rare personage and usually a dependent of princes; but now he advertises in the public papers and flourishes as never before. Men and women of all classes, no matter what their education, seek advice on grave matters from clairvoyants, seers, Christian scientists, mind-cure practitioners, bone-setters, Indian doctors, and fortune-tellers. The ship of state barely escapes from one cyclone of popular folly, like the fiat-money delusion or the granger legislation of the seventies, when another blast of ill-informed opinion comes down on it, like the actual legislation which compels the buying and storing of silver by Government, or the projected legislation which would compel Government to buy cotton, wheat, or corn, and issue paper money against the stock."

The great trouble is, says President Eliot, that our popular education is not really conducted in such a way as to develop intelligence. It teaches children to read (after a fashion), to spell, to write, and to cipher; it also imparts a little knowledge of geography; but none of these things, as commonly taught, calls into activity in any adequate manner those powers on the due exercise of which the growth of intelligence depends—the power of observing facts, the power of accurately and faithfully recording facts, the power of reasoning correctly in regard to facts. Nor is any sufficient practice given in the important art of composition or correct expression in writing. To give a proper training in the observation of facts some branch of natural science or some kind of handicraft should be taught. At present whatever quickness of observation children acquire is acquired in connection with their sports; and their school studies lack vitality and effect simply because the element of original observation has no part in them. To make an observation of one's own in regard to any matter is to gain at once an interest in that matter, and in all probability to prepare the way for other observations. While we agree with President Eliot that some branch of natural science or some "well-conducted work with tools or machines" furnishes the best means of developing the observing faculty, we also agree with him in holding that almost any line of study may, in the hands of a competent teacher, be turned to good account for the same purpose. As he rightly observes, one teacher will get better results out of one subject and another out of another. Geography, which, "as commonly taught, means committing to memory a mass of curiously uninteresting and unimportant facts," may, under proper treatment, become a most stimulating study; but, in order that this may be the case, a teacher is required who has a vivid apprehension of the relation of geographical facts to one another, and a clear conception of the general relation of physical to political geography. So with language: it may be made a mere thing of arbitrary rules or it may be exhibited in its vital connection with thought, and its structure and etymology made to yield abundant exercise both for the observing and the analytical faculties.

In the recording of facts opportunity is given both for the cultivation of accuracy of statement and for the acquisition of correct modes of expression. We do not, indeed, see how first lessons in composition could be given with greater advantage than in connection with the statement of facts observed by the pupil. Every fact is observed under some conditions of place, time, etc., and, in the due setting forth of these, various adverbial and other elements of a well-developed sentence come into requisition. There is no point at which the inefficiency of our higher schools has been more apparent, or has given rise to severer criticism, than in the matter of composition; and the reproach will remain until the problem of its removal is approached in a scientific spirit and by scientific methods. Language is the garb of thought, not a substitute for thought, nor a thing to be acquired and possessed independently of thought. He alone can use language with freedom, certainty, and accuracy who is conscious of *needing* for the expression of his thought all the words and phrases that he employs. First catch your thought and then array it suitably. A lesson in language should therefore always be a lesson in thinking; and words, instead of appearing, as they so often do in language lessons, as meaningless superfluities, should be exhibited as essential for that communication of our thoughts on which the whole of our rational and social life depends. Language lessons in the earlier stages should always turn upon such words, phrases, and narratives as actually relate to the daily life of the child. Thought should be stimulated until the *need* for language to express it is felt, and language should never be presented for use or imitation beyond the limits of such consciousness of need. The more the different lessons which the child receives can be brought into relation with each other, the better it will be: arithmetic and grammar, for example, may be made to support each other in the following manner. A child reports: "A big dog barked at me as I was coming to school this morning." Now this sentence may be continued in either of two ways: "And frightened me a good deal," or, "But did not frighten me a bit." In the first case we have what, by analogy, may be called *addition*, and in the second what, by analogy, may be called *subtraction:* on the one hand, the fright superadded to the barking heightens the significance or seriousness of the occurrence; on the other, the indifference of the child to the barking makes little of the occurrence. The first phrase, which has the effect of addition, is introduced by "and"; the second, which has the effect of subtraction, is introduced by "but," and a key is thus afforded to the proper use and practical effect of these two prepositions.

President Eliot makes a very true remark when he says that correct reasoning can best be taught by the study of the best classical examples of sound, forcible, and well-sustained argument. "The actual arguments," he says, "used by the participants in great debates should be studied, and not the arguments attributed to or invented for the actors long after the event. . . . As examples of instructive arguments I may cite Burke's argument on conciliation with the American colonies, and Webster's on the nature and value of the Federal Union; the debate between Lincoln and Douglas on the extension of slavery into the Territories; the demonstration by Sir Charles Lyell that the ancient and the present systems of terrestrial change are identical; the proofs contrived and set forth by Sir John Lubbock that the ant exhibits memory, affection, morality, and co-operative power; the prophetic argument of Mill that industries conducted on a great scale will ultimately make liberty of competition illusory; and that well-reasoned prophecy of disturbance and disaster in the trade of the United States written by Cairnes in September, 1873, and so dramatically fulfilled in the commercial crisis of that month." Of course, for younger pupils simpler examples of reasoning would have to be found, or possibly their own daily experience might suggest a sufficient number of questions upon which to employ and exercise their reasoning faculties.

Here, however, we are compelled to pause, and suggest a difficulty. President Eliot tells us what ought to be done, but he does not satisfy us as to what persons are going to do it. Why have not all these things been done before? Why are they not being done in all our schools now? Is it because no one has perceived or made clear to others how intellectual life may best be awakened and strengthened? By no means. The world is well supplied to-day with sound and valuable works on every branch of the science of education. The trouble is, that to awaken thought we require *thinkers;* and the public-school teachers as a body are not thinkers. As a body they are, in this respect, nowise superior to any other class of ordinarily educated persons. How, then, can we expect any early or general improvement in the present routine methods, the general results of which, so far as the production of intelligence is concerned, are acknowledged to be so unsatisfactory? The State has taken up the business of education and made it almost a monopoly, and the State-appointed teachers are such as the State can get. But how many persons with a decided vocation for education take service in the public schools? Not many, we imagine, for the simple reason that the consciousness of such a vocation and the thought of working by prescribed routine methods are very apt to clash. Yet what is the man or the woman with such a vocation to do? Set up in opposition to the State? Well, sometimes they do, and in certain parts of the country private schools are gaining steadily on the State-supported ones, but manifestly the competition of the State is a serious thing to reckon with, and quite sufficient to deter many a one from following his or her strong desire and bent. We are disposed to believe that in this way the larger part of the special talent which would otherwise go into the work of education is diverted into other channels. All we can do, therefore, for the present is to unfold and enforce right methods, as President Eliot has done in his article, hoping that here and there the good seed may fall on good soil and yield fruit abundantly.

LITERARY NOTICES.

Les Altérations de la Personalité (Disorders of the Personality (or Consciousness)). By Alfred Binet. Paris: Félix Alcan. Pp. 325. Price, six francs.

Physiologists and philosophers have been much interested during the last fifteen years in researches in pathological psychology, based upon the study of hysteria and suggestion; and a considerable quantity of observations and experiments has been collected in a very short time. Hallucinations, paralyses by suggestion, morbid affections of the personality or consciousness, disorders of the memory and of the muscular sense, suggestions in the waking state and during hypnosis, and unconscious suggestions, are some of the principal questions that have been examined and profoundly searched into. Numerous discussions have arisen among the investigators as the researches have multiplied and extended; discordant theories have been put forth, and important assertions made by some have been disputed by others, and school has been arrayed against school. Such controversies, which appear inseparable from new systems and are useful in their way, have cast some doubt on the real value of the collected material. The author's intention in writing this book is not to continue controversies or to oppose his own experiments to those of other observers, but, collecting all the results that have been reached, to inquire what ones among them are in accord and can be grouped under a common synthesis. For this he retains only the experiments which, repeated by many or all of the observers, have led to the same conclusion, whatever might have been the object of the experimenter, while he has put aside without judging concerning them, phenomena which have been observed by only a single person, and which do not logically relate themselves to an assemblage of known and acquired facts—subjecting his own observations, too, to the operation of this rule. The phenomena of double personality or consciousness include those in which the two states succeed or alternate with one another—successive personalities—and those in which they are coexistent. The modifications or transformations in the former case are spontaneous or provoked. It is mentioned as an advantage in the study of the spontaneous phenomena, and as a reason for beginning the discussion with them, that they are influenced only in the most insignificant degree, if at all, by the persons who observe them. They have not been prepared at long range and unconsciously by an author whose opinion was already formed; they consequently respond to no preconceived theory. They consist of incidents of hysteria, dreaming, intoxication by various drugs, aberrations caused by disordered circulation, and effects of epilepsy. In these cases the patient has, psychologically, two lives, quite distinct from one another—his usual normal life, and his life under the influence of his aberration—in either of which he has no consciousness or recollection of his experiences in the other; while, on the other hand, he often takes up the thread of life in either stage, when he resumes it, where it was dropped on coming out from the last preceding spell. Somnambulism affords the most familiar instances of this form of double personality. The study of provoked somnambulism, or hypnotism, is more subject to error, and the distinction between the hypnotic and the normal state is not so clearly marked as in spontaneous somnambulism. But experimentation has the great advantages over the observation of spontaneous manifestations that, under it, the conditions of the observation can be indefinitely multiplied and varied, the phenomena can be regarded under a large number of phases, and it can sometimes arouse new phenomena which passive observation could never have reached. Coexistent personalities, or the simultaneous existence of two selfs, among which the still obscure and doubtful phenomena of spiritualism are included, are of two classes: first, hysteric insensibility, where a part of the body is insensible to what is going on, while the nervous centers in relation with the same region may continue to act, as in hysteria, from which it results that certain acts, sometimes simple, but often very complicated, may be accomplished unconsciously in the body of the hysteric, which acts may, further, be psychical, and exhibit an intelligence consequently distinct from that of the patient, constituting a second self; and, second, a particular attitude of the mind, concentration of attention upon a single point, by virtue of which the mind becomes distracted and as it were insensible, opening the way to automatic actions; and these actions, in their complications, like those in the other case, may take on a psychical character and constitute parasitical intelligences, living, unknown to it, by the side of the normal personality.

A third part of the essay is devoted to the discussion of the disorders in the personality provoked in experiments in what is called hypnotic suggestion, as when a person in a condition of artificially provoked somnambulism is made to execute what is suggested to him by the operator. The attempt is made to show that the suggestion usually provokes a division of consciousness and can not be realized without it. Suggestions are divided into two groups—those directly intended to produce a new personality, and those which, while having some other purpose, can not accomplish it except by causing a division of consciousness. In this part are considered hallucinations, the measurement of time by suggestion, systematic anæsthesia, the doubling of personality, and spiritualism.

The conclusions drawn from the whole are, that the self is composite, a grouping or resultant of several elements. The unity of our normal and mature personality exists, indeed, and no one should think of doubting its reality; but there are pathological facts to prove that that unity must be sought for in the co-ordination of the elements that compose it.

Taxation and Work. By Edward Atkinson. New York: G. P. Putnam's Sons, 1892. Pp. 296. Price, $1.25.

This volume forms Mr. Atkinson's contribution to the recent tariff discussion, the outcome of which has been so disastrous to the advocates of high protection. Though the successive chapters appeared first as articles in the daily papers, the book lacks nothing on that account, in the way of thoroughness or the logical grouping of the subjects considered. The discussion takes a wide range, covering not only the relation of a protective tariff to industry, wages, and the revenue needs of the Government, but the relation of a depreciated currency to the same as well. Mr. Atkinson opens his discussion with a consideration of taxation in terms of work, and presents very forcibly and graphically the truth, so frequently lost sight of, that a government can have only what it takes from the people. When it is realized that this demand upon the people is at present equivalent to the labor of a million men at two dollars per day, and that the total number of people engaged in gainful occupations is but twenty-three millions, the great importance of the subject of taxation becomes manifest. In discussing the cost of a protective tariff, Mr. Atkinson shows with especial clearness how extravagant this method of taxation may be. The cost to the country, so far from being measured by the amount of the tax, may be, and generally is, many times greater. This is particularly true of taxes upon raw materials, which, by raising the cost of manufactured articles, curtail our markets and subject us to an indefinite and undeterminable loss. Mr. Atkinson estimates that the cost to the country during the past year of such taxes, which have yielded only fourteen millions of revenue, has been not far from three hundred millions of dollars.

The strength of the protective system in this, as in every other country, lies in its supposed effect in raising wages. The fallacy of this has been many times demon strated, and Mr. Atkinson adds his word to that of others who have written upon the subject.

He thinks that the effect of the tariff on wages has been greatly overestimated by both free-traders and protectionists. The number of those who can be directly benefited in their wages by a tariff is for the country as a whole not much over five per cent. Wages have steadily risen in the last twenty-five years, and the rise has been much more rapid in the non-protected than in the protected industries. The tariff cuts but a small figure as a factor in determining wages, and so far as it is an element its tendency is to lower wages. Mr. Atkinson considers that the important factor in raising wages is the steady improvement in the tools and processes of the mechanic arts, agreeing entirely with Mr. Schoenhoff that a high rate of wages is the necessary concomitant of high efficiency and low cost of production. His discussion of bimetallism, though brief, is clear and to the point. He arranges it in the form of a number of propositions, as the readiest means of exposing the essential elements of the question to the understanding of the reader. It is perhaps unnecessary to state that he shows clearly the folly of the silver advocates. Taken as a whole, this discussion is one of the strongest and clearest presentations of the tariff question in all its bearings which the current interest in the subject has brought forth, and it can be unreservedly commended to those seeking light upon this important issue.

Experimental Evolution. By Henry de Varigny. London and New York: Macmillan & Co., 1892. Pp. 271. Price, $1.50.

Prof. de Varigny has gathered together in this volume five lectures delivered by him before the Summer School of Art and Science at Edinburgh, advocating the desirability of experiments in organic evolution to prove in a direct way the birth of new species of plants and animals out of antecedent ones. In his discussion of the character of the proofs we now have of evolution, he points out that they are all inferential, and, while they are convincing to the great body of naturalists who have studied the facts, he thinks that the main contentions of the evolutionist can be demonstrated beyond question by direct experiment. Already much experimenting of this kind has been done, which has resulted in the production of a great number of varieties, but this has not been carried on systematically through a sufficient period nor simply with reference to the scientific value of the experiments. The lectures are very suggestive in an important line of scientific work, and will doubtless receive adequate attention from the naturalists.

The Farmers' Tariff Manual. By Daniel Strange. New York: G. P. Putnam's Sons. 1892. Pp. 363. Price, $1.25.

Mr. Strange has given in this volume a very excellent tariff talk to the farmers. He is himself a farmer, and is therefore able to bring to the attention of the farmers in an effective way the things in our tariff medley which bear most directly upon their interests. The author's method of dealing with the subject is to take a quotation from a speech or the writings of well-known protectionists and comment upon it. As such quotations embody the points made by protectionist orators in the current discussions of the tariff issue, this method has considerable advantage over the systematic treatment of the subject by economists. The work is divided into four main parts, devoted to a Tariff for Revenue, Theories of Protection, History of Protection, and the Practical Results of Protection. The author deals with the first of these divisions very briefly. He does not believe in such a tariff on account of its extreme inefficiency, but holds that all taxation should be direct. In the division devoted to theories of protection he disposes in very short order of the ridiculous claim of the latter-day protectionists that the foreigner pays the tariff tax. He also considers Mr. Blaine's wonderful reciprocity scheme, and once more endeavors to make clear to the average man the meaning of a "balance of trade." In the historical division he gives a brief account of the successive tariffs from the foundation of the Government down, which the protectionist farmer, who is at all open to conviction, will find very instructive reading. The book closes with a review of the practical results of protection, and an earnest appeal to the farmers of the country to drop all side issues, such as have been advocated by the various farmer organizations, and concentrate their attention upon the one overmastering issue of the tariff. It has long been recognized that the ultimate disposition of the tariff question lies with the farmers. They constitute forty per cent of those engaged in gainful occupations, and in the very nature of their occupation can not be benefited by the tariff while the cost of nearly everything they buy is enhanced by it. Whenever they thoroughly realize that the tariff is a tax and is paid by the consumer, that the current appeals of protectionists are the merest sophistries, they have it in their power to make very short work of this antiquated system. There are not wanting signs that a good many farmers are coming to a sense of the real state of the case, and books like that of Mr. Strange can not but help them to reach rational conclusions.

Lightning Conductors and Lightning Guards. By Oliver J. Lodge. London: Whitaker & Co. New York: Macmillan & Co. 1892. Pp. 544. Price, $4.

This volume is a discussion of the subject of lightning protection, in view of the recent advances which have been made in our knowledge of currents of high potential and high frequency. It contains two lectures before the Society of Arts, as well as a number of miscellaneous papers upon the general subject. Prof. Lodge takes exception to the current view that conductivity is the main thing to be considered in an efficient lightning protector. Experiment has shown that, even with lightning rods of many times the conductivity necessary to carry off a current of the dimensions of a lightning stroke, the lightning refuses to follow the conductor, and makes all sorts of curious detours through paths of enormously high resistance. This phenomenon, which is inexplicable on the theory that a lightning flash is simply a high-tension current for which a conducting path must be provided to assure its safe disposition, finds ready explanation on Prof. Lodge's theory. He likens the lightning discharge to a blow on the water contained in a pipe. If the blow be quick enough, the water will not be set in motion, but the pipe will burst. The remedy is, not to make the pipe larger, but to make it elastic. A lightning flash, in this view, is a disruptive discharge between the opposite surfaces of a condenser through the intervening dielectic. The clouds form one surface of this condenser and the earth the other, the intervening air being the dielectic. It is now well known that the discharge of a condenser is alternating and of great frequency. The discharge of a condenser of such a great extent of surface as that presented by the clouds and the earth, Prof. Lodge maintains, must be not only of enormous tension and frequency, but of large current volume as well. It is commonly stated that the amount of current in a lightning discharge is very small indeed, and this is quite true. The discharge, however, occupies but an infinitesimal fraction of time. If it were prolonged so as to make it comparable with our standards of current, the current flowing would be at the rate of thousands of ampères per second. In this view of lightning discharge, lightning protection is not so simple a thing as has generally been supposed. Instead of providing simply a drain for the electric fluid, lightning protection has to devise means for escaping a tremendous blow, delivered with almost inconceivable rapidity. Happily, we are not helpless in the presence of this requirement. It has long been known that no charge resides in the interior of a closed metal chamber, no matter how strongly the surface is charged. Such a chamber is, of course, impracticable as a means of protection, but a metallic network will answer nearly as well and is practicable. Prof. Lodge's practical suggestions, therefore, take the form of multiple wires, all connected together to form a large mesh network, and terminating at the roof in points. These points may be roughly fashioned, as there is no practical difference in protection between rough and highly finished points. There is no advantage in carrying the points high up in the air, as this simply invites a discharge which might not occur. Such a network, well grounded, he conceives, will form ample protection in most cases. The wires used need not be larger than ordinary telegraph wires, and, as resistance is a matter of no moment, iron will do as well as copper. The great importance of adequate lightning protection renders such a discussion of the subject as Prof. Lodge has here given us of no little value from the practical point of view, while the scientific aspect of the subject can not fail to interest and stimulate the intelligent reader.

Physics, Advanced Course. By George F. Barker. New York: Henry Holt & Co., 1892. Pp. 902. Teacher's price, $3.50.

One of the most obvious and radical changes wrought by modern investigation in the science of physics is the greater importance which the phenomena of energy have assumed. Until comparatively recent times matter was considered the far more essential factor, and received a considerably larger share of attention. The reverse is now the case, and, as Prof. Barker well says, "The physics of to-day is distinctively the science of energy. Henceforth every physical change must be regarded as conditioned upon the transference or the transformation of energy. Hence, the classification which has been adopted in the present work is based on the most recent views of energy, considered as being ultimately a phenomenon of the ether."

The introductory portion of this book deals with the general physical relations and the laws of motion. Energy is next treated of as a mass condition, and work as the transference or transformation of energy. Potential is considered as a consequence of mass attraction. Matter is then treated of with reference to the modern views of its structure. Heat comes next, under the head of molecular physics. The remainder of the work is devoted to the phenomena of the ether, which are classified as follows: ether vibration or radiation; ether stress or electrostatics; ether vortices or magnetism; and ether flow or electrokinetics. The metric system is used throughout. What illustrations there are are well placed, but they are not as numerous as might be wished. There is a detailed table of contents, and a useful index.

The book is not, like many scientific works, an encyclopædia, nor is it, as some of the others are, a purely theoretical treatise. It combines very happily the important experimental facts of the science with the more probable theory or theories based upon their consideration. It fully justifies Prof. Barker's reputation as a thorough scientist. It is written in a plain and lucid style, and is very readable. The author's treatment of the subject varies somewhat from that of the old standards, but it is a treatment which recent work has been increasingly leading up to, and, in fact, making necessary.

The old text-books, notwithstanding frequent revisions, are unsatisfactory, and a new book, not only embodying the results of the most recent investigations, but also applying these results in the treatment of the subject as a whole, has been a growing necessity. Prof. Barker has given us just such a book, and it is fortunate that so careful and thoroughly equipped an author was at hand.

Manners and Monuments of Prehistoric Peoples. By the Marquis de Nadaillac. Translated by N. D'Anvers. New York: G. P. Putnam's Sons. Pp. 412. Price, $3.

Any one who wishes to have a handsome volume, fully illustrated, and giving a remarkably interesting account of the discoveries that have been made in regard to the peoples that lived before any mode of writing was invented, should get this work of De Nadaillac. The author begins with a general sketch of the stone age, in which he shows that its duration and its place in time can not be set off by any hard-and-fast bounds. He then proceeds to tell what has been learned as to the food of early man, which involves the subjects of prehistoric hunting, fishing, and cannibalism. The author names the horse, the aurochs, the stag, the reindeer, and other animals as furnishing food for the ancient men of Europe, and he names place after place where human bones, charred, and all those containing marrow broken, just as the bones of the lower animals were treated, give evidence of cannibalism. In rapid succession he touches upon the numerousness of animals in the stone age, the weapons used by man in killing them, the implements used in fishing, and various early efforts at navigation. Taking up weapons, pottery, and other articles of use or ornament more in detail, he describes implements from the caves of France, the river valleys of America, and from England, Italy, Spain, Algeria, and Hindostan. He speaks of pottery from Germany, Italy, France, Belgium, and other countries. This leads to a few words on the ancient use of fire, after which come descriptions of ornaments in various materials, and of the carvings on horn, bone, and wood, which testify to the artistic ability of the man of the stone age. The next chapter is devoted mostly to dwellings, and in it we find described the earth holes of France and South America, the natural caves used as abodes, especially in France, the lake stations of Switzerland, the crannoges of Ireland, the burgs of Scotland, the nurhags of Sardinia, the talayoti of the Balearic Isles, and the castellieri of Istria. Megalithic monuments are treated with no less fullness than are the dwellings, and the same may be said in regard to fortifications. There is also a brief summary of Dr. Schliemann's discoveries on the site of Troy. A somewhat miscellaneous chapter deals with industry, commerce, social organizations, fights, wounds, and trepanation; and the volume ends quite appropriately with tombs. One hundred and thirteen figures illustrate the text.

Longmans' Object-lessons. By David Salmon. Revised and adapted to American Schools by John F. Woodhull. New York: Longmans, Green & Co. Pp. 238. Price, $1.

These lessons are intended for children in infant or primary schools, and full notes are given for a course which may extend through four or five years. Plants, animals, and the common properties of substances are studied at first; later on, the general principles of chemistry, physics, and botany are considered. The first part of the work is devoted to hints for teachers, and a strong plea is made for early training. Many children enter upon life ill equipped, since their school education ends before the definite study of science begins.

The method of the author is excellent, but a false idea is conveyed by illustrating modes of manufacture which have been superseded, as that in the making of pins.

The book is fully illustrated, and provides blank notes for teachers and an index.

The Story of Kaspar Hauser. By Elizabeth E. Evans. London: Swan, Sonnenschein & Co. Pp. 188. Price, $1.75.

The pathetic tale in this volume will appear entirely credible to those who read it here for the first time. Even in these days of quick intelligence and watchful societies children are abducted, secreted, and finally lost to their friends, so that at the outset it is not improbable that such a scheme should have been effectual in past times with the heir to a royal house. The preponderance of proof is that Kaspar Hauser was indeed the Prince of Baden. Supposing that a group of such diverse characteristics as the city officials, a scholarly professor, and noted criminal lawyer could be easily deceived, the autopsy performed in another city showed their observations to be well founded. The abnormal flatness of knee-line, the enlarged liver, and undeveloped brain were unimpeachable witnesses. The portrait given ought also to furnish some evidence if it bears a marked family resemblance. The literature that has grown up on this subject is quite extensive. A list of forty-five books and pamphlets is appended for those who wish to consult the original testimony.

Nature Study. By Wilbur S. Jackman. Second edition, revised. New York: Henry Holt & Co. Pp. 448.

The teacher of elementary science in the common school has not only his class to instruct in the study of Nature, but probably himself; and this volume is designed to guide him in this task of manifold difficulty. An acquaintance with scientific fact and principle can be gleaned from books, but the method, which is generally an untrodden way for him, must be learned by individual effort, and it is advised that he should begin and work with his pupils. The plan of the book is altogether novel. An outline of subject matter for a year's course of lessons is given; this is divided into twelve sections corresponding to the months. In each of these an effort is made to study the special phenomena of the season, chiefly by practical work. Although no illustrations are furnished, explicit directions are given for performing experiments, collecting specimens, and keeping mineralogical and meteorological records, charts for which are also published separately. Topics are indicated by questions, but it is not intended that the teacher shall use these except as suggestions. Class work can be varied by drawing, painting, modeling, and the making of apparatus.

The list of sciences entered upon is long. A weekly lesson is prescribed in zoölogy and botany; physics, meteorology, astronomy, geography, and geology receive attention once in two weeks; chemistry and mineralogy once a month. The author, however, considers the exaltation of one science above another and the artificial sequence found in various curricula very misleading. The life of the individual is the natural center of interest, and each science has its value in revealing the forces that modify it. This idea should be emphasized as the motive for acquiring knowledge. From another standpoint, the author does not believe in specialization for beginners. The child-mind is drawn toward Nature at first from all sides. To accord with this, study should be primarily broad rather than deep. It will be useful to note if this method results in preserving the youthful zest for knowledge. The book contains an index and suggestions for reading in connection with each subject.

In a paper on *Comparative Architecture*, Mr. *Barre Ferree* defines his subject as taking the facts of historical and descriptive architecture and describing the comparative progress made by all nations under all conditions. It does not concern itself with the history and descriptions of styles, but with the reasons for their existence. There is no greater evil in architectural study than isolation. No just estimate of all the works of men can be possible which does not take into account their buildings; yet architectural historians do not hesitate to prepare essays on these subjects in which the historical events that rendered possible the great structures they are describing are ignored or scarcely referred to. "As complete a record is needed for understanding the life of a building as for understanding the life of a man." Such are some of the features which the author regards as essential to an adequate treatment of the subject.

The *Report for 1891 of the Chief of the Weather Bureau* refers more particularly to the scientific and practical work of the office, and enlarges upon some of the features of especial interest to the public. The chief of the bureau has endeavored to extend the benefits of the meteorological service to agricultural interests, as they had already been applied to commercial requirements. The attempt to enlist in the work scientific men of established reputation not regularly connected with the bureau has been fairly successful. In their reports especial attention will be paid to the applications of meteorology to agriculture.

A very useful number of the Experiment Station Bulletins of the Department of Agriculture is that which consists of a paper on *The Fermentations of Milk*, by *H. W. Conn*, of Wesleyan University. The paper contains a summary of our present knowledge regarding the decomposition changes in milk under the influence of ferment changes and bacteria, with particular reference to the needs of the dairy industry. Among the special topics discussed are fermentation by rennet, souring, the number of bacteria in milk. relation of electricity to souring, alkaline fermentation, butyric acid, bitter milk, alkaline curdling and the peptonizing process, blue milk, alcoholic fermentation, slimy fermentation, miscellaneous fermentations, and the practical bearing of the subject upon dairying in its several branches.

The Seventh Annual Report of the Board of Health of the State of Maine is largely devoted to school hygiene, and embodies what might be called considerable treatises on the healthfulness of schoolhouses, school diseases and infectious diseases, the personal hygiene of the pupil, the hygiene of instruction, physical culture, the schoolroom, desks and seats, ventilation, heating, water-closets, etc., and schoolhouse plans. An act to provide for the registration of vital statistics went into effect in the beginning of 1892, some of the fruits of which may be looked for in future reports. *A. G. Young*, M. D., secretary, Augusta.

A feature in the movement to secure the systematic construction of better roads, which is now pushed with vigor all over the land, is *A Memorial to Congress on the Subject of a Comprehensive Exhibit of Roads, their Construction and Maintenance, at the World's Columbian Exposition*, with an open letter to the President of the United States, in which *Albert A. Pope* is the chief promoter. The memorial is re-enforced by a large volume of expressions of personal and newspaper opinions.

Contributions from the Botanical Laboratory of the University of Pennsylvania, Vol. I, No. 1, contains papers on *Rudbeckia hirta* (a monstrous specimen), by J. T. Rothrock;

Dionæa muscipula (Ellis), by J. M. MacFarlane; An Abnormal Development of Inflorescence of *Dionæa*, by John W. Harshberger; Mangrove Tannin, by H. Trimble; *Epigæa repens*, by W. P. Wilson; A Nascent Variety of *Brunella vulgaris*, by J. T. Rothrock; and Movements of the Leaves of *Melilotus alba* and other Plants, by W. P. Wilson.

The History of the Higher Education in Ohio is published by the United States Bureau of Education as a number of Herbert B. Adams's series of contributions to American educational history. The preparation of the work was undertaken by Prof. *George W. Knight*, and, he falling ill, has been continued and completed by Mr. *John R. Commons.* The history of college education in Ohio is of peculiar interest, on account of the relatively large number of colleges that have been organized within the State, and the variety of the experiments that have been tried in connection with them. The success and failure alike of these institutions afford lessons valuable to men interested in education.

The *Lake Magazine* is a new monthly periodical, devoted to politics, science, and general literature, published at Toronto, Ont., and intended to represent Canadian thought, discuss Canadian questions, and promote Canadian interests. The first number contains articles on Canada and Imperial Federation, The Franchise, A Canadian Literature, Art in Canada, etc. For succeeding numbers, articles are promised from leading politicians, divines, and literary men, on topics of current interest.

The report of the *Public Industrial and Art School*, Philadelphia, gives an account of the objects of the school, its methods, rules, regulations, and course of instruction. The directors claim that this school was the first practical and successful attempt ever made in Philadelphia or elsewhere to incorporate manual training as an integral branch of common-school education. It was started in 1880, largely through the efforts of Mr. Charles G. Leland. It has grown rapidly, and its facilities have been enlarged till now nearly seventeen hundred pupils, from every grade of the public schools and the teachers' classes, are taught in it weekly.

A Sketch of the Life of Joseph Leidy, prepared by Dr. *W. S. W. Ruschenberger* for the American Philosophical Society, is published by MacAlla & Co., Philadelphia. It contains in an appendix a list of Dr. Leidy's publications, society papers, and verbal reports to scientific societies, occupying twenty closely printed pages, together with a list of learned societies at home and abroad of which he was a member.

The *National Popular Review* is a new illustrated journal of preventive medicine and applied sociology, edited by *P. C. Remondino*, M. D., and published by J. Harrison White, at San Diego, California. It proposes in all matters to occupy a middle ground whereon the profession and the laity may meet to discuss matters of common interest.

Department M of the World's Columbian Exposition, Chicago, includes the branches of *Ethnology, Archæology, History, Cartography, Latin-American Bureau, Collective and Isolated Exhibits.* It will have forty acres of floor space in the building, and a strip of land nearly a thousand feet long in addition. The plan and classification of the exhibit are published in detail by Prof. F. W. Putnam, chief of department, and provide for a very full showing, particularly in the North American and Latin-American departments.

Of the fifth volume of the *Journal of the College of Science, Imperial University, Japan*, Part I contains Studies on Reproductive Elements; on the Formation of the Germinal Layers in *Chelonia*; on the Development of *Limulus longispinus*; on the Lateral Eyes of the Spider; on a Collection of Birds from Tsushima; and on the Formation of Germinal Layers in *Petromyzon*—all by Japanese authors. Part II is mainly devoted to a Study of the Disturbance of Isomagnetics attending the Mino-Owari Earthquake of 1891, by Profs. A. Tanakadate and H. Nagaoka, with an Optical Note by K. Takizawa.

We have received Part III of Vol. I of *Iconographia Floræ Japonicæ*—descriptions, with figures, of plants indigenous to Japan, which has been prepared by Mr. Ryōkichi Yatabe, and is published in Tokio. Plants belonging to seventeen orders are described and illustrated, with Japanese and English text and full-page engravings.

A lecture on *The Discovery of America by Christopher Columbus*, which was delivered before the Young Men's Hebrew Association, in Wilkesbarre, Pa., in December

1891, by Mr. *Harry Hakes*, has been published in a convenient pamphlet for the reading of that large class who, "in this hurrying age, will neither purchase, peruse, nor possess the extensive literature pertaining to the discovery of America." It presents a clear and fully adequate statement in brief of the work of Columbus, and of his right to be regarded as the real discoverer of America, of which the author is a strenuous upholder.

A paper on *Michigan Flora*, prepared for the Thirtieth Annual Report of the Secretary of the Michigan State Board of Agriculture, by *W. J. Beal* and *C. F. Wheeler*, has in it an element of surprise. Expecting to find it a formal botanical catalogue, we find instead a series of brief sketches, appealing at once to readers who are of the people, on various aspects of the vegetation of the State. First is an account of the topography of the State and the botanical regions, with lists of the characteristic plants; then a comparison of the trees and shrubs of Michigan with those of the rest of the world, the reason explained why Michigan has so many trees and Great Britain so few, Planting the Roadside and about the Home, Planting a Wild Garden, plants of various habits suitable for cultivation, The Procession of Flowers, timber plants, forage plants, weeds, and so on, till finally, after all the plants have been told about, the formal catalogue is given.

Mr. *John Luchsinger* contributed to the eighth volume of the Wisconsin Historical Collections a sketch of the Swiss colony of New Glarus, Wis., which attracted much attention, it being the first monograph on the planting of an organized foreign colony in the State. Since that time, thirteen years ago, a healthy popular interest has been awakened in the history of the several foreign groups of the State, and a renewed call has been made for the Luchsinger paper. The account has accordingly been rewritten by the author, who came over a child with the first settlers, and has been prominent in the life of the colony. The present paper, *The Planting of the Swiss Colony at New Glarus*, Wis., greatly enriched by additional documentary material and brought down to date, is practically a new monograph, drawn from original sources, and of great interest to all students of our composite nationality.

In a paper on *The Relation of Philosophy to Psychology and to Physiology*, Prof. *Joseph Le Conte* uses the term philosophy as meaning the science which treats of the activities of free, self-conscious spirit. The various forces, physical or psychical, are regarded as operating on separate planes without gradations, changeable from one form to another, and always related by mutual dependence. As the physical underlies and conditions chemical phenomena; the chemical, life phenomena; and the vital forces, psychical phenomena; and as the accomplished chemist must understand physics, the physiologist chemistry, and the psychologist physiology, so also psychical forces underlie and condition the phenomena of free spirit, and therefore the philosopher must understand psychology.

In another paper, on *Plato's Doctrine of the Soul, and Argument for Immortality, in Comparison with the Doctrine and Argument derived from the Study of Nature*, Prof. Le Conte presents the evolution doctrine of spirit—that the only significance of the whole history of the evolution of the cosmos through infinite time is, that it is a gestative process for the birth of spirit; and, with this, a corresponding theory of knowledge and method of extending its domain, and a philosophy of right conduct of life, or a theory of *spirit culture*—a philosophy equally removed from the ascetic on the one hand and from the hedonistic on the other.

The third part of Volume IX of the *Journal of the Academy of Natural Sciences of Philadelphia* contains a Memoir on the Genus *Palæosyops* Leidy and its Allies, by Charles Earle, and a paper on the Fossil Avifauna of the Equus Beds of the Oregon Desert, by Dr. R. W. Shufeldt. Palæosyops is a fossil of the Bridger Eocene, of an animal that was more like the tapir than any other living animal, of which a considerable collection of material exists in the Museum of the Philadelphia Academy and a larger collection at Princeton, the two collections being ample enough to permit a satisfactory conjectural restoration. Dr. Shufeldt's studies of fossil birds are based upon the collections of Prof. Thomas Caydon, of Eugene City, Ore., and Prof. Cope, of specimens from Fossil and Silver Lakes. In the view of the author, they establish the fact that the birds of the later Tertiary time were simply the direct ancestors of existing genera and species of birds, from which, in the majority of instances, they hardly departed; and they suggest questions why certain types should have perished without leaving any apparent descendants, while others, seeming to enjoy no more favorable conditions, have been preserved.

The elaborate memoir of Profs. *W. K. Brooks* and *F. H. Herrick* on *The Embryology and Life History of the Macroura* is based upon the studies by Prof. Brooks of the larval stages of the order continued at every opportunity during ten years, in connection with the Marine Laboratory of Johns Hopkins University, and upon studies of the life histories of additional species made by himself at Beaufort, N. C., and Green Turtle Key and New Providence in the Bahamas, and (chiefly) by Prof. Herrick under his general supervision. Marine crustaceans are regarded by the author as of exceptional value for the study of the laws of larval development and for the analysis of secondary adaptations as distinguished from the influence of ancestry by reason of the greater stability of their inorganic environment as compared with that of land animals, permitting greater persistency of type; and of the more definite character of the changes that make up their life history. The memoir, of about forty quarto pages, is illustrated by fifty-seven large colored plates.

Stone and *Milling* are two monthly magazines the fields of which are indicated by their titles, published by the D. H. Ranck Publishing Company, Indianapolis, Ind. The tables of contents embrace a variety of information, technical, practical, and popular, on stone-quarrying and working the kinds of stone available in the arts, road-making, contracting, and building, in the former magazine; and the operations, industries, economies, financial interests, etc., connected with the art of preparing grain for food, in the latter.

A convenient epitome *Sketch of the Geology of Alabama* is published by *Eugene Allen Smith*, State Geologist, in which a general comprehensive survey of the formations is given in a small space. As appears from the table appended, the formations represented are the Archæan (crystalline schists), Cambrian, Silurian, Devonian, Carboniferous, Cretaceous, the three Tertiaries, the Pleistocene, and the Recent.

The Royal Road to Beauty, Health, and a Higher Development is described in a pamphlet of 85 pages, by *Carrica Le Favre*, as lying through a vegetarian life. The author has complete faith in her doctrine, writes forcibly, and, together with some assertion that is only opinion, presents some strong arguments. Published by the Fowler & Wells Company. Price, 25 cents.

The Government Printing Office has published, in 1892, the *Report of the United States Commissioner of Fish and Fisheries* for the year ending June 30, 1889, a pamphlet of 128 pages. The year was the first one of operations as a branch of the public service distinct from the Smithsonian Institution. The inquiry respecting food fishes and the fishing grounds was continued, with more attention to details than in preceding years, the first surveys being necessarily general in their character. The most important seacoast inquiries were those conducted by the steamer Albatross in the North Pacific Ocean. On the Atlantic coast the steamer Fish Hawk was assigned to special investigations having reference to the oyster grounds of Long Island Sound and Rhode Island. Other sea work was done in the Gulf of Mexico. An essentially novel feature of the scientific work was the systematic investigation of interior waters with respect to their physical and natural-history characteristics.

Physical Education is a monthly magazine devoted to physical culture, published by the Triangle Publishing Company, Springfield, Mass., *Luther Gulick*, M. D., and *James Naismith*, editors, of which specimen numbers have been sent us. It has among its contributors some of the best-known physical culturists in the country. Some of the articles in the numbers before us are on Ventilation in the Gymnasium, by R. A. Clark, M. D.; Physical Education in its Relation to the Mental and Spiritual Life of Women; Bicycling for Women; Form in Gymnastics, by Dr. W. G. Anderson; Gymnastic Classification, and others of like bearing.

The Report of *Robert T. Hill*, Assistant Geologist, *On the Occurrence of Artesian and other Underground Waters in Texas, Eastern New Mexico, and Indian Territory, West of* *the Ninety-seventh Meridian*, relates to a region vast in extent—including more than three hundred thousand square miles, and embracing many diverse conditions that influence the water supply—and one that has been little studied by geographers and geologists. The regions discussed—for there are more than one of them—are radically different in most natural aspects from the older inhabited portion of the United States. "It is far more different from New England than is Japan. It has more points in common with Europe than with the great Mississippi Valley. The chalk lands and downs of Texas are more related to France than to the rocks of the adjacent Arkansas and Missouri States." The author has endeavored to give only the laws of the occurrence and distribution of water. First, he corrects some prevailing mistakes on the subject, and shows how water really gets under the ground and is found there; then he describes the several regions topographically and geologically, and with reference to the conditions as to underground waters. This part of the work is well illustrated by maps and sections.

The *Industrial Magazine* is a new periodical devoted to the Promotion of Legitimate Industrial Enterprises, Railroad and Manufacturing Interests, and General Topics; Mrs. *Kittie F. Miller*, editor; published by the Industrial Magazine Company, Chicago. In the first two numbers railroad matters are given prominence and occupy by far the largest proportion of the space. Other enterprises are noticed in special articles; and information of what is going on in the railroad and industrial world is given in brief items.

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POPULAR MISCELLANY.

The Indo-European Conception of the Soul.—In a paper in the British Association on The Indo-Europeans' Conception of a Future Life and its Bearing upon their Religions, Prof. G. Hartwell Jones said that three heads naturally suggested themselves: 1. The connection of body and soul. 2. The condition of the deceased. 3. The relations between the departed and those left behind. With regard to the nature of the soul, he pointed out that in primitive times souls were ascribed to the universe—the *anima mundi*—to nymphs of various kinds, to the lower animals, to fountains, or trees. Heaven was the source from which the soul of man was derived, and to which it returned after purification. As to its creation, it had no corporeal element; it was created before the body; sometimes it was identified with fire. The etymology of the expressions for soul were instructive—e. g., Sanskrit *atindriya*, or "transcending the senses"; Greek *θυμός*, from a root meaning to shake, or fan; so, too, the notion of "air," "vapor," "shade." Still more common was the idea of "breath." Its seat was the heart or blood. At the moment of dissolution the soul escaped through the mouth or nostrils; it left with a groan, it passed to the ethereal regions. Death was often looked upon as a kind of sleep. Their stoicism in the face of death was attested by the frequency of suicide, or of substitution, or the prohibition of mourning. The theory of a future life prevalent in the animistic stage was that of continuance, the tastes and occupations being the same as in this world; even Homer had not overgrown this. But this existence was incomplete and dreary; the ghosts gibbered and were doomed to silence. The severance was not complete, for the welfare of the spirit depended upon the proper treatment of the body, else it wandered disconsolate. Hence the observance of rites. At first the body was disposed of by inhumation, probably to preserve the identity of the deceased; but in certain conditions of life, as during war or the chase, cremation was employed. At least a handful of dust had to be sprinkled over the corpse before the spirit could obtain repose; its neglect was regarded with horror. The same motive dictated the rearing of cenotaphs. The tomb was constructed on the model of the house. The deceased was furnished with all the necessaries for his new home—attendants and wives, dogs and horses, weapons, clothing, and earthenware. As to the abode of the dead, the earliest theory was that the soul became ethereal, passing into the wind, or fire, or constellations. The exact locality was uncertain, because of the nebulous character of their life, for they followed certain Great Spirits. Then the region of bliss was placed in the west. The germs of a theory of recompense and punishment were found early. No doubt the idea gained in clearness when they came into contact with the Semites. Transmigration, regeneration, and purification belonged to a later time. The relation between the living and the departed was a wide question. In addition to the care taken at burial, there was constant communication—e. g., in dreams. Hence the respect shown to (1) kindly spirits, like the *pitaras*, *fravashi*, *manes*, etc.—the givers of wealth; (2) the evil-disposed, like the *lemures* or *larvæ*. This gave rise to ancestral worship, and was connected with the sustentation of the family; children were buried under the eaves of houses, and did not need propitiation. Thus the worshipers were actuated by fear and sympathy.

Cultivation of Sunflowers.—The history of the cultivation of the sunflower in Russia is easily written, for it was begun in 1842 by one Bokareff, at Voronezh, for the purpose of making oil from the seed. It has now extended to the adjacent provinces in the Volga basin, so that the acreage in sunflowers increased from 367,800 acres in 1881 to 704,500 acres in 1887. Sunflowers with small seeds are cultivated for the oil, and those with large seeds for eating the seeds as nuts. The oil is extremely nutritious, and has a pleasant flavor. Another source of profit is found in the residual cake, for which there is a constant and growing demand abroad. The shells or husks of the seeds also form a valuable article of trade as fuel, when wood is scarce; and the seed "cups" are prized by farmers as food for sheep. The money value per acre of the crop is large, perhaps superior to that of any other crop cultivated in Russia. The methods of cultivation are various. Some of the Russian farmers invariably sow sunflowers after wheat or rye, and others only after oats. Others advocate sowing after clover, and some consider it most profitable to put sunflowers into land which, after four or five crops, has lain fallow for two years. On the other hand, it seems generally admitted to be a mistake to sow grains immediately after a sunflower crop, an interval of a year being necessary to rest the land. Some of the farmers of Voronezh sow sunflowers in the same field for seven years in succession; then sow buckwheat; and then, after a year's rest, rye. As firewood, the stalks of the sunflower plants produce a bright, hot flame quickly, and form a pleasant and fragrant fire. An acre of sunflowers will yield about a ton of this fuel. As the sunflower is rich in potassium, even the ashes have a commercial value for fertilizing purposes.

Respect for Books.—The London Spectator remarks upon the respect which the average Briton has for libraries in themselves, no matter how little he reads or how averse he may be to spending money for books, as one of the most inexplicable features of his character. "The impressiveness of a library," it says, "is felt by classes far outside the one which passes its life in using books. The ordinary population of an ordinary town, though it will not always vote the cost of a free library, is proud to believe that the town library is a good one, regards its increase as something to be recorded with triumph, and enters the rooms in which it is kept with a kind of awe. It is considered a mark of caste to possess a good library, and a house will sell better because there is a room in it which has been devoted to the keeping of books, and that to men who would regard a day spent among books . . . as intolerably tedious." The feeling is said to extend to those who can not read, "and it is undoubtedly true that servants, though they will neglect a library to any extent, and apparently believe that dust on book-shelves is matter in the right place, will take any trouble not to injure books if they are accumulated in any numbers. . . . We suppose the true reason is that, as all men respect knowledge, and especially knowledge of which they only dimly perceive the use, they regard a library as a deposit of bottled wisdom, by which they can hardly profit, indeed, but which they had rather not injure or disperse." There are evidences that the same feeling of respect for books as books has influence also with cultivated people.

A Hopi (Indian) Baby.—After a child is born to a Hopi Indian (says Mr. J. G. Owens, in an article in the American Journal of Ethnology and Archæology) the mother bathes her head in a suds made of the amole root, and an attendant bathes the baby in a suds of the same, and rubs it, except its head, in ashes, these being supposed to kill the hair on the body. The baby is then put in a cradle, and an ear of corn is placed by its side to watch it. The regular Hopi cradle consists of a wicker base, woven of small twigs of *Rhus trilobata*, about two and a half feet long and a foot wide. Six or eight inches from one end, the head, is a bow of the same material, about two inches wide and nine inches high in the center. This is to keep anything thrown over the cradle from falling on the face of the baby. Covering three quarters of the base is a mat of cedar bark. Several small blankets are laid across the cradle and the little one is placed upon them, with its head generally lower than the rest of the body. The arms are laid straight by its side, and the blankets are folded over and kept in place by lacing a heavy woolen cord with loops of the same material on either side of the cradle. Frequently the presence of a baby in a house would be entirely unsuspected; but should you attempt to sit upon what appears to be a pile of blankets in a corner, the protests of the watchful mother will at once admonish you of your mistake. Until the fifth day the mother must not see the sun or put on her moccasins. On the morning of that day she bathes her own head and that of the baby with amole, puts on her moccasins, and is then at liberty to go out of the house. She resumes charge of the household affairs, and by the tenth or twelfth day seems to have regained her normal strength. Sometimes a mental record of the age of the baby is kept, with the aid of the fingers; in other cases scratches are made by the thumb-nail on the wall. On the tenth and fifteenth days, respectively, the mother again washes her head with amole, and bathes and rubs the baby with ashes, just as on the first day. On the twentieth day the chief ceremony takes place, which includes the purification of the mother, the naming of the baby, and the presentation of the baby to the sun. These are described in detail in Mr. Owens's article.

The Crustacean's Shell.—No group of animals, says Prof. W. K. Brooks, is more favorable than the Crustacea for the study of the significance and origin of larval forms, for these animals possess a number of peculiarities which serve to render the problem of their life history both interesting and significant, and at the same time unusually intelligible; nor are these peculiar features exhibited in the same degree by any other great group of animals. The body of the arthropod is completely covered, down to the tip of each microscopic hair, by a continuous shell of excreted matter, and as this chitinous shell is not cellular, it can not grow by the interpolation of new cells, nor can it, like the excreted shell of a mollusk, grow by the deposition of new matter around its edges, for there are no such edges, except in a few exceptional cases, such as the barnacles. Once formed and hardened, the cuticle of an arthropod admits no increase in size, and as soon as it is outgrown it must be discarded and replaced by a new and larger one. The new shell is gradually excreted, in a soft condition, under the old one, and as soon as this is thrown off the new one quickly becomes distended and solid. As a result, from the very nature of the chitinous shell and the method of renewal which its structure entails, the growth of an arthropod, from infancy to an adult condition, takes place by a series of well marked steps or stages, each one characterized by the formation of a new cuticle and by a sudden increase in size. In most arthropods the newly born young are very different in structure from the adults, and growth is accompanied by metamorphosis. As the changes of structure are necessarily confined to the molting periods, the stages of growth coincide with the stages of change in organization, and there is none of the indefiniteness which often characterizes the different larval stages of animals with a more continuous metomorphosis. On the contrary, the nature of each change is as sharply defined and as characteristic as the structure of the adult itself. As the molting period is frequently a time of inactivity, the animal may then undergo profound changes without inconvenience, and the successive steps in the metamorphosis of an arthropod are not only well marked but often very profound as well.

The Bantu.—More than thirty-five years have elapsed since the term *Bantu* has been applied to a large and widespread family of African languages; but it is little known except to specialists. There is no Bantu country, no nation of that name; the word has become an ethnographical but hardly a geographical expression. And yet, after a little explanation, says The Athenæum, it will be found so pregnant of meaning, so expressive of the hundred and more languages to which it applies, that it is not likely ever to be superseded. *Bantu* is the plural of *mu-ntu*, the general term for a human being common, with hardly any modification, to the languages spoken throughout South Africa, "from the Keiskamma River to the equator on the east, and from Walfish Bay to the Old Kalabar River on the fifth parallel of north latitude in the west"—that is, to the whole of the southern half of that vast continent, with the sole exception of the territories occupied by the Hottentot and Bushman tribes. The term *Bantu*, it should be added, is mainly used by the natives when speaking of themselves in contradistinction to white people. One of the various characteristics of these languages is to mark the grammatical categories almost exclusively by prefixes; and another to regulate the building up of sentences by certain laws of alliteration, the so-called "concords." It is, moreover, a remarkable fact that there is common to all these languages a great resemblance, not only of grammatical forms, but also of words, and, to a certain extent, of idioms, so that it is in some cases difficult to decide whether any two languages, though separated by wide tracts of country, do not actually stand in the relation of mere dialects. Indeed, as to closeness of kinship, the Bantu languages can far more fitly be compared to the Neo Latin or Slavonic than to the Indo-European languages. There are on the northwestern confines of the Bantu field, and beyond, a number of languages somewhat akin to the Bantu, to which Mr. Torrend, in his Comparative Grammar of the South African Bantu Languages, assigns the name of semi-Bantu. They stand in the same relation to the Bantu as the Melanesian languages do to the Malayo-Polynesian.

Intemperance in Cycling.—Noticing some recent extraordinary achievements in cycling—such as the conveyance of a dispatch from Chicago to New York in one hundred and eight hours and the covering of four hundred and thirteen miles in twenty-four hours—The Lancet inquires into the cost of such exploits, and answers: "The cost to the rider is, we say at once, altogether unwarrantable, for during the twenty-four hours in which a rider is occupied in covering four hundred miles his heart knows no rest from full activity, and the elastic coat of every artery in his body is in full tension. In some instances such is the tension that the man literally propels himself in what may be called blindness. His legs work automatically and his course is directed in a manner very little different. When a bicyclist was unfortunately killed from an accident caused by fast riding, a witness said, on oath, that the rider was going so fast and was so intent on the race he did not hear witness until it was too late, that is to say, until he got within two yards of a cart into which he ran, when he altered his whole position, called out 'Oh!' and coming into collision received the fatal injury. In another instance, where one of the long and sleepless rides was carried out, the rider was seized with vomiting, which never ceased during the whole of the effort. He, too, lost the guiding power of his senses, and for some miles tugged on as if he were blind, tearing away, in fact, in a kind of trance, his higher nervous centers paralyzed and his body retaining its life and mere animal power, held living by the respiratory center and the heart, they also being taxed to the very extremity of danger." Young men may occasionally do such things for once, without apparent immediate damage, but it is with great peril to their future vigor.

Famous Automatons.—Many ingeniously constructed automatons are mentioned in history or the fiction that goes with it. Among them are a wooden dove that was made B. C. 400; a fly presented to Charles V which went round in a circle and returned to its starting point; a bronze fly made by a bishop of Naples in the eleventh century which kept real flies out of the city; an eagle that flew before the Emperor Maximilian; and the brazen men that were made by Roger Bacon, or, according to others, by Albertus Magnus or Reysolius. A spider of the ordinary size was exhibited in London in 1810, which was caused by wheelwork to walk on a plate, and to shake its paws when taken hold of. A swan was on view about the same time, swimming in a basin of water along with some fish. It would seize a fish, swallow it, and then shake its wings. A few years afterward a gold bird appeared, which would come out of a tobacco box, spread its wings, and sing. The famous automaton chess-player was a humbug. It was not moved by machinery, but by a man hidden inside. Some very curious automatons were constructed by Vaucanson in the eighteenth century. Among them were a flute-player which played a dozen airs, and another performer which played twenty different tunes with a tambourine and a flageolet. These "artists" were worked by a strong spring that acted on numerous whistles supplied with air from reservoirs which were opened at the proper times. Vaucanson also made an asp for Marmontel's Cleopatra theatre, which could coil itself, thrust out its tongue, and hiss. His duck was a very famous imitation; for it could move its head around in search of food, swallow, and "digest." The secret of its "digesting" was discovered by Robert Houdin when he was engaged in repairing it. The food that was given it was removed during the intervals between the exhibitions and suitable "digested" matter, or the imitation of it, supplied. Houdin was very ingenious and was employed to repair other complicated machines. Among them was a mechanical organ that could improvise variations, that had been taken to pieces without marking where the several parts belonged. He succeeded in putting it together again, but it is not known what eventually became of it. The visitors to a certain seminary in the old times were met at the door by an automatic skeleton which welcomed them by clapping its fleshless finger-bones.

Periodical Variations of Glaciers.—The question of the periodicity of changes in the glaciers of the Alps is hereafter to be studied systematically. It has been taken up by the Council of the Canton of Le Valais, which has put the matter in charge of the administration of forests. A report made by M. Forel to the head of the Home Department represents that glaciers in general, and particularly those of Le Valais, are subject to variations in shape, which, according to an irregular periodicity, cause them sometimes to grow in length, in breadth, and in thickness, and sometimes to decrease, often in very considerable proportions. It has been recognized that most of the great catastrophes which have ravaged the region of the high Alps have been caused by these glacial variations. It is when the glacier extends, lengthens, and arrives at its maximum, that it invades the fields and destroys Alpine chalets, barricades the valleys, arrests the flow of rivers, and creates temporary lakes, the evacuation of which devastates the country; or else, surpassing its usual dimensions, it forms an avalanche, the destructive power of which is terrible. The preparatory study of these variations that has been made in the last few years has shown that their periodicity is much longer than was formerly believed to be the case; the popular dictum that the increase in size of glaciers recurs every seven years is certainly incorrect. Definite figures can not yet be given, but probably the cycle of glacial variation is as much as from thirty-five to fifty years. If 1850 or 1855 be fixed upon as the epoch of maximum, they have been steadily decreasing in past years, so that from 1870 to 1875 not a single glacier was known to be on the increase. Since then an increase appears to have begun in the glaciers of the Mont Blanc group, but most of the others are still retreating or stationary. Hence the phenomenon is one of which a man in an ordinary lifetime can see only a single manifestation; and it is therefore impossible for one man to make an adequate study of it. This is the ground on which M. Forel asked the state to take charge of the matter.

A Remarkable Fig Tree.—Fig trees grow in Brittany, usually in sheltered places, where they are rarely much taller than the structures that protect them. Near Roscoff is a tree of unusual size and which is very famous. It is about the same height as the other trees of the region—say twelve or sixteen feet—but covers with its branches a surface which may be estimated at about four hundred square metres. It is situated in a farm garden. Its single low, gnarled trunk is partly inclosed in a broad wall, so that it is difficult to measure its diameter exactly, but it is in the neighborhood of twenty inches. From it, starting at about six feet from the ground, a great many limbs extend horizontally in all directions—some of them as far as fifty feet. These limbs are supported on two garden walls and on thirty-eight granite posts, between two of the rows of which is a covered alley-way, about eighty feet long. A French writer, M. A. Mehard, says that when he saw this tree for the first time, in September, 1884, it was covered with a thick, green foliage, and had on it a great many figs, some of which were beginning to ripen. He asked how old it was, and was told that the oldest persons in the region had never known it to be different from its present appearance. "How many figs a year does it bear?" "As many as we want; if we pick them every day, there are always some left." "But how many do you pick a day?" "Several baskets a season" (of two or three months). "Is it still growing." "Yes, sir; it would soon cover the whole plot if I didn't cut off the ends of the limbs every year." It is true that the tree, though very old, is still vigorous and bears good fruit; and that, notwithstanding the disproportion between the trunk and branches, the latter make good growths. The tree stands at the extreme limit of vegetation approaching the seashore.

Botany as a University-extension Study.—Writing in University Extension in favor of placing botany among the subjects of extension lectures, Prof. J. M. McFarlane remarks upon the extent to which the mind has been blinded by the current system of education to the perception of all that is in the living world outside it. One, he says, "can watch the process going on. Every average child shows a natural desire to become acquainted not only with the men, women, and children that he meets day by day, but with the animals and plants that he sees moving and growing. This tendency is usually encouraged by the parents if they are sensible and know something of the facts of Nature. In the majority of cases, however, through pure ignorance they stifle the budding qualities of the child. And as school education advances, the stifling process is completed, for the child is silently taught that all knowledge can only come from books or the talk of teachers, and that to acquire knowledge through the tongue, by touch, from the sounds of natural objects, or by an eye-to-eye study of them, is a waste of time." Perceiving that the course of a few extension lectures is not sufficient to ground pupils well in Nature studies, the author suggests the combination with it of correspondence teaching. In proof of the feasibility of this, he shows that he has himself for eight years directed the work of students hundreds of miles apart, some of whom were advanced to the study of the highest works on the subject. But, besides the use of books and hand diagrams, he every fortnight forwarded from ten to thirty fresh specimens to each, which they were required to examine, describe, and classify. Material for microscopic study was supplied for those possessed of suitable instruments. Many of these pupils are now successful teachers of biology in schools and colleges, and two of them have established school botanic gardens.

Pepper-raising in Cambodia.—The pepper plant, says M. Adhémard Leclère, in the Revue Scientifique, is not a bush, as some writers say, but a vine which has to be supported by a tree when wild and by a strong stake when cultivated. The author has seen the vines growing nearly wild near Chandoc in Cambodia, where they had been planted by the villagers and left to themselves. They grew vigorously and to considerable length, but bore only a few bunches of fruit and that of an inferior quality. An abundant crop of good pepper can be obtained only by careful and skillful cultivation. The industry thrives in the province of Kampot, where it is pursued in some twenty villages. At the village of Suam Ampil there are eighty-nine planters and more than a hundred plantations, containing 48,441 stocks. The plants are propagated from cuttings, which are made about eighteen inches long and are taken from stocks two or three years old; they are supported by stakes about ten feet high, which are solidly planted in the ground; and are fertilized at the same season every year with a special manure which is composed of eight parts of good soil and one part of pounded shrimp shells. The plants are liable to attack by a minute parasite that destroys their fruitfulness, to obviate which they are treated with a decoction of tobacco. The first crop, but an insignificant one, appears in the third year from planting. A crop of about a kilogramme per stake of two plants is gathered in the fourth year, and the increase continues for eight or ten years. Exceptional plants in good soil may return four kilogrammes per stake; but a crop of from two to two kilogrammes and a half is considered a fair average. Some plants will live fifty years, but they are seldom remunerative after forty years; and, as a rule, a plant thirty-five years old is considered of no further value. The plants bloom in May and June, and the gathering of the crop begins in February. The bunches which have turned red are picked, and the others are left for future visitations. The berries are stripped from the bunches and dried in the sun till they are black, when they are packed and made ready for sale. White or gray pepper is produced by letting the berries get a little riper, and cleansing them from their outside envelopes. In some districts the removal is assisted by soaking the berries in sea-water. One laborer can usually take care of about one thousand stakes.

Yaks, Wild and Domestic.—Immense herds of wild yaks still pasture on the steppes in the region of the Lob Nor and Thibet. Individual species have been domesticated and are as cows and oxen to the people of the country. Thick and strong cloths are made from their hair; the tufts of their tails are used in standards; their meat is juicy, and their milk is not inferior to that of our domestic cows; and they are highly valued by the Thibetans as draught and pack animals, and even for riding, on account of their hardiness, readiness, and sure-footedness. Attempts have been made to domesticate them in France, but the climate proved not suitable to them. Comparison of the skins of domestic yaks with those of wild ones shows how the animal has been modified under human influence and through changes in its medium. The hide of the domestic yak has become fine, is often silver-white, or gray varied with white; and the horns, when they have not disappeared, form a simple curve outward and upward; while in the wild yak the hide is uniformly black or very lightly shaded with brown, and the horns, which are nearly three feet long, describe an incomplete S, starting outward, then growing forward and then upward. Judging from the specimens presented to the Paris Museum by the Prince of Orleans, the wild yaks are much larger than the domestic animals, and the long hair on their flanks and legs grows lower down. Like the buffalo, these animals are dangerous to hunt, unless they are killed at the first shot.

Color Phenomena on Mars.—Prof. W. H. Pickering writes to the Journal of Astronomy and Astro-Physics concerning his observations of Mars at Arequipa, Peru: "The sudden changes of color exhibited by some of the smaller areas upon the planet Mars are sometimes almost startling. A recent view was obtained shortly before sunrise, when the snowy region about the south pole appeared of a most brilliant green, quite equaling in color the rather narrow green band situated just to the north of it. Later, as the sun came up, the color of the snow changed to a bright yellow, the rest of the disc changing in the mean time to orange. Later the seeing improved, several of the canals became visible, and the snow became as colorless as upon our surrounding mountains. The two former effects were probably due to bad seeing, the fluctuations of our own atmosphere superporing the colors of the surrounding regions upon the snow. We have laid it down as a rule never to rely greatly upon our color observations unless the snow-caps of the planet appear perfectly colorless and the canal system is well defined." A curious feature of the observations described by Prof. Pickering is an actual change of color which, eliminating all probable sources of error, the planet really seems to undergo. He believes that some time in the future these changes will be understood and their laws determined. He thinks the greatest danger lies from optical illusion.

NOTES.

A correspondent of the London Spectator, Violet Davies, tells the following story of "a canine member of the Society for the Prevention of Cruelty to Animals": "Last week a sick dog took up its abode in the field behind our house, and, after seeing the poor thing lying there for some time, I took it food and milk and water. The next day it was still there, and when I was going out to feed it, I saw that a small pug was running about it, so I took a whip out with me to drive it away. The pug planted itself between me and the sick dog, and barked at me savagely, but at last I drove it away, and again gave food and milk and water to my *protégé*. The little pug watched me for a few moments, and as soon as he felt quite assured that my intentions toward the sick dog were friendly, it ran to me, wagging its tail, leaped up to my shoulder, and licked my face and hands, nor would it touch the water till the invalid had had all it wanted. I suppose that it was satisfied that its companion was in good hands, for it trotted happily away, and did not appear upon the scene again."

The vermilion-spotted newt (*Diemyctylus viridescens*), as described by Simon H. Gage, has the curious property of changing from the aquatic to the terrestrial life and again to the aquatic, modifying or partially modifying its breathing organs to correspond with each change of medium. It appears that, after having lived on the land, the preparation for reproduction requires the terrestrial forms to enter the water, when the life becomes for a greater or less time once more partially aquatic, and that "the surroundings of larval" life and the necessity for respiration brought about by the prolonged stay under water required for fertilization and ovulation recall by a kind of organic memory the mode by which respiration was accomplished in larval life. The tree-toad and the yellow-spotted salamander are likewise capable of partially returning to an aquatic mode of respiration; and the siren, after having had its gills so far absorbed as to be mere stubs, returns to the water and reacquires them.

An extraordinary grotto was recently revealed at Taverney, France, by an explosion during the progress of the ordinary work in a quarry. This subterranean gallery, with walls polished as if by water, is about 1,500 feet long, and ends in a chamber about 40 feet in diameter and six feet high.

The expedition sent in 1891 from Bowdoin College to Labrador has confirmed the truth of the reports that have been vaguely current for many years of the existence of a great cataract in Labrador. The stream forming the falls and rapids rises in the plateau known as "the Height of the Land." The spray of the falls was visible to the explorers when twenty miles away. The river, rushing through a gorge hardly more than 150 feet wide, makes a sheer plunge of 200 feet. Below the falls are rapids, which prolong the whole descent to quite 500 feet. The explorers sailed down the river for 300 miles below the falls.

At the last anniversary meeting of the Royal Society the Copley medal was awarded to Prof. Rudolph Virchow for his services in natural history, morbid anatomy, histology, pathology, and ethnological and archæological science; the Rumford medal to Nils C. Dunér, of the University of Lund, Sweden, for his work in spectroscopic astronomy; Royal medals to Prof. Charles Pritchard, of Oxford, for photographic investigations in astronomy, and J. N. Langley for physiological researches; the Davy medal to Prof. François Marie Raoult for his researches on the freezing-point of solutions and on the vapor pressures of solutions; and the Darwin medal to Sir Joseph Dalton Hooker.

Among the Laos of the Siamese dominions, according to an article in the Kew Bulletin, tea leaves are not used for making an infusion as in other countries, but are prepared wholly for the purpose of chewing. They are steamed and then tied up in bundles and buried in the ground for about fifteen days. Leaves thus prepared, which are called *mieng*, are said to keep two years or more. The habit of chewing *mieng* is nearly universal among the Laos, and is said to be almost indispensable to men engaged in hard work.

Experiments on the suitability of aluminum for horseshoes made in a Russian regiment of Finnish dragoons have resulted favorably. The horses were shod with three iron shoes and one aluminum shoe. When it was time to renew the shoeing, the shoes of aluminum were found to have worn as well as those of iron. None of them were broken, none showed any traces of rust. Among the advantages anticipated from the use of aluminum in horseshoes are greater facility in forging and a reduction of the load to be carried by the horse's feet.

The American Microscopical Society has funds supplied it, from which it offers two prizes of fifty dollars each for the best papers giving results of original investigations relating to animal and to plant life respectively; two prizes of twenty-five dollars each for the second best papers on these subjects; a prize of thirty dollars for the best six photomicrographs on some subject in animal or vegetable histology; a prize of thirty dollars for the best collection of six mounted slides illustrating some biological subject; and two prizes of fifteen dollars each for the second best collections of photomicrographs and slides. The papers should be submitted to the committee on or before July 1, 1893 (W. H. Seaman, Secretary, Washington, D. C.). All photographs and slides for which prizes are given are to become the property of the society. The object of the prizes is to stimulate and encourage original investigation in the biology of North America.

Dr. Alcock, of the Marine Survey of India, has observed in the structure in the nippers and arm of the red cycopod crab of the shores a regular fiddling apparatus like the stridulating apparatus of many insects. Its music is heard when the crab's burrow is threatened by an intruder, and gradually rises in loudness and shrillness and frequency if the presence of the intruder is continued, until it becomes a tumultuous low-pitched whirr or high-pitched growl, the burrow acting as a resonator. Crabs of the same species will not enter one another's burrows unless they are forced to, whence Dr. Alcock infers that the use of the stridulating apparatus is to warn others against crowding upon its hole.

Mr. F. W. Doughty, of Brooklyn, claims, in a pamphlet which he has published on the subject, to have discovered in the Glacial drift at different places in Massachusetts, Connecticut, New Jersey, and Pennsylvania, and on Staten Island and in the city of Brooklyn, evidences of man's work, testifying that the human race was old at the Glacial period. The evidences consist of representations of the human head cut in various kinds of stone or modeled in clay, flat tablets of clay bearing portraits of men and women and of existing and extinct animal forms, together with objects of primitive symbolism, such as occur on the most ancient coins, and clay molds and stone seals. His pamphlet contains a number of illustrations of these objects, which are curious, to say the least.

The committee of the American Association to which the subject was referred, approve the resolutions of the Australasian Association concerning an international committee on biological nomenclature, advise that the French and Italian biologists be invited to appoint branch committees to act with the others, and make some suggestions respecting the underlying principles that should govern biological terminology. Thus the committee recommend that the names of organs and parts and the terms indicating position and direction should be single, designating words, so far as possible, rather than descriptive phrases; that morphological terms should be etymologically correct and derived from Greek or Latin, and each term should have a Latin form; that terms relating to position and direction in an organism should be *intrinsic* and not *extrinsic*—that is, should refer to the organism itself rather than to the external world; that in addition to its proper Latin form each of the technical words should have a form that shall make it conform to the genius of the various languages, or that a paronym be made for each technical word.

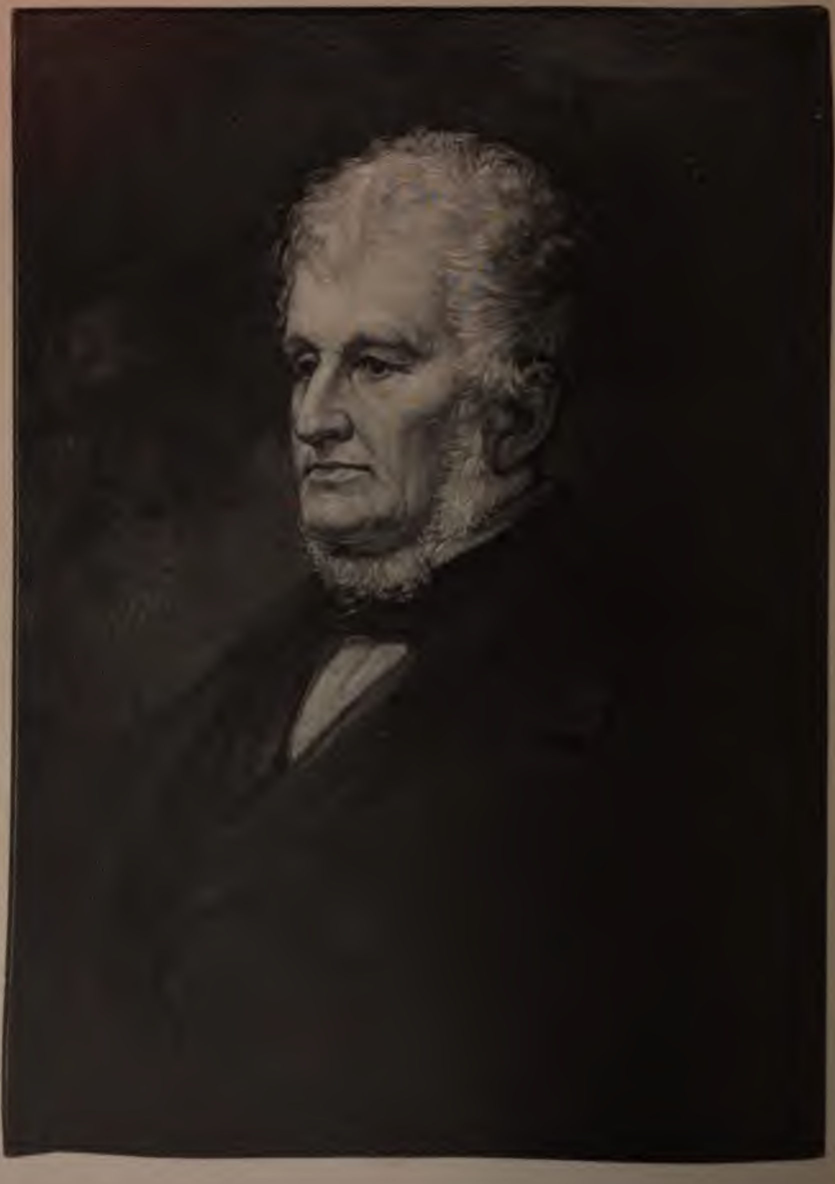
OBITUARY NOTES.

Sir Richard Owen, one of the most famous comparative anatomists of the age, died in London, December 18, 1892, in the eighty-ninth year of his age. A full sketch of his life and work was published, with portrait, in The Popular Science Monthly, Vol. XXIII, No. 1 (May, 1883).

Mr. W. Mattieu Williams, author of the series of articles on The Chemistry of Cooking, published in the Monthly a few years ago, died suddenly at his home in Neasden, England, November 28, 1892. The book by which he was best known is The Fuel of the Sun. Much of his work was contributed to serial publications, and a volume of his popular essays was issued several years ago under the title of Science in Short Chapters. His Through Norway with a Knapsack called attention to the advantages of Norway as a summer resort for tourists.

Dr. E. W. Siemens, a distinguished German engineer and electrician, died in Berlin, December 6, 1892. He was born at Leuthe, in Hanover, in 1816, taught in the Lubeck gymnasium, joined the Prussian artillery in 1837, and withdrew from the service of the Government in 1850 and devoted himself to scientific studies and private enterprises. He was the inventor of many of the most valuable practical applications of electricity and of devices in electrical apparatus, instituted the Siemens quicksilver unit, contributed much to the successful establishment of the electric railway, and devised the pneumatic dispatch system and the Siemens alcoholimeter.

Prof. John S. Newberry, of Columbia College, died in New Haven, Conn., December 7, 1892, after a long illness. He suffered an attack of paralysis in December, 1890, from which he never fully recovered, and which left him with a gradually failing mind. A sketch of his life and scientific work—chiefly in geology, in which he was one of the most eminent American experts—was given in The Popular Science Monthly, Vol. IX, No. 4, August, 1876. He received the Murchison medal from the Geological Society of London in 1888.



ROBERT HARE.

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THE GLASS INDUSTRY.

By Prof. C. HANFORD HENDERSON.

THE DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS. XVII.

AT the beginning of the eighteenth century the glass industry was practically dead. The latter part of the century witnessed its slow revival. Some of these enterprises were short-lived; others outlasted the century. No very striking improvements were made, the most noted change being the substitution of coal for wood. But an immense amount of experience had been gained, and meanwhile a home market had grown up. The nineteenth century, therefore, opened with very flattering prospects. A united people had taken the place of a group of scattered colonies, while the improved standards of domestic comfort made greater demands upon the glass-maker's skill. The majority of people were no longer willing to make oiled paper do duty for glass in their windows, though even now, at the close of the century, there are thousands of cabins throughout the South which are destitute of a single window of any sort whatever. There was also an increased demand for glass table furniture and articles of luxury. The invalidism of an aging civilization created an unhappy market for patent medicines and other nostrums which must needs be put up in glass bottles. Greater delicacy in diet gave rise to the preservation of fruit and vegetables for the winter season, and made the production of jars for the purpose almost a separate industry. Both technical conditions and social requirements have thus conspired during the present century to forward the development of glass-making. Its history divides into two periods, that preceding and that following the introduction of natural gas as fuel. The century opened with the almost universal use of wood, the new and experimental plant at Pittsburg alone making use of coal. It ends with an almost universal use of natural gas, where it can be obtained, and an unmistakable tendency to substitute manufactured gas for coal where Nature has not supplied the gaseous fuel.

The States which now lead the glass industry, Pennsylvania and New Jersey, were already at the front in the beginning of the century. In Pennsylvania there were a number of enterprises on foot. Philadelphia took quite an active part in this development. The Kensington works, established by Robert Towars and Joseph Leacock in the fall of 1771, had passed through a number of hands, but was fairly continuous in its operations. It ultimately came into the possession of the Rowland family, and was sold by them in 1833 to Dr. Thomas W. Dyott, a notable figure in the annals of our early glass-making. They were at this time the most extensive glass works in the country, melting about 8,000 pounds of batch every day and turning out something like 1,200 tons of glass a year. This was chiefly in the form of bottles and druggists' supplies. There were five furnaces adapted for burning both coal and wood, as well as North Carolina rosin. From two hundred and fifty to three hundred hands were employed in carrying out the various operations. Dr. Dyott failed in 1838, and the works were idle for several years, thus losing their former prestige. There were also window-glass works at the Falls of the Schuylkill, and another lower down on the river at South Street wharf. When the first census of manufactures was taken, in 1810, there were two glass works in the county and one within the city limits, the joint product of which amounted to only $26,000. Glass-making does not seem at that time to have been very successful in Philadelphia, for in 1820 there was but one plant reported in the whole county. In that year a co-operative flint-glass works was started in Kensington, but it did not succeed. In 1840 there was but one works reported.

Here as elsewhere throughout eastern Pennsylvania there has been, since then, a steady increase in productive power, but relatively there has been a marked decrease in the industry. The character of the product, too, has changed. Philadelphia probably produces at the present time about two million dollars' worth of glass a year. None of this, we believe, is sheet or window glass, except a little for decorative windows. The most of it consists of the fancier sorts of hollow ware, lamps, globes, chimneys, cut glass, and other forms of domestic glassware and of articles of luxury. The reason of this change is quite obvious. In the production of glass in the mass, such as window glass and plate glass, Philadelphia and the eastern part of the State could not possibly compete with the Pittsburg district. The conditions are much less favorable in the matter of fuel and crude materials. Skilled labor, however, is more available, and artistic influences are more in the air. In the production of this finer ware the intellectual element is so much the larger ingredient that the cost of the bare material itself is of less moment. In consequence we find Philadelphia at the present time an important center in what may be called the æsthetic department of glass-making. We find here the manufacture of large quantities of decorated gas globes, together with such other wares as require the etching action of hydrofluoric acid, and of cut and engraved articles of various designs and for multiform uses. It was here that the process of making cameo glass was imported from England. This department of glass-making, it is true, has not proved commercially successful, but the manufacture of the cameo ware well illustrates the tendency toward variety of product which is shown by industrial centers depending for success upon nicety of workmanship rather than quantity of output.

These conditions have also given rise to the invention of machines and processes noted for their ingenuity and importance. The sand blast, by which glass is quickly and cheaply ground by exposure to a blast of air charged with sharp sand, is the invention of a Philadelphia gentleman, General B. F. Tilghman. So powerful is the abrading action that a plate of corundum may be drilled in this manner, and even the diamond is worn away. The blast has also been applied to the manufacture of files, and to the drilling of metal plates.

The industry also started up in a number of other districts in the eastern part of the State. The attempt made by Mr. George Lewis, an English gentleman, to establish glass works at Eaglesmere some time between 1803 and 1809 was scarcely less picturesque than the earlier efforts of Baron Steigel. In 1886 the ruins of the glass-house were still to be seen on an eminence overlooking the lake. An old frequenter of the place—for it has since become a well-known summer resort—was fortunate enough to have in his possession some excellent specimens of the early glass. But in the first decade of the century it must have been a lonely place, and we can not help wondering that any one should have had the temerity to put a glass-house there. It is true that the natural conditions were good. The sand at one end of the lake is beautifully white and pure, while the surrounding forests furnished an abundance of fuel and alkali. The glass-making seems to have been a technical success, and it is said that Mr. Lewis made considerable money during the War of 1812, but the difficulties of transportation were ultimately too much for the enterprise. The works were separated from the markets by long distances, and by roads which, after the lapse of nearly a century, are still very rough. Mr. Lewis appears never to have lost faith in the undertaking, but after his death the works were finally abandoned.

There are doubtless many other quiet localities scattered throughout the State which could tell a similar story of endeavor and perseverance and failure. West of the mountains the development of the glass industry has been phenomenal. The works established by Mr. Gallatin at New Geneva in 1797 continued to make window glass for many years. They were, however, finally abandoned toward the middle of the century. But the establishments at Pittsburg became the nucleus of a glass-making center which is to-day quite unrivaled in importance by any other glass center in the world. In the early days it was not all smooth sailing by any means. But the men who nourished the industry seem to have possessed unusual enterprise and perseverance. Their pioneer efforts in the use of coal in place of wood was in itself an act of no little industrial courage, for even in 1810 this remained the only plant in America which used coal. The product of the Craig and O'Hara factory was chiefly window glass, though an occasional lot of bottles was also turned out. About 1800 a second glass-house was established in Pittsburg by Denny and Beelen. It used wood exclusively as a fuel—being so situated, indeed, on the north side of the Ohio River that coal was not readily obtainable. The works did not prove successful and were soon abandoned.

The records of the industry show the establishment of various other works during the early part of the century, but the majority of them were unsuccessful and were sooner or later forced to suspend. The first flint-glass works were probably those established by Messrs. Bakewell and Page in 1808. They started with one six-pot furnace, but met with such flattering success that they constantly enlarged the capacity of their works. In the census of 1810 it is stated that "decanters, tumblers, and every other description of flint glass of a superior quality" were manufactured at Pittsburg. From this time onward the growth of the industry has been continuous and rapid, except during a brief period preceding 1819, when a temporary decline was experienced.

It would be both uninteresting and foreign to the present purpose to enumerate the separate histories of these various enterprises, but the figures illustrating the growth of the industry from this time on to the tenth census are too significant to be passed over in silence. Thus in 1837 there were thirteen factories in Pittsburg, yielding an annual product of about $700,000. In 1857 there were twenty-five factories, with a yearly output valued at

$2,600,000. It will be noticed that while the number of establishments only doubled during this interval of twenty years, the value of the product was nearly quadrupled. At the time of the tenth census—that is, in 1880—there were fifty-one factories, yielding an annual output of about $6,000,000. The importance of Pittsburg as a glass center can best be appreciated by considering these figures relatively to the whole American output. The one district of Allegheny County produced a little over a quarter of the entire glass manufactured in this country, while the State, as a whole, made a trifle over two fifths of the total. The product was window glass, hollow ware, and green glass, no plate glass appearing in the State returns up to that time.

While the other conditions were also favorable, the chief cause of this marked development in Pennsylvania has undoubtedly been her fuel. During the first ten years of the century her forests alone were used to any extent, but the substitution of coal for wood went on continuously for the succeeding seventy years, until in 1880 it was everywhere the chief fuel, wood being employed only in heating the annealing ovens and for other minor purposes. Up to 1880, however, the development of the industry consisted for the most part in the improvement of already existing devices. The furnaces were made larger, the chemicals were purer, the melting pots more capacious. The coal was burned to better advantage, and consequently the batch was more thoroughly fused. Greater differentiation of the processes was being slowly brought about. In window-glass factories separate furnaces were provided for melting and blowing. In the handling of the glass there were similar improvements. The continuous rod leer was coming into use, while bottles and other hollow ware were annealed in iron trucks and no longer needed separate handling. All these were substantial gains; yet up to 1880 the fact remained that no very radical changes had been introduced into general glass-making practices—we do not here refer to the subsequent working of the material—and it was undeniable that the American product was in many respects inferior to the imported. We could not at that time successfully compete with Belgium even in the matter of window glass.

But during the past decade there has come a change so radical and so far-reaching in its results that more glass history has been condensed into these busy ten years than is to be found in the previous eighty years. The natural-gas well has been a veritable Aladdin's lamp to the glass industry. The fuel itself has been known for many years. As early as 1775 Washington had a "burning spring" on the tract of land deeded to him in the Kanawha Valley for military service, which he desired to make public property; but through some technicality the grant was never completed. The first utilization of natural gas of which we have record was at Fredonia, in New York, in 1821. This first well was an inch and a half in diameter and only twenty-seven feet deep. The gas was used solely for illumination, and when Lafayette visited the town, in 1824, the inn where he stopped was thus lighted. The Fredonia well excited an immense interest on both sides of the Atlantic, and so great a man as Humboldt is said to have declared it the eighth wonder of the world. Yet there seems to have been little effort to duplicate the wonder. Even at Fredonia a second well was not sunk until 1850. The first use of the gas for manufacturing purposes was probably in 1841, when William Tompkins burned it to evaporate brine in the Kanawha Valley. From this time onward the natural gas came slowly to be used under boilers to drill salt and petroleum wells, and occasionally to heat and light the houses in neighboring villages, but on the whole the gas was regarded as a danger and a nuisance. It was not until April, 1873, that gas was used in iron-making. In the fall of 1875 it was introduced into a large rolling mill near Pittsburg.

About this time the new fuel was also introduced into glass-houses. It is believed that the Rochester Tumbler Company, at Rochester, Pa., was the first to utilize the gas in the processes of glass-making. At the present day it seems odd that so eminently convenient and economical a fuel should have been so slow in coming into use. The Government reports on the Mineral Resources of the United States make no mention of natural gas until 1883 and 1884. In the volume for those years it appears for the first time as an economic product of sufficient importance to be noticed. Eight years have passed, and now the capital invested in natural gas is probably not far from one hundred million dollars. In the latter part of 1883 the gas began to be introduced into Pittsburg glass-houses. Mr. John B. Ford took an active interest in this development. During this and the following year he exploited the now celebrated Tarentum district in order to obtain a supply of gas for the plate-glass works which he had just built at Creighton.

The transition from solid to gaseous fuel took place with astonishing rapidity. By 1885 all the glass-houses in Pittsburg and the neighborhood which could obtain gas cheaply were using it for all purposes of melting, blowing, manufacturing, and annealing. It was possible to make the substitution so suddenly both because of the rapid exploitation and development of the gas territory, and because of the comparatively small changes needed to adapt coal-burning furnaces to the gas. Where the gas was burned for power, under boilers, the old grates were in many places retained and the gas-burners so arranged that, in case of any interruption to the flow, a coal fire could be started in six or eight minutes. In the glass furnaces themselves greater changes were necessarily made. As the supply of gas became more abundant and assured, the tendency was toward the evolution of distinct apparatus for its utilization. At the present time the glass furnaces burning natural gas are models of simplicity and efficiency. In the melting furnaces the gas is admitted at each end of the furnace and mixes with air which has previously been heated by passing through flues in the brickwork. The combustion thus takes place in the melting chamber directly above the crucible pots, and produces an intense and easily regulated heat. The blowing furnaces are even simpler. They merely provide a chamber of brickwork with suitable openings in the sides, and immediately under each opening a large Bunsen burner supplied with natural gas and drawing the requisite air directly from the atmosphere.

Under the stimulus of the new fuel the development of the glass industry since 1885 has been without precedent. The greatest growth took place first in the flint-glass works, because in these the advantages of the gas were most manifest. The absence of coal smoke and dust, and the tendency to reduce the lead oxide to the metallic state, were in themselves sufficient to bring about the substitution of the gas for the coal, had there been no other reasons. But the economic advantage was also in favor of gas. Thus, a factory which was run by coal in 1883 at a weekly cost of $175.17 was operated by natural gas in 1885 for $94.96, effecting a saving of forty-six per cent. In addition to this the repairs were less costly and the product was more salable.

The introduction of natural gas into window-glass factories was held for some reason to be less advantageous than in flint-glass works, but the tradition rapidly melted away in the face of a larger experience. By 1885 and 1886 natural gas had made its way into all departments of glass-making, and everywhere turned out to be an immense improvement. Now it is the universal fuel, and up to the present year it has been the cause of that concentration of the industry of which we have already spoken. It has not only given a better product and more economic working, but it has made possible the carrying out of operations on a scale hitherto undreamed of. In plate glass and window glass the product is now measured by the acre, and even by the square mile, where formerly it was reckoned in feet. Hollow ware is shipped by the ton in place of pound lots. One hundred and twenty thousand dozen lantern globes are turned out as a summer's work. With the more complete organization of the industry it is no longer necessary for large plants to grow out of small ones. The conditions needful for success are now pretty well known, and where these are found the most extensive works may spring up without any previous history. So we find in the enumeration of an establishment, now in course of construction, one item of one hundred and twenty-five two-story houses, while the plant itself is to be one of the most perfect and extensive in this country. These sudden growths will become more and more possible with the progress of industrial analysis.

In the neighboring State of Ohio the industry gained small footing until within recent years. There were two glass-houses in operation in 1817, and others were subsequently started, but they do not appear to have succeeded, for none were reported in the census returns of 1840. Ten years later there were six in operation, but in 1860 the number had decreased to four. In 1870 the total establishments numbered nine, and at the time of the tenth census had increased to a score. With the discovery of natural gas, however, the industry experienced a sudden expansion, and the State is now one of our most active glass-producing centers. Gas was known as early as 1836, but it was not until 1884 that it was regularly sought for and utilized. In the fall of that year a successful well was drilled in the now famous Findlay district. This was followed by other wells in 1885, and in 1886 by the Karg well, one of the most prolific in the entire country. A few months later the Van Buren well yielded even larger returns, and firmly established the reputation of western Ohio as assured gas-producing territory. Bowling Green, twenty-four miles to the north of Findlay, became a second important gas center. Both towns are underlaid by Trenton limestone, and draw their supplies of gas from the same geological horizon. Other gas rock has been discovered, but this remains by far the most productive.

The history of these and other districts in the gas country reads quite like an industrial fairy story. Quiet country towns have expanded in a surprisingly short space of time into manufacturing centers of national importance. In this development glass-making has been the foremost industry. By 1888 there were a dozen different establishments at Findlay alone, making bottles, window glass, and flint ware of fine quality, while the population had increased from six thousand to thirty in about eighteen months. At the same time Bowling Green had five glass-houses, and Fostoria five more. Numerous other establishments are found scattered over the entire State.

The development of glass-making in Ohio, in addition to the mushroom rapidity with which the industry has sprung up, presents a number of unique and interesting economic features. It has been practically a race between the different localities as places [illegible] should secure the greatest number of establishments

View of Ford City, Pa., showing the Extent of a Single Plate-Glass Establishment.

and build up the largest communities in the shortest time. The means employed were eminently socialistic. The business of town "booming" was intrusted to the town corporation itself, instead of being left to private effort. The town undertook the work of exploration, drilling the wells, and finally of supplying free gas to all manufacturing concerns which would settle within the town limits. Tiffin has been particularly active in these corporate ventures. In about one year it spent two hundred thousand dollars in the work of development, and, besides the pledge of free gas, furnished fifty thousand dollars to secure a large glass factory. It was a somewhat daring policy, but it succeeded so well that other towns soon followed its example. Where they had no money to give, they gave free gas and ten-acre lots. Thus solicited, the glass industry became a willing immigrant and invaded the State in generous proportions. This phase forms indeed a curious chapter in our industrial history, and is a strong contrast to the mortal struggles of our earlier glass-makers.

The industry had a very similar history in Indiana, though on a less extended scale and at a somewhat later period. The State was early identified with the plate-glass manufacture, but it was not until the development of natural gas that it took a prominent place. The whole southeastern part of Indiana is underlaid by the Trenton limestone, and is a highly productive gas territory. Its history begins with the drilling of the Kokomo well in the fall of 1886. This gave a daily output of two million cubic feet, and was soon followed by others yielding six and seven million feet. Throughout the entire State the work of exploration proceeded with astonishing rapidity. Few districts, indeed, have been so thoroughly exploited. It is now one of the three chief gas-producing areas in the United States, and has attracted a proportionate number of glass factories.

Certain branches of the industry, such as the manufacture of plate glass, can hardly be said to belong to any State, for it has shown itself decidedly peripatetic. The first attempts were probably those made at Cheshire, Mass., in 1852–'5. After an unprofitable run of six months, the works were removed to Brooklyn, N. Y. Here there was more experimenting and more loss. The enterprise was abandoned in 1856. This same year a second attempt was made at Lenox, Mass. After some initial difficulties and failures the works got successfully under way and continued to manufacture rough plate until the close of the war. A new company was then formed and undertook the production of polished plate. A machine which had been invented to grind and polish marble was found to do equally good work on glass, and was put into operation with excellent results. In a modified form it is still employed, both in this country and in Europe. The company prospered for some time, but through unwise management finally failed. But the American plate-glass industry, though apparently doomed to suffer severe reverses, was not doomed to die. In 1869, two years before the Lenox failure, a carefully designed plant was put into operation at New Albany, Ind., by Mr. John B. Ford. He imported the first grinding and polishing machinery from England. Although these works have been operated continuously ever since then, and are now reasonably successful, they had to run the gantlet of early reverses. Their owner, Mr. W. C. De Pauw, stated before the tariff commission that up to 1879 no money was made at his own works, and that he believed other

INTERIOR VIEW OF THE CASTING HALL AT FORD CITY, PA.

manufacturers of plate glass in America had had a similar experience. The industry up to that year seems indeed to have been one succession of financial disasters. Yet these failures do not appear to have discouraged their promoters. Between 1870 and 1875 Mr. Ford established other works at Jeffersonville, Ind., and at Louisville, Ky. About the same time a large plant was also built at St. Louis, and, like the others, was equipped with English machinery. It was at that time the largest factory in the United States. The industry was slow in establishing itself at Pittsburg, but it has since reached its greatest development in that district. The Pittsburg Plate Glass Company began operations in 1883, their first factory being at Creighton. The monthly output was about

40,000 square feet, or nearly an acre of plate glass. The demand for the glass increased so rapidly that two years later, in 1885, a second plant was built at Tarentum. Meanwhile the methods of manufacture at Creighton had been so far improved that the joint output of the two factories was 280,000 feet per month, or between six and seven acres of polished plate. In another two years the same company built a third factory at Ford City, with a capacity of 200,000 feet per month. At the present time these works are being still further enlarged, and will soon have more than twice their original capacity. The growth of the enterprise has been remarkable. It is doubtful whether any other industry could show a parallel development. At the present time the annual output is in the neighborhood of a third of a square mile of polished plate. That means a great deal of sunshine for somebody.

These American plate-glass works compare very favorably in equipment and management with the more historic establishments of Saint Gobain and Ravenshead. The native product, we believe, is now quite equal to the foreign, and promises sooner or later to so far discourage importation as to be itself exported. It is pleasant, too, to record that, after so many disasters, this branch of glass-making is at the present moment the most flourishing of all departments of the industry. It is the one in which the American genius for mechanics has had the greatest scope. Few of the operations are performed by hand. These are precisely the conditions under which America can compete most successfully with the Old World, and feel the least disadvantage from her more expensive labor market. This thoroughness of organization has had its effect upon the price. Plate glass is to-day so cheap that, as some one has said, it may be used in farm-houses, though it should perhaps be added that in this case the farm itself must in times past have been rather profitable. It is, at any rate, no longer exclusively the window glass of the rich. This widening of the market has made possible the present success of the industry. When the price becomes so low that we can afford to use twice as many acres of plate glass as we now allow ourselves we may expect a still greater success. At the present time the tendency is decidedly toward largely increased production. There are now eight plants in full operation, and four more in course of construction, which will probably be under way during the early part of the year. The market is large enough for all, though there is naturally a considerable rivalry between the different factories. This shows itself, among other ways, in the effort to outdo one another in the size of the plate produced. The largest yet turned out is one, we believe, made by the Diamond Glass Company at Kokomo, Ind., which measures 153 by 212 inches. It is almost needless to say that the sole fuel used in all these works is natural gas. It has, indeed, made possible their large extension and success. At Ford City alone contracts were recently given for the drilling of seven wells at the same time.

In the second producer of glass in the United States, New Jersey, there has also been a continuity of operation not met with elsewhere. The early factories of Salem County and at Glassboro were the nucleus of a large and thriving glass settlement. The very favorable natural conditions early made the State the center of the bottle trade. Many of the works established during the first half of the century went out of existence after a few years'

INTERIOR VIEW OF THE GRINDING HALL AT FORD CITY, PA.

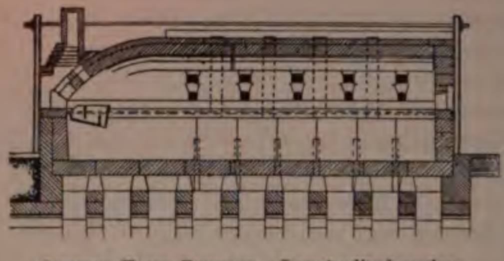
more or less successful run. But others, such as the works established at Millville in 1822, continue among the most important in the State. The introduction of anthracite as a fuel does not seem to have been made until 1856, though even at the present time wood is largely used in the annealing ovens. The weakest element in the New Jersey glass industry lies right here, in her deficient fuel. With various town corporations in Ohio and elsewhere offering natural gas free to glass-producers, the competition is very unequal, for the manufacture of bottles requires no great purity in the sand and no very special skill in the blower. Yet this rivalry appears to have been successfully met, for there has been during recent years a marked increase in the output of the Jersey glass-houses. New plants have been established in various places, and the capacity of old ones enlarged. At Glassboro, for instance, one of the oldest glass-houses in the country, the output was recently doubled within a period of three years, and has since gone on steadily increasing. The history of these works is indeed typical. The original glass-house was built in 1775 by the Stanger brothers, seven in number, who were all practical glass-blowers. They continued operations with reasonable success until the close of the Revolution, when the works were sold to Colonel Heston, the great-grandfather of the president of the company now operating the works. It is of interest

Tank Furnace used in the Manufacture of Lamp Chimneys at Jeannette, Pa.

that four generations have been connected with the one enterprise, a somewhat unusual persistency in the history of American industry. In 1887 the enterprise was incorporated as the Whitney Glass Works, and in the following year purchased the works at Camden. These, with the works at Glassboro and Salem, give the company an immense productive power and make their undertaking the most important glass industry in the State and one of the most important in the whole country. This increase of capacity is largely, if not entirely, due to the introduction of improved tank furnaces, the invention of the chemist of the Glassboro Works, Mr. Andrew Ferrari. These are modifications of the Siemens regenerative furnace, but differ from it in having the gas generator directly alongside of the melting chamber instead of at a distance. The coal is burned on the ordinary step-grate to carbon-monoxide gas which passes while still hot directly to the combustion area. At the bridge separating the generator from the melting chamber the gas mixes with the requisite amount of heated air, and, being itself hot, produces by its combustion a sufficiently intense heat to accomplish the perfect fusion of the batch. This proximity of the generator to the melting chamber obviates the great difficulty which had hitherto interfered with the use of gas as a fuel in glass-making—that is, the difficulty in obtaining a sufficiently high temperature. There are five of these tank furnaces at Glassboro, two at Salem, and one at Camden. This improvement is directly in line with local needs, since it has effected a saving of over fifty per cent in the cost of fuel. The expression is somewhat hackneyed, and unavoidably brings to mind the individual who was so delighted with a stove which saved fifty per cent that he proposed to buy two and so save a hundred per cent; but the reported saving in the case of the furnaces is the result of several years' experience and is quite authentic. Nor is this the only saving effected by the tank furnaces. They do away with the large expense of crucible pots and reduce the cost of repairs to a purely nominal sum.

No invention could have been more timely. In the face of the serious competition at Pittsburg, the New Jersey bottle industry, with its expensive fuel, would have fared but ill had it continued to melt its sand and lime and alkali in the old-time pot furnace. The tank furnace has served the industry in good stead. Within the past few months another important improvement has been introduced at Glassboro, in the substitution of crude petroleum for coal as fuel. Formerly its use was limited to the "glory-holes," where the mouths of the bottles were finished in an aureole of yellow flame. Now it serves also for melting the glass and annealing the ware. A large storage tank has been constructed, and it is believed that in a short time oil will entirely supersede the use of coal. A fourth chapter in the history of glass-making may soon have to be written in which petroleum figures as the dominant element. The Glassboro people, at least, are disposed to look upon its introduction as somewhat epoch-making.

At the present time the eyes of the bottle-making world are also turned toward New Jersey for another reason. Their glance centers upon Woodbury, for in that quiet village the destiny of the bottle-blower may be said to be on trial. The Ashley bottle-making machine has been set in operation to see if it can not do the work of human hands and lungs, and do it better and more economically. The machine was described before the British Association in 1889, when it was stated that bottles had been made by the machine, quite complete, which had successfully been subjected to an internal pressure of three hundred pounds to the square inch. The career of the machine in England, we believe, has been most unfortunate, but this does not at all diminish the interest which its introduction into America has excited. The advantages to be gained by the use of such a machine are much too solid to permit small obstacles to hinder its success. The trial run at Woodbury has been fairly successful. The automatic principle has not been developed to the full extent in these machines, but it has been carried so far that one man and three boys—none of them necessarily skilled glass-blowers—can operate two machines, each of which is capable of turning out two bottles a minute. The machine does not gather the glass. One of the boys, the "gatherer," is specially detailed for that service. He feeds the molten "metal" to the machine, in which it is mechanically molded, the neck and mouth formed, the interior blown by means of compressed air, and the finished bottle automatically delivered to a carrier which takes it to the annealing oven. There is undoubted room for improvement both in the performance and capacity of the machines. But the important step has been taken, and bottles have really been made in this country by machinery. One need not be very sanguine to believe that the initial step will lead to others, and that in the future not only bottles, but all other forms of blown ware, will be made mechanically. This is indeed only in the line of industrial development which is everywhere substituting continuous automatic processes for those which are discontinuous and organic. An experienced glass manufacturer, who has been for many years identified with the development of the industry in New Jersey, thus sums up present realities and tendencies: "The use of petroleum, the introduction of the tank furnace, and the bottle-making machine are the three great and only improvements that have been



Siemens Tank Furnace. Longitudinal section.

Siemens Tank Furnace. Transverse section.

made in glass-making for a long period of time. The tank furnace is rapidly superseding the old-fashioned pot furnaces, and in a very few years I do not think a pot furnace will be in operation in the entire country. The manufacture of bottles by machinery is comparatively new here, and, although it has been attempted a number of times, it has never been a pronounced success until recently. It is still in its infancy, but next year I think will see a large portion of the commoner kinds of bottles made in this way. I have no doubt that ultimately all articles of blown glassware will be made by machinery."

Although the attempt to establish glass-making in New England never met with great or permanent success, it is to Yankee inventive skill that we owe much of the means of success elsewhere. In these attempts Massachusetts took the lead in the nineteenth century, as she had in earlier days. In addition to the Boston works, established in 1792, a successful window-glass factory was started at Middlesex village in 1802. This gave employment to one hundred persons in all and turned out annually about eight acres of glass. It continued in operation a full quarter of a century, when it was shut down on account of the failure of the proprietors. The works were burned, but were soon after rebuilt, and in 1829 a company undertook to manage an industry which had failed in individual hands. They continued to make glass there for about ten years, when they removed to New Hampshire, attracted probably by greater abundance of fuel. Works were also established at Cheshire in 1812, and others in 1853 at Lenox. The latter was devoted to the production of window glass, and proved the most successful and enduring of the number. Several flint-glass houses were started in and around Boston, and were very successful during the early part of the century. The works at East Cambridge, built about 1812, have been particularly productive. Six years after they were started they are reported to have been "one of the most extensive flint-glass manufactories in the country." They had at that time two furnaces and twenty-four cutting wheels. The plant also included a furnace capable of turning out two tons of red lead a week, and was in other ways well equipped for the production of the finer wares. In 1823 22,400 pounds of glassware represented the weekly product. In 1865 the number of furnaces had been increased to five, the number of people employed being five hundred, and the value of the yearly product not far from $500,000. This, however, represented high-water mark, and was soon followed by a considerable decrease in activity. More significant was the flint-glass house established at Sandwich in 1825, for it has the reputation of having made the most important of American contributions to the technique of glass-working, and that is the glass-press used in the production of pressed glassware. The works started in a modest way with one eight-pot furnace, and increased their capacity as circumstances warranted. About two years after the works were built a local carpenter applied to the proprietor for a bit of glassware needed in some building operation, and was told that it could not be supplied. He suggested that the material might be pressed

A MODERN GLASS-PRESS.

into the shape he wanted. With the co-operation of the proprietor a rough press was made, and after some experimenting was found to answer the purpose admirably. A glass tumbler, stated to have been the first one made, was exhibited at the Centennial Exposition in 1876, but was unfortunately broken. From this incidental suggestion, given, too, by an outsider, the present extensive industry takes its rise. The American press is now used in nearly all the glass-producing countries of Europe, and has made possible our own plentiful output of beautiful and inexpensive tableware, as well as of artistic panels used in transoms and elsewhere. The pressed glass is not, of course, so brilliant as the cut, but it has the merit of costing less than one twentieth as much, and therefore of being within the reach of all. Later, the glass works were operated by the Boston and Sandwich Glass Company, and enjoyed quite a boom during the civil war. The stock commanded a ready market and became one of the conservative investments in which careful Bostonians took pleasure in putting their money. Since then operations have not been continuous, but the enterprise is still represented. After the war the glass industry in Massachusetts dwindled sadly until, in 1880, there were only five flint-glass houses and one window-glass factory in operation in the entire State. The cause of this decline was largely due to lack of fuel, and also in part to the pressure of other industries for which the locality is better adapted.

Massachusetts must, however, always hold a prominent place in the annals of American glass-making, both because of her service in developing the plate-glass manufacture and the possibilities of pressed glass, and still more because she has now within her borders the most noted of American workshops for glass. The lens-grinding establishment of Alvan Clark and Sons, at Cambridgeport, is known wherever the science of astronomy is cultivated. Its achievements in producing the glass for the Russian Imperial Observatory at Pulkowa and the giant lens for the Lick Observatory in California are still in mind. The contributions of the State must, therefore, be measured by intellectual standards rather than by avoirdupois or dollars and cents.

In other parts of New England the development of the industry has been exceedingly moderate. New Hampshire seems to have been an asylum for the disgruntled glass-makers of Massachusetts. Since the times when Robert Hewes betook himself to Temple and the Middlesex workers removed to Pembroke, the forests of the State have been fatal allurements to those across the line. Few, if any, of these northern migrations proved successful. The works established at Keene, in 1814, for the manufacture of window glass continued in operation until the middle of the century, but appear to have been a losing venture in the hands of the several parties who attempted to run them. The bottle factory established in the same town, in 1817, was somewhat more prosperous, but in 1848 succumbed to the same enemy which attends all such industries, a lack of sufficient fuel. At the time of the tenth census the bottle-house at South Lyndeborough was the only glass factory in the State.

The development of the industry in the other New England States has been correspondingly meager. In recent times there has been a slight revival of activity, but it is of little moment compared with the greater work being accomplished farther west.

The records of glass-making in New York and Maryland are somewhat fragmentary. In both States there have been a number of more or less promising enterprises whose histories are not dissimilar to those of corresponding glass works in Pennsylvania and New England. In Maryland, at the present time, the activity in these lines is chiefly centered about Baltimore and Cumberland, the product being for the most part window glass and hollow ware. The development of the industry in New York has been more varied. In objects of strict utility the output of the western part of the State is now quite large, but the most distinctive products are in the line of artistic workmanship. The cut glass produced in the *ateliers* of New York State is equal and probably superior to that of any other section. It compares indeed very favorably with the imported product. But the most praiseworthy product of the State, and indeed of the entire country, if we except the lenses of Cambridgeport, is found in the magnificent picture windows made in New York city from glass especially cast for the purpose in Brooklyn. In these translucent mosaics we have the very crown of American workmanship in glass. The most admirable of these mosaics, such as the memorial windows done by Mr. Tiffany, are works of art of the highest order. In addition to their wealth of luminous color and form they present something which, unfortunately, all reputed works of art do not, and that is, a clearly discernible idea. Compared with the intellectual pleasure which these windows afford, the beauties of other forms of glass work, however brilliant they may be, must appear somewhat unsatisfying.


A Modern Picture Window. Copyrighted by the Tiffany Company.

If we ventured in this sectional summary of the industry to pass judgment upon the work being done, we should be obliged to accord the first rank to New England in the matter of intelligence; to New York, for artistic merit; and to the belt of country stretching westward from New Jersey and Pennsylvania, for the eminently utilitarian quality of its products.

But the most important thing in regard to the development of glass-making in America remains yet to be said. It is the tendency which the industry discloses in this year of grace 1893, four centuries after the discovery of the country. The events briefly outlined in the foregoing pages have given the industry a certain heredity, if one may so express it, a certain projectile force which tends to carry it along easily distinguishable lines of development. Acting with this in point of time, and occasionally against it in the matter of direction, there is an equally definite industrial environment in the midst of which this force is to operate. One is made aware of these dual factors by a comparative study of the census reports. But industrial history is made so rapidly at the present time that, if one is to speak of the tendency of to-day, it must be in the light of strictly contemporary events. The importance of the glass industry has warranted the establishment and maintenance of a number of very admirable trade journals, and it is in the columns of these journals that one is able to discern the signs of the times.

There is an unmistakable tendency toward the substitution of machine for hand processes. It suits the American temper better to exercise itself over the invention of a machine, or over the improvement of one already invented, than it does to plod along in the exercise of a routine dexterity. So we find the most rapid growth and the greatest relative perfection in those departments the most dependent upon mechanical processes, such as the manufacture of the pressed ware, of bottles, and of plate glass. Not less marked is the tendency to supplant the reservoir system of melting in pots by the continuous system represented by tank furnaces. In one department, that of bottle-making, this substitution, as we have already seen, has been in large measure carried out, and in other departments it seems indeed only a question of time as to when it will be realized. Similarly in the matter of fuel, the continuous supply of gas is rapidly taking the place of the less convenient and less continuous solid fuel. But the centralizing force of natural gas is beginning to lose its power. It is being practically demonstrated that manufactured gas and petroleum are able to economically compete with the natural product. Even within the natural-gas territory, shortage of supply and other irregularities have led several glass-makers to turn for their gaseous fuel to manufactories more contemporary than the Devonian gas rock. At Beaver Falls, Pa., for instance, the Co-operative Glass Company was threatened with disaster by the failure of its gas supply. But it turned at once to gas-producers and improved melting furnaces, with results which were highly satisfactory. What can be done at one place, however, can be done at another. Such cases as these serve to loosen the bond which has heretofore made a geographical and geological unit of the gas-blower's calling. Already this disintegrating force is at work, and there is plainly visible a scattering of glass works. In New England old enterprises are slowly reviving. New plants are being built and projected in New Jersey. In the new South there is much activity. Large works are established in Virginia, at Roanoke and Buena Vista, while others are talked of for Buchanan. A substantial project has taken form at Denver. The Board of Trade Reports of the enterprising cities of the new State of Washington mention glass sand among their natural resources, and look to the speedy establishment of glass-houses in their midst. On all sides is to be seen this delocalization of the industry. For such a large country this seems indeed more like the static condition of affairs, since much of the glass product is too fragile and too bulky for ready transportation. Another most important tendency has been at work for some years past in the matter of labor organization among the glass-blowers, and is perhaps more potent now than ever. In such concentrated centers of the glass manufacture as Pittsburg the solidarity of labor is doing much to place the economic advantage in the hands of less compact and less affiliated bodies of workers in the outlying districts. Where labor is well organized and so perpetually on the defensive as at Pittsburg the most stringent regulations are forced upon manufacturers in regard to the number of apprentices who shall work at each furnace and attend each master blower. In consequence of this jealous watchfulness, much work which could as well be done by unskilled and less expensive labor must be reserved for those who are duly accredited by the unions and who receive schedule pay. In other districts where Nature has been less kind and trade-unionism less powerful, it is possible to make some of the commoner forms of glassware, such as bottles particularly, at a lower cost than in the more highly favored districts, for the simple reason that the manufacturers are at liberty to employ whom they will, and let unskilled labor do the work proper to it. This is a factor not to be lightly considered, for it is to-day sending business into the hands of out-of-the-way glass-houses, and it promises in the future to be very powerful in determining the course of the industry. It is a vexed question, but, if one is to judge from past industrial history, the victory will not be in favor of solidarity. The desire to hamper and restrict the growth of an industry by saying who shall and who shall not participate in it, is a remnant of the old mediæval guild spirit which is not in harmony with the modern way of thinking. It is much as if farmers attempted to dictate who should and who should not grow watermelons. The oft-repeated declaration on the part of manufacturers who are bound by trades-union regulations that they can not successfully compete with less favorably located factories free from such dominion is exceedingly significant to the future of glass-making. If it continue, the over-organization of labor promises to defeat its own purpose. The supremacy will pass from the center to the periphery. The scattering of the industry will be forwarded by the selfishness and short-sightedness of labor itself, as well as by those technical and physical conditions which have just been pointed out.

A final glance at the industry shows a manufacture well organized and well developed. It is one full of substantial promise, and full, too, of a power to transform itself greater than it has ever shown before. When the glance extends, as this does, so far back as Jamestown, and includes the long series of disasters which appears to have been the necessary prelude to our present success, the impression grows that, gratifying as this success must be, we have paid a very high price for it. But in this respect glass-making does not differ from the other American industries developed since Columbus.

ARTESIAN WATERS IN THE ARID REGION.

By ROBERT T. HILL.

THE United States Government expends annually over twenty million dollars, mostly in the Eastern half of the country, for the improvement of its rivers, harbors, and other surface waters. The Western half of our domain, which with the exception of the upper coast of the Pacific is known as the arid region, possesses no superabundance of surface waters to improve, but, upon the contrary, the scarcity of water for ordinary domestic and agricultural uses prevents the settlement and utilization of the remaining portion of the public lands. Even the semi-humid or Great Plains region, east of the Rocky Mountain front, has been retarded in development by this scarcity of surface water; and many settlers, who purchased alleged agricultural lands from the Government in this region, are begging Congress to apportion for the investigation of its underground resources a sum at least as large as that given for the smallest creek upon the River and Harbor Bill. Our national legislators have not been entirely neglectful in the matter, however. The rivers of the arid region have been gauged, and the rainfall ascertained, with the disheartening conclusion that, could every drop of the rainfall be utilized, it would still be insufficient to water the fertile lands. Large sums of money have also been wasted in vainly bombarding the skies for rain, contrary to every known law of Nature. The Department of Agriculture has investigated the underground waters of the Great Plains region east of the Rocky Mountains, but the underground supply of the true American Desert lying between the Rockies and the Sierras has been little studied.

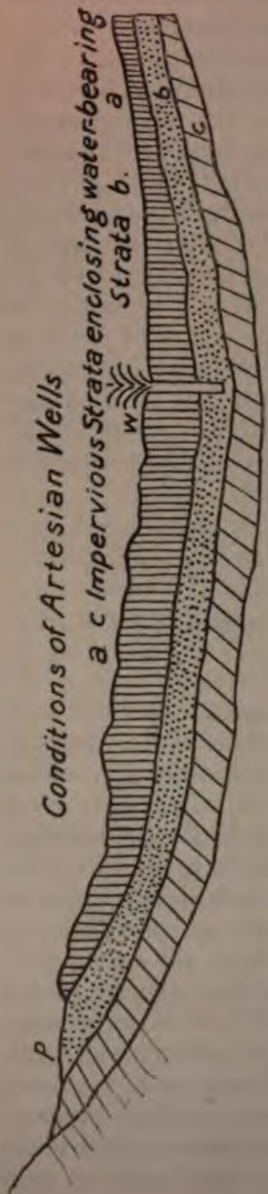


Fig. 1.—Prevalent Conception of Ordinary Artesian Conditions. Drawn from a Geological Report.

This section includes one fifth the total area of the United States and most of the great central plateau of Mexico. It is marked by peculiar geographic, geologic, and climatic phenomena altogether different from those of the rest of the country, chief of which is the absence of surface water. Streams are rare even in the mountains, and, with the exception of the Colorado, the Snake, and the Rio Grande, not a drop of its surface water reaches the sea, so great is the evaporation and the capacity of the porous desert soils for absorption. Almost any Eastern State has a greater area of surface water than has all the arid region; and the smallest New England brook, could it be transported West, would be a great blessing. In this arid section there are many thousand square miles without a drop of water even for drinking purposes. Nearly every available stream has been appropriated for irrigation by the present population, and all improvement in the water supply must come from underground sources.

It is wrong to encourage anticipations of enormous supplies of underground water where rainfall is so slight; but when we remember that in this region water is of greater value than land, or rather that land is worthless without water, the procurement of even small supplies, sufficient for stock, for irrigating small areas, or for supplying the thirsty locomotive, will be of great value. In view of these facts it is well to understand the laws of the occurrence and availability of underground waters, for not only have large sums been wasted in boring in unfavorable localities, but impracticable notions have been obtained from scientific treatises on this subject.

The laws of the distribution and utilization of underground water are as simple as those controlling the surface supply, but the popular fallacies concerning them are appalling. The most prevalent of these is that the waters originate at some remote point from their outlet, and flow in subterranean streams like the "blood in the human body," as a farmer once said, and that these streams must be tapped by the well borer or digger before water can be obtained. In nearly every community is some person supposed to possess the art of locating the exact spot above these currents by means of a switch called the divining rod. It is also a current fallacious belief that all underground water is due to rain which falls on the more or less distant mountains, and especially is this true in the region between the Rocky Mountains and the Mississippi, where every spring and well, even on the Texas

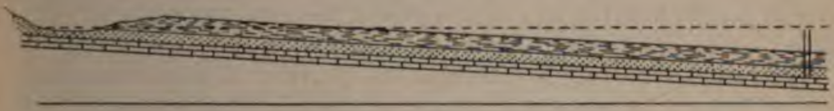


FIG. 2.—FAVORABLE STRUCTURE FOR ARTESIAN WATER, IN WHICH THE RECEIVING AREA IS A VALLEY.

coastal plain a thousand miles distant, is commonly explained upon the hypothesis that the water comes from this lofty range.

These prevalent impressions in the minds of those untrained in geology are more excusable than the widely prevalent idea conveyed by cuts in geological text-books that the usual and ordinary conditions for artesian wells are in great synclinal areas in which the strata can be seen markedly dipping from two including mountain borders against which their edges are upturned as shown in the following figure.

While there is no theoretical objection to this ideal conception, the conditions it represents seldom occur in Nature; on the contrary, as will be shown later, mountain rocks are not the source of great artesian wells; neither do they usually occur in synclinal valleys, but the most favorable conditions are gently sloping monoclinal plains in which the receiving areas, instead of being the upturned mountain rocks, are, in fact, the escarpment valleys of the plains. (See Fig. 2.)

To understand the distribution of earth water, it is necessary to be familiar with the true laws of its occurrence. The rainfall is the source of all underground water, and with the exception of certain deep-seated artesian wells the source is always the rain which falls in the immediate vicinity, as the physician knows when called to treat disease caused by seepage of the adjacent surroundings into the family well.

Part of the rainfall is quickly drained away by the surface channels, a part is evaporated, and a third, and for our consideration the most important part, is imbibed by the rocks and soil. The proportional disposition of the rainfall in the above manner varies with the climate and geologic conditions, but so far as underground waters are concerned it is necessary to consider only the water which sinks into the ground.

That portion of the earth visible to human inspection, known as the crust, is more or less saturated with water. In times of drought and in the arid region this is not always evident at the immediate surface, where evaporation is taking place, but a post hole, a plow furrow, a blast in a quarry, or a newly dug well reveals the dampness of the rock material. This moisture is sometimes invisible to the eye, but in general its quantity varies in proportion to the compactness or porosity of the rocks, the number of joints, fissures, or other crevices, and the topographic situation which controls the drainage.

If rainfall be long continued, the portion of the crust upon which it falls becomes completely saturated. Upon cessation of the rain, evaporation or drying begins at the surface, causing the line of saturation to sink deeper and deeper. Thus it is that in the Eastern States, where rainfall is excessive and evaporation slow, the line of saturation usually coincides with the surface, while in the arid regions it is often several hundred feet below. In this section, holes three hundred feet deep are often drilled through soil and rock as dry as powder without reaching the line of saturation, while on the East, as for example in New Orleans, water is so near the surface that dry graves can not be dug for the dead.

If the earth were of uniform porosity, temperature, and composition the water it contains would be uniformly distributed through it, as is the water in a well-soaked sponge. But this is not the case, for the outer portion of the globe consists of rocks of much less density than are those of the interior, while the downward percolation of water in some instances encounters the superheated mass of the earth's interior, and is forced back to the surface as steam, as in geysers and volcanoes, or enters into mineral combinations. Hence the available water is confined to that portion of the earth's crust between the lines of heated interior and surface evaporation. Even in this narrow belt the distribution of water is very irregular.

Inasmuch as there is a great diversity of geologic structure, the possibility of securing water at any given point must be determined by the local formations. All rocks imbibe moisture in proportions varying with their physical structure, a fact which can be demonstrated experimentally by saturating familar types of rocks. Glass is similar in water capacity to large areas of volcanic and other igneous rocks, and will absorb no perceptible amount of moisture; marble will drink in only a slight quantity; while chalk, sand, and brick will absorb nearly their own weight of water. The manner in which rocks absorb water is simple.

FIG. 3.—MESA STRUCTURE OF LLANO ESTACADO.

In most rocks, however compact to the eye, there exist interstices, cavities, and other spaces in which water may enter and be stored. This is especially true of all sedimentary rocks, which comprise ninety-nine per cent of the earth's crust. A fine sandstone whose grains and intervening spaces are indistinguishable to the eye, when placed under the microscope resembles a mass of cobblestones in which the spaces occupy as much of the aggregate area as the solid particles. Into a gallon measure of dry pebbles varying in size may be poured half a gallon of water. The consolidated rocks which compose most of the mountain masses are more compact and less adapted for the storage and passage of water than the sedimentary rocks. Nearly all the minerals which compose them are impervious, as is readily seen in a large crystal of quartz, feldspar, or mica. The rocks of valleys and plains usually consist of detrital material less hardened by mountain-folding, and hence more pervious.

Rocks which have imbibed all the moisture they can contain are in a condition of saturation, and all water in excess of this

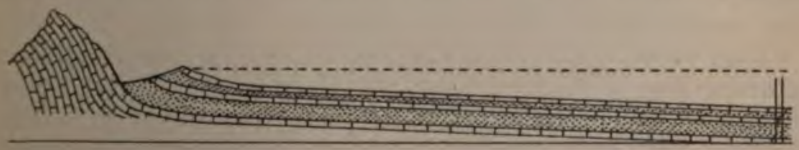


FIG. 4.—ARTESIAN FUNCTIONS OF IMPERVIOUS AND PERVIOUS STRATA.

amount will pass off by gravity or evaporation. The excess above the water of saturation is available as the source of springs, but the supply of wells is from the water of saturation.

Each kind of rock has an individual capacity for the transmission of the water which it has imbibed, and this is entirely distinct from its capacity for imbibition. If the component particles of a rock—for instance, the quartz pebbles of a loose conglomerate or the grains of a sandstone—present an impervious surface, water will cohere to the individual surfaces until the entire specimen is enveloped in a coat of water. If the interstices are smaller than the average drop of water, the resistance of cohesion to the transmission of water will be greater; hence a chalk or a fine-grained brick will drink in much water, but will transmit it slowly, while water will pass rapidly through coarse gravel. The capacity for transmission in variously grained rocks and the accompanying cohesion is similar to that seen in passing water through sieves of different mesh. Thus, some sandstones of exactly the same capacity for imbibition as chalk transmit water six hundred times faster.

The rock materials of the earth with these different capacities for imbibition and transmission have been sorted into definite sheets or strata by the water which deposited them, and thus another important fact in the question of underground water is introduced—the stratification or arrangement of the rocks relative to one another. Earth water percolates downward through a

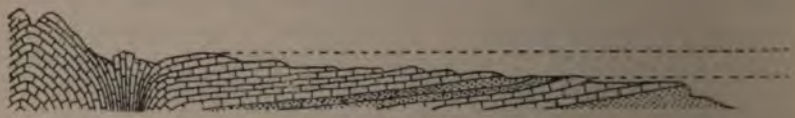


Fig. 5.—Unfavorable Conditions for Artesian Water.

porous stratum until an impervious one is reached, while an impervious stratum at the surface will prevent the saturation of a pervious one below. Stratification performs the important function of controlling the distribution of earth water, of resistance, transmission, and storage. If the surface rock stratum is pervious and horizontal, it simply serves as a sponge to hold the water until disturbed by evaporation or seepage, unless the supply is constantly renewed by rainfall. (See Fig. 3.)

If an impervious sheet is above an inclined outcropping porous stratum (Fig. 4), it opposes the tendency of water to rise by hydrostatic pressure and retains it in the porous sheet. If an impervious stratum is beneath a porous one, it prevents the water of the latter from percolating to greater depths. If vertically arranged from folding, the including strata cut off the horizontal transmission of underground water. (Fig. 5.)

Water is transmitted by gravity in the direction of the inclination of the strata—i. e., with the dip; and if the topographic conditions are favorable, flowing wells can be obtained at lower points more or less distant from the outcrop. If the strata in-

Fig. 6.—Typical Scene in Arid Region, Trans Pecos, Texas.

cline in a direction opposite to the general slope of the country, no matter how favorable the conditions, they will furnish no flowing artesian supply, for water can not rise above the height of the receiving area. (Fig. 5.)

If strata are excessively inclined, as in most mountain regions, artesian wells are improbable if not impossible over any wide area, for the strata soon dip below all available borings; hence the generally accepted idea that artesian wells are peculiar to regions of great stratigraphic dip is fallacious. A dip of one per cent is scarcely visible to the eye, but it will carry a stratum downward 52·8 feet per mile; a dip of ten per cent is hardly noticeable, but will carry a stratum 528 feet in a mile; a dip of forty-five degrees will carry a stratum deeper in a mile than any drill has yet penetrated.

If the earth's surface were level, and a homogeneous mass, earth water would be at a uniform depth throughout, as in an undrained field. But the surface is broken into mountains and plains, and scored by valleys, and the line of saturation sinks toward the level of these, where springs are often found escaping at the level of the streams. There are in Nature two kinds of valleys: (1) Unfinished, or active valleys, which are in the process of being cut out at the present time by the streams seeking base level; and (2) finished, or ancient valleys, which originated in past geologic time, and have been partially refilled with the *débris* of the adjacent region. All the valleys in the mountains proper, and of the eastern United States, belong to the first class, which may be called stream valleys, and their function is to furnish a channel for the passage of the surface waters to the sea. The valleys of the second class, or basin valleys are characteristic of the great arid region, and, with one or two exceptions, they are void of running surface water.

In mountains the surface and underground water is constantly seeking the level of the surrounding valleys, owing to the action of gravity. In general, mountains owe their existence to the superior hardness and imperviousness of their strata, and are of little importance to the problems of underground water.

Basin plains surrounded by the great areas of mountain surface are more favorably situated for the occurrence of underground water in quantity than those with a smaller surrounding area of mountain slopes, for impervious mountains serve to concentrate the rain-water which runs down their slopes upon the pervious valleys, thereby increasing the available water supply beneath the latter. (Fig. 6.)

The water of saturation in *buttes* and *mesas*, which usually consist of horizontal strata, is reduced by gravity toward the level of the surrounding plain, or, when alternations of pervious and impervious strata occur, the water seeps out as springs at their contact. The Llano Estacado, or great Staked Plain of Texas and New Mexico, is the largest of all the American *mesas* in area. Its geological structure is practically that shown in Fig. 3, consisting of a pervious surface formation, averaging three hundred feet, resting upon a foundation of impervious clays and other rock. The upper formation readily imbibes all the surface rainfall; hence the region is void of running streams.

Throughout this large area, once considered hopelessly void of water, good non-flowing wells are now everywhere obtained by boring to the lower depths of the saturated, sponge-like surface formation, while springs occasionally break out at the margin of the plains where the two formations are in contact.

While water-bearing strata should always be porous, and usually are but slightly if at all consolidated, the degree of consolidation has but little bearing upon the retaining function of impervious strata. Soft clay shale is practically as impervious as hard slate. In the West many people discredit the possibility of artesian water in many favorable localities, because of the absence of consolidated strata which they suppose are necessary to constitute the impervious stratum above the one containing the water. In fact, the less consolidated the rocks of a region are, the more favorable are the artesian conditions; and, inasmuch as the older formations of the earth are more consolidated, metamorphosed, and disturbed by greater tilting, faults, and folds, they are least favorable for the occurrence of artesian water. Upon the other hand, the later formations present the opposite and more favorable conditions, and with few exceptions the great artesian wells of the world are found in them. These later rocks play an important part in the geology of the arid region.

The adjoining section from the Gulf of Mexico to the Rocky Mountains, from Galveston to s. New Mexico, illustrates some of the rein set forth. From the coast to h meridian is a large series (a)

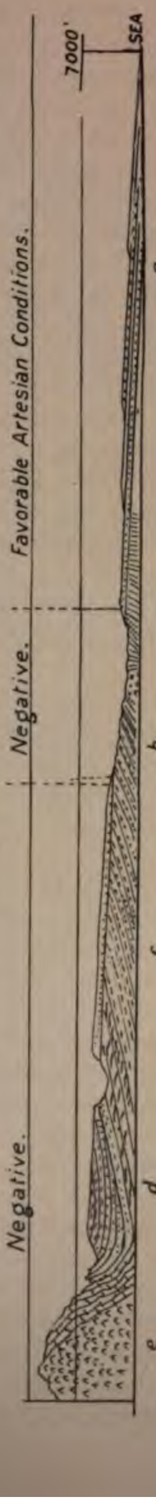


Fig. 7.—Section from the Rocky Mountains to the Gulf.

FIG. 8.—BASIN AND MOUNTAIN SCENERY OF ARID REGION, SOUTHWEST NEW MEXICO. From Mexican Boundary Report.

of alternations of porous and impervious strata of the later geological ages, dipping at an almost imperceptible angle toward the sea and accompanied by slight scarp valleys along their western outcrop, which are the receiving areas for the artesian waters. The Atlantic coast plain from New Jersey to the Rio Grande nearly everywhere presents similar conditions, and abundant artesian wells have been obtained. This group of rocks rests upon another series of older rocks (*b*, *c*), which presents negative conditions for artesian water, owing to their inclination in a direction opposite to that of the topographic slant. No artesian wells of large flow have been, or are apt to be, obtained in this region. Above the west part of this series is the great *mesa* of the Llano Estacado (*d*), the non-flowing wells of which have been explained. A second negative area is shown in the portion of the diagram in northeastern New Mexico (*d*), where the inclination of the strata is again opposite to that of the topographic slant. Where the front of the Rocky Mountains appears (*e*), the principle that the mountain rocks are unfavorable for artesian conditions is shown by the faulting and excessive dip of the strata.

Let us now briefly examine the bearing of the foregoing principles on the question of underground water in the great arid

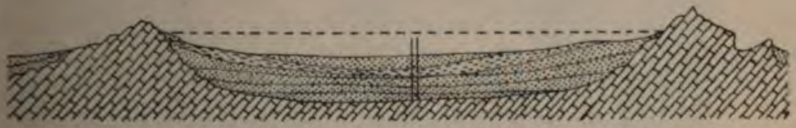


FIG. 9.—FILLED-IN VALLEY OF ARID REGION.

region proper, west of the Rocky Mountain front. Topographically this country, from the union of the Cordilleras in southern Mexico to the British boundary, consists in alternations of mountain and desert plain (Fig. 8). The mountains are isolated masses of hard, impervious rock, broken by faults, and dipping at angles which render the strata unpropitious for artesian exploitation. The wide areas of desert plain separating the mountain masses are of the older type of valleys described on a previous page, which are now filled to a depth of two thousand feet by the detrital deposits from the adjacent mountains (Fig. 9). The original valley floor, consisting of mountain rock, is entirely obscured by these deposits, and of no value to the artesian possibilities. The rainfall upon the mountains is rapidly shed by cañon-streams and *arroyos* to the level of the adjacent valleys, where it sinks into the ground, owing to the thirsty character of the valley formation, and gravitates downward toward the lower and usually central depths of the deposit, the underlying floor of mountain rock serving as a bottom for the retention of the water in the valley deposits. So great is the capacity for imbibition of these desert plains that every drop of rain upon them, except such as is evaporated, is quickly drunk in, and all the mountain streams of the vast region, with three exceptions, completely disappear upon reaching them, and are known as "lost rivers" in the parlance of the West. Under the old erroneous idea that the mountain rocks contained the artesian waters, many hundred futile and costly experiments have been made by the Government, railroad corporations, and private individuals, in boring wells at the margins of these deserts, where the mountain rock was seen disappearing beneath the valley deposit, instead of seeking the lowest topographic point in the

Fig. 10.—Desert Travelers.

plains, and relying upon the unconsolidated formation of the desert as the probable source of water.

Within the past few years there have been many accidental demonstrations of this principle; and when it is generally understood, it is probable that in nearly every one of these now useless waste places at least a small quantity of water will be secured, and in many instances good flowing artesian wells. Wells of this character have been procured in great number in California, at Riverside and in the San Joaquin Valley, not one of which penetrates to the underlying floor of impervious mountain rock, but are all secured in the detrital valley deposit. Similar wells have been found in numbers in the Great Salt Lake Desert of Utah, and a few in the deserts of Nevada. In Mexico they are obtained in the valley deposits of the city of Mexico, the Lake Chapala basin of Jalisco, and could be secured at many other points. The grandest demonstration of the principle, however, is found in the famous San Luis Park of Colorado. It is true that this valley, owing to the large area of mountains surrounding it, has an unusual number of "lost rivers" supplying water to the valley deposits from which over thirty-seven hundred flowing wells have been obtained. Less than ten per cent of these attain a depth of seven hundred feet, and barely fifteen per cent reach four hundred feet. On the great La Noria Desert, stretching for one hundred miles northeast of El Paso, Texas, between the Organ and Franklin ranges, which is void of a drop of surface water, abundant supplies of underground water are now procured at a depth of two hundred feet, and are pumped by windmills for irrigating purposes.

The wells of all these localities were drilled haphazard, without reference to the geological principle we have endeavored to describe. If this principle could be made known that the underground waters of the arid region are stored in the desert deposits, and not in the mountain rocks, there is no reason to doubt that wells could be procured in most of these innumerable wastes of the arid region, which would at least suffice for the passing traveler, and in many cases supply water for live stock and irrigation, sufficient to supply the necessaries of life to the mining populations of the adjacent mountain regions.

According to M. V. Brandicourte, of the Linnæan Society of the north of France, the *Eucalyptus alpina*, once abundant in Mount William, Australia, is now known only by a single specimen in the botanical garden of Melbourne; *Psiadia rotundifolia*, a tree of the composita of St. Helena, is reduced to a single natural specimen and a few cultivated ones at Kew. No living representative is now known of the dwarf palm (*Chamærops humilis*) which once grew near Nice. The orchid *Spiranthes Romanzoviana* has apparently disappeared from the meadow in Ireland which was its only known station. Some fifty species have disappeared, or nearly disappeared, from the department of Sonne, in France. Most of this devastation is the work of amateurs, horticulturists, or botanists.

A party of Chinese traders who recently visited the interior of southern Formosa have brought back, according to Mr. D. J. MacGowan, stories which remind one of the fairy tales or of the fancies of the Arabian Nights. They lodged in stone caverns, and the chattering of monkeys and the sounds of insects seemed to them "appalling and indescribable." The region was so weird that it reminded them of "legends of the kingdom of hobgoblins." They describe forests of trees of "prodigious girth," some of them measuring more than ten outstretched arms; and a tree flourishing in those forests that bears "flowers, red and white, which ... than a sieve and of extraordinary fragrance." The flowers thus de- ... to be epiphyte orchids.

WHITE SLAVES AND BOND SERVANTS IN THE PLANTATIONS.

By Colonel A. B. ELLIS,
TOWER HILL BARRACKS, SIERRA LEONE, WEST AFRICA.

FEW but readers of old colonial state papers and records are aware that between the years 1649 and 1690 a lively trade was carried on between England and the "plantations," as the colonies were then termed, in political prisoners, who were sentenced to banishment in the former country and shipped to the colonies, where they were sold by auction to the colonists for various terms of years, sometimes for life, as slaves.

The government of the Commonwealth appears to have been the first to adopt this convenient if unjustifiable method of disposing of troublesome adversaries; and in Cromwell's proclamation to the Irish people, dated Youghal, January, 1649, and written in answer to the declaration of the Irish prelates at Clonmacnoise, we find the following: "The question is of the destruction of life, or of that which is but little inferior to it—to wit, of banishment. Now, first, I shall not willingly take or suffer to be taken away the life of any man not in arms, but by the trial to which the people of the nation are subject by law for offences against the same; and, secondly, as for the banishment, it hath not hitherto been inflicted on any but such who, being in arms, might justly upon the terms they were taken under have been put to death, as might those who are instanced in your declaration to be 'sent to the Tobacco Islands.'" And in a dispatch from Cromwell to the "Hon. William Lenthall, Esq., Speaker of the Parliament of England," dated September 17, 1649, and describing the storming of Drogheda, we find with reference to those men who, contrary to the custom of war, had continued their resistance after the place had been carried and quarter given: "When they submitted, these officers were knocked on the head, and every tenth man of the soldiers killed; and the rest shipped for the Barbadoes."

Banishment, however, was not a punishment reserved for the Irish taken in arms against the Commonwealth, for the same measure was meted out to Englishmen and Scotchmen who incurred the displeasure of the Protector; and the "Tobacco Islands"—namely, St. Christopher, Nevis, and Barbadoes—did not enjoy a monopoly of this traffic, for prisoners were sent in large numbers to the New England colonies, and, after the capture of Jamaica from the Spaniards, to that island. Of the ten thousand Scottish prisoners who were taken at the battle of Dunbar, five thousand were dismissed on account of sickness and other causes, and the remainder marched to Durham and shipped for North America and the West Indies. How those who reached the former country were disposed of we learn from Hutchinson's Papers relative to the History of Massachusetts (Boston, 1769), in which is a letter from the Rev. John Cotton to Oliver Cromwell, as follows: "The Scots whom God delivered into your hands at Dunbar, and whereof sundry were sent hither, we have been desirous as we could to make their yoke easy. Such as were sick of the scurvy or other disease have not wanted physic and chirurgery. They have not been sold for slaves to perpetual servitude, but for six or seven or eight years, as we do our own; and he that bought the most of them, I hear, buildeth houses for them, for every four a house, and layeth some acres of ground thereto, which he giveth them as their own, requiring them three days in the week to work for him by turns and four days for themselves, and promiseth as soon as they can repay him the money he laid out for them, he will set them at liberty."

The lot of these unfortunate Scots was pitiable enough, but it seems they were treated with far more consideration than their follow-sufferers in the West Indies. In Massachusetts, too, to judge from the foregoing letter, the purchaser could terminate the period of slavery when he wished; but in the West Indies the banished were sentenced to specific terms of servitude which could not be shortened; and where no term was mentioned the slavery was, before the law of 1681 (33 Charles II), for life. There is still in existence in Jamaica a deed executed in the secretary's office in November, 1671, between Robert Nelson and Thomas Pitts, by which the former, in consideration of the sum of £10, conveys to the latter and his heirs forever one white servant named Stephen Ayliff.

As we have said, Englishmen were likewise banished, and a great many of the royalist party who took part in the abortive rising of Wagstaff and Penruddock at Salisbury in March, 1655, were sent to Jamaica and Barbadoes, with reference to whom Carlyle says: "A terrible Protector this. . . . He dislikes shedding blood, but is very apt to 'barbadoes' an unruly man—has sent hundreds and hundreds to Barbadoes, so that we have made an active verb of it, 'barbadoes you.'"

After the Restoration, Charles II did not scruple to use against his political opponents a weapon which they had employed so effectually against his party. The House of Commons which was returned by the general election of 1661 revived the old ecclesiastical policy and recommenced the persecution of Nonconformists, a series of penal statutes against them being passed and assented to by the king, in spite of the promises he had publicly made, both before and after his restoration, to grant liberty of conscience to all men. It was made a crime to attend a Dissenting place of worship. A single justice of the peace might convict without a jury, and might, for the third offense, pass sentence of transportation beyond the seas for seven years. With refined cruelty it was provided that the offender should not be transported to New England, where he was likely to find sympathizing friends. If he returned to his own country before the expiration of his term of exile, he was liable to capital punishment.*

Charles II made Jamaica one of the places of banishment for the Quakers, who would take no oaths either abjuring papacy, acknowledging the supremacy of the king, or swearing allegiance to him, all which omissions were considered to be treasonable offenses, and hundreds of them were sentenced as convicts and sent out. These were soon followed by the conspirators of the Whig and Rye House Plots in 1683, and in 1684 the Jamaica House of Assembly passed by command an act entitled "An act for ascertaining the servitude of the rebels lately sent from England, and to prevent all clandestine releasements and buying out their time, to the end, that after so great a mitigation" (as reprieve from hanging) "their punishment might yet in some measure be answerable to their crime." The author of the Annals of Jamaica informs us that these poor wretches were sentenced to ten years' servitude, and adds that few lived to its expiration, as may be readily believed when we remember that they were employed as "field hands" in a climate that at that time was notoriously unhealthy for Europeans, were insufficiently fed, badly housed, and hard worked.

In the reign of James II this inhuman practice was still continued. More than three hundred persons who took part in, or were suspected of being connected with, the rising in Argyleshire, were transported to the West Indies, many of them having first been subjected to mutilation; and several women were banished, after being branded on the cheek with a hot iron. The prisoners taken at the battle of Sedgemoor in 1685, and persons otherwise implicated in the rebellion of Monmouth, who were all technically liable to suffer death, were granted in batches to the members of the court, who sent them out to the colonies to be sold as slaves. The number of prisoners transported by the notorious Judge Jeffreys was eight hundred and forty-one. They were divided into gangs and granted to court favorites, the conditions of the grant being that the convicts should be carried beyond the sea as slaves, that they should not be emancipated till after ten years, and that the place of their banishment should be the West Indies. This last condition was studiously framed for the purpose of aggravat-

* Macaulay.

ing the misery of the exiles, for it was thought that in New England they would have found a population kindly disposed toward them. The stipulation, however, that the place of banishment should be a West India island was not in every case complied with, for some of the exiles certainly found their way to Virginia; and a letter addressed to the government of Virginia on the subject of the convicts says: "Take all care that they continue to serve for ten years at least, and that they be not permitted in any manner to redeem themselves by money or otherwise until that term be fully expired. Prepare a bill for the Assembly of our colony with such clauses as shall be requisite for this purpose." Less compliant than the Jamaica Legislature, which, as we have seen, had passed by command a similar act the year before, the Virginia Legislature appears never to have passed the measure sought to be forced on it, and at the accession of William and Mary all the exiles were set free.

Such was the condition of the slave market at this time that the convicts, notwithstanding the high rate of mortality during this, the earliest "middle passage," were very valuable in England. From a letter addressed to James II by Judge Jeffreys, protesting against the sycophants of the court sweeping up all the spoil, we learn that they were considered worth £15 apiece. He says: "I beseech your Majesty that I may inform you that each prisoner will be worth £10, if not £15, apiece; and, sir, if your Majesty orders these, as you have already designed, persons that have not suffered in the service will run away with the booty." The royal party in Somerset and the western counties pointed out that by the losses they had sustained during the rebellion, and by their exertions in its suppression, they had earned a right to share in this profitable speculation; but the king turned a deaf ear to their expostulations, and the court favorites remained victorious. The queen did not disdain to share in the profits of this inhuman business; and, instead of endeavoring to save even one single victim from this most frightful proscription, the only request that she is known to have preferred touching the rebels was that a hundred of those who had been sentenced to transportation might be given her. Macaulay declares that the profit which she cleared on the cargo, after making large allowance for those who died during the passage, can not be estimated at less than a thousand guineas. Of the horrors of the passage itself he says: "The misery of the exiles fully equaled that of the negroes who are now carried from Congo to Brazil. It appears from the best information which is at present accessible, that more than one fifth of those who were shipped were flung to the sharks before the end of the voyage. The human cargoes were stowed close in the holds of small vessels. So little space was allowed that the wretches, many of whom were still tormented by unhealed wounds, could not all lie down at once without lying on one another. They were never suffered to go on deck. The hatchway was constantly watched by sentinels armed with hangers and blunderbusses. In the dungeon below all was darkness, stench, lamentation, disease, and death. Of ninety-nine convicts who were carried out in one vessel, twenty-two died before they reached Jamaica, although the voyage was performed with unusual speed. The survivors when they arrived at their home of bondage were mere skeletons. During some weeks coarse biscuit and fetid water had been doled out to them in such scanty measure that any one of them could easily have consumed the ration which was assigned to five. They were therefore in such a state that the merchant to whom they were consigned found it expedient to fatten them before selling them."

John Coad, an honest carpenter, who joined the rebellion under Monmouth, was badly wounded in the skirmish at Philip's Norton, and tried by Jeffreys and sent to Jamaica, where he appears to have fared better than most of his fellow-exiles, has left us a narrative from which the reader may gather many curious particulars. He and those who were shipped with him were consigned to a Mr. Christopher Hicks, of Port Royal, Jamaica, who at first, having some Nonconformist leanings, refused to sell them; but on its being represented that if he declined that office it would only be filled by some one else, and that he might be instrumental in getting them good places, he consented to put them up to auction. The hour at which the market opened for the sale of the convicts was announced by the firing of a gun, and John Coad, more fortunate than some of his fellow-sufferers, passed into the hands of a humane planter with whom he was secure from ill-treatment, and in whose service he passed five years of his servitude. Immediately after the Revolution, and the elevation to the throne of William and Mary, a new governor, the Earl of Inchiquin, was sent to Jamaica, with instructions to release from their bondage and send to England such of the exiles as were still alive. This news spread rapidly among the convicts, and some of them went to the Governor to inquire about their freedom. The earl, who appears not to have read his instructions, and to have been of a choleric and hasty temper, had the deputation flogged and sent away; but was astonished to find, a few days later, that the men he had thus ill-treated were those who were specially recommended for kind treatment. He accordingly summoned the Council and proclaimed the freedom of all the exiles, who, after some little delay, were finally shipped home.

The participators in Monmouth's rebellion were the last who were ever sold into bondage beyond the seas and consigned to slavery, and the reception met with by those who went to interview the Governor will give us some idea of the manner in which exiles were usually treated. In most cases, in the West Indies, they were herded with the negro slaves, insufficiently fed, ill-clad, compelled to sleep without beds on the earthen floors of the hovels that were provided for them, driven out to work daily under a tropical sun, and flogged for the most trivial offenses. Scores of them succumbed to this treatment, and it must be remembered that these men were not malefactors, nor indeed criminal at all, except in a political sense. Most of them were men of blameless lives, and, as says Macaulay, they were regarded by themselves, and by a large proportion of the people of England, not as wrong-doers, but as martyrs who sealed with their blood the truth of the Protestant religion.

So much for the white slaves; we now turn to the bond-servants—that is, persons who engaged themselves as servants in the colonies for a certain number of years, and whose condition was little better than that of the convict-slaves. It is true that the bond-servant came to the colonies voluntarily, in theory at least, for in fact he was often a poor wretch who had been kidnapped in some English seaport and hurried on board a vessel, while the convict was banished; but, once in the colonies, there was little distinction made between them. Indeed, their position in most of the colonies was such that it is incredible that any persons should knowingly have engaged themselves; and we are forced to conclude that they were not informed of the conditions of their servitude, and were misled by false representations made by the agents of the colonists in England.

Each colony appears to have had its own law on the subject of bond-servants. That of Jamaica provided that bond-servants might be of either sex, and those who had not entered into contracts or agreements in England were compelled, after arriving in the island, to serve seven years if they were under eighteen years of age, and four years if they were above that age. The clause of the act ran thus: "All servants shall have according to their contract and indenture; and where there is no contract and indenture servants under eighteen years of age, at their arrival in this island shall serve seven years, and above eighteen years, shall serve four years, and all convicted felons, for the time of their banishment; and at the expiration of the terms aforesaid, shall receive from their last master, mistress, or employer, forty shillings, and a certificate of freedom on demand; and whosoever shall refuse, without just cause, to give such certificate to servant, certifier, or labourer, whose time is expired, shall forfeit forty shillings for every such refusal." The words "certificate of freedom" smack rather of slavery, and the bracketing together of convicted felons with bond-servants, as if they were much the same kind of persons, gives us a hint at the social position of the latter. In fact, the bond-servant was little better than a slave. No person was allowed to employ a servant who was not possessed of a certificate of freedom from his last employer, or to buy from or to sell to any servant any kind of article whatever, without the consent of the master or mistress, under penalty of forfeiting to the owner treble the value of the article bought or sold, and £10 of the island currency. Any servant who offered violence to his or her employer was compelled to serve an additional twelve months, without wages, for each offense; and if a servant stole, made away with, or wasted any of his employer's property to the extent of over forty shillings, he was to serve two additional years without wages. For each day of absence from work the servant was to serve a week, but additional services on this ground were not to exceed a total of three years.

Any man-servant who married without the consent of his employer was to serve two additional years for the offense, but if a free man married a servant he was to pay the employer £20 and the servant was free. If a free man had an illegitimate child by a servant, he was to pay £20 to the employer, and to provide for the maintenance of the servant and child, or, in default, was to serve the employer double the time the servant had still to serve; while if one servant had a child by another, the man-servant, after serving his own time, had to serve double the time the woman had to serve when the offense was committed.

If any one knowingly entertained a servant, he was liable to a fine of £5 for each day and night; if it was done without knowledge the fine was £1. If one servant was guilty of entertaining another servant, he was to forfeit a year's service, or receive thirty-nine lashes on the bare back, at the option of the party injured. Any person who forged a certificate of freedom was to be subjected to the punishment of the pillory, and to the loss of his ears. Any servant who permitted any one to ride his master's horse, or use his cart, was to serve an additional three months for each offense.

These were the clauses of the act framed for the protection of the employers of bond-servants; those designed for the protection of the servants were much fewer, and their purport was as follows: Should a servant fall sick, he or she was to be provided for, under a penalty of £20; but if the servant's sickness arose from misconduct, or from indiscretion, or if it was the yaws or a broken limb, he or she was to serve double the time lost. No servant was to be flogged naked without a justice's order, under a penalty of £5; and no servant could be buried until the body had been seen by a justice, constable, or tithingman, or by two neighbors. This last provision was framed to prevent servants, who had been murdered or who had died from the effects of ill-treatment, being buried quietly and the matter hushed up. The owner was bound, under a penalty of ten shillings, to provide each white servant weekly with four pounds of meat, or four pounds of fish, with such vegetables "as may be sufficient." Owners were further bound to give yearly to each man-servant three shirts, three pairs of drawers, three pairs of shoes, three pairs of stockings, and one cap, and to a woman-servant in proportion.

Such was the law governing the relations between bond-servants and their employers in the island of Jamaica, and so far from being exceptional it compares favorably with others. The object of the law was clearly the prolongation of bond-service, most offenses being punishable by additional terms of servitude; and the master consequently had an interest in their committal, and not infrequently provoked the servant to commit them. It can scarcely be believed that any one should knowingly have expatriated himself to serve under such conditions as these in a country which then bore a very unenviable reputation for unhealthiness; and it is fairly certain that those who came voluntarily must have been ignorant of the law; but a very large proportion of the bond-servants were carried off from England by force, and such kidnapped laborers are those who are referred to in the act as persons arriving without a contract or indenture. In 1682 large numbers of laborers were seized in England and shipped to Jamaica, and the fact was so notorious that an order in Council was issued regarding it. In 1685 kidnapping had become very common in Bristol, and young persons, guilty of no offense, were seized, hurried across the Atlantic, and sold for money. Even the city magistrates dabbled in this kind of traffic. At that time many offenses which are now considered very trivial were punishable with death, and it was the practice of the mayor and justices to intimidate persons brought before them, and to induce them, under fear of being hanged, to pray for transportation; the profits of the business being divided among the members of the magistrate's court. In connection with this scandalous abuse, Judge Jeffreys appears for once in a light which is quite novel to most readers of history—viz., as the champion of the liberty of the subject, and a redressor of grievances; for, chancing accidentally, when at Bristol, to discover the proceedings of the mayor, he, when sitting as judge, took the opportunity of denouncing him, and compelled him to plead for mercy at the bar.

Kidnapping was not limited to England, as we learn from the pages of Esquimeling, servant of Morgan, the notorious buccaneer, and author of the History of the Buccaneers, who had himself been a bond-servant and had twice been sold. He tells us that the bond-servants were usually treated worse than the negro slaves, for, as the latter were the actual property of their masters, they took some care to preserve them. After describing the situation of the bond-servants in the islands belonging to France, and saying that he has seen bond-servants beaten to death in the French portion of Hispaniola, now Hayti, he thus continues: "The planters that inhabit the Cariby Islands are rather worse and more cruel to their servants than the precedent. In the Isle of St. Christopher dwelleth one, whose name is Bettesa, very well known among the Dutch merchants, who hath killed above an hundred of his servants with blows and stripes. The English do the same with their servants, and the mildest cruelty they exercise towards them is that, when they have served six years of their time (the years they are bound for among the English being seven complete), they use them with such cruel hardship as forceth them to beg of their masters to sell them unto others, although it be to begin another servitude of seven years, or, at least, three or four. I have known many who, after this manner, served fifteen and twenty years before they could obtain their freedom. . . . To advance this trade, some persons there are who go purposely to France (the same happeneth in England and other countries), and, travelling through the cities, towns, and villages, endeavour to pick up young men or boys, whom they transport, by making them great promises. These having once allured and conveyed them into the islands I speak of, they force to work like horses, the toil they impose upon them being much harder than what they usually enjoin unto the negroes their slaves."

A terrible indictment of seventeenth-century planters this, and on the whole, except perhaps in the actual number killed by the Dutchman Bettesa, not an exaggerated one, for we find General Brayne, who arrived in Jamaica as governor in December, 1656, urging Cromwell to have negro slaves imported from Africa, on the ground that, as the planters would have to pay for them, they would have an interest in the preservation of their lives, which was wanting in the case of bond-servants, numbers of whom were killed by overwork and cruel treatment.

The little village of Payerne, near the Lake of Neubourg, Switzerland, possesses a unique curiosity in the shape of the saddle of Queen Bertha, who founded the Abbey of the Benedictines at Neubourg, now converted into an educational establishment, in A. D. 961. The saddle is of marked antique shape, and has an opening on the pommel, which was intended to hold the lady's distaff; for the good queen would not lose a moment of her time, and set a profitable example to her subjects by busying herself with spinning while she was on horseback.

THE DECREASE OF RURAL POPULATION.

By JOHN C. ROSE.

WHEN the Constitution of the United States was adopted, only one in every thirty of the people who ordained and established it were residents of cities or towns having eight thousand inhabitants or upward. There were but six such places in the entire country. San Francisco, situated sixteen hundred miles west of our then western boundary, and not founded until nearly sixty years after Washington was inaugurated, has now more than twice as many inhabitants as had all the cities of the United States together when the first census was taken. To-day we think and speak of such States as Kansas, North Carolina, Texas, and Arkansas as almost purely agricultural States. On such political questions as the tariff and the currency we expect to see their representatives take such positions as the farmers, whether rightly or wrongly, suppose will best promote their interests. Yet every one of the States just named, and indeed every State east of the Missouri River, with the single exception of Mississippi, has a larger proportionate urban population than had the country as a whole when Hamilton carried through Congress his measures to levy duties on imports for the "support of government, for the discharge of the debts of the United States, and the encouragement and protection of manufactures"; to make "provision for the debt of the United States," and "to incorporate the subscribers to the Bank of the United States." So great and far-reaching are the differences between the social, economic, and political conditions of city and country communities that there are few features of the eleventh census which are more deserving of close study than those which show how rapidly the United States is changing from an almost purely rural to what promises ere long to be a predominantly urban country.

In making such a study the first thing to do is to determine where the necessarily arbitrary line between urban and rural shall be drawn. For the purpose of this article, all cities, towns, and villages which were separately returned by the census as having on June 1, 1890, 1,000 inhabitants or upward, are considered as urban communities. There were 3,715 such cities, towns, and villages; and when hereafter in this article mention is made of "urban population," the population of these places is intended, while the term "rural population" will be used to designate all the inhabitants residing outside of such cities, towns, and villages. Of course, this division is not only arbitrary, but to a certain extent, particularly in New England, it may be misleading as well. There are in the New England States 411 towns of between 1,000 and 2,000 inhabitants, and 209 of between 2,000 and 4,000 inhabitants each. Of the former class the majority were doubtless largely if not altogether rural communities, as were many of the latter; and considerable rural population is often included in New England towns with a still greater aggregate number of inhabitants. The impossibility of drawing as hard and fast a line between the rural and urban or semi-urban population in New England as may be done in the other portions of the country is of course due to the fact that while geographically the towns in New England correspond to the towns, townships, election, militia, or magisterial districts, hundreds, wards, precincts, beats, etc., into which the counties in the other parts of the country are divided, it is in New England very unusual to incorporate a village or borough within a town. When separate government is desired by a portion of a New England town, the more common practice is to set off the area asking for it as a new town. It is not possible to determine with mathematical precision the precise increase during the decade of the 3,715 places having each over 1,000 inhabitants in 1890. In a number of instances the territorial limits of cities and towns were not the same in 1890 as in 1880. Usually, of course, when changes have occurred there have been extensions of corporate boundaries. Among the smaller towns and villages there are many whose population in 1880 was not separately returned. In some instances the places did not exist in 1880, but more frequently their not being mentioned in the census was due to failure of the enumerators to separate their inhabitants from the persons residing in other portions of their census districts Both the circumstances last mentioned would operate to make the apparent increase in the population of the cities and towns greater than it actually was. On the other hand, many of the larger cities are surrounded by more or less extensive belts of territory outside of their corporate limits, the increase of the population of which belts is due entirely to the growth of the cities around which they lie. On the whole, therefore, it is believed that to compare the population as returned by the eleventh census of cities, towns, and villages of 1,000 inhabitants or upward in 1890 with the population of the same places as returned in 1880 will afford a practically accurate measure of the rate of growth of the city, town, and village population of the country as a whole. In particular States, however, one or the other of the above causes of error may so predominate as to exert an appreciably disturbing influence on the accuracy of the comparison. In local comparisons, therefore, proper allowance has been made whenever necessary for the operation of these causes. The increase of the rural and urban population, as above defined, during the decade has been:

	United States.	Urban.	Rural.
1890	62,622,250	26,142,025	36,480,225
1880	50,155,783	17,775,076	32,380,707
Increase	12,466,467	8,366,949	4,099,518
Percentage of increase	24·86	47·07	12·66

In 1880 the 3,715 places which in 1890 had more than 1,000 inhabitants each, had but little more than half as many inhabitants as resided outside their limits, yet during the decade their absolute increase was more than twice as great as was that of the rest of the country, and relatively nearly four times as great. Striking as this difference is, it tells only a small part of the story; for such increase as there was, was confined almost entirely to the portions of the country hitherto altogether unsettled or but scantily peopled.

In northern Maine, in the Adirondacks in New York, in northern Michigan, Wisconsin, and Minnesota, in southern Florida, in the Dakotas and Texas, and in nearly all the States and Territories west of the Missouri, large areas of hitherto unsettled land received inhabitants. The settled area, by which phrase the Census Office means the area on which there is a population of at least two to the square mile, increased during the decade 377,715 square miles, or more than the entire settled area of the country at the beginning of this century, and nearly as much as the areas of France and Germany combined. Almost three millions of the entire four millions of increase in rural population was in the States west of the Mississippi, and the remainder was in the comparatively thinly settled States south and west of Virginia and in northern Michigan and Wisconsin. Speaking generally, it may be said that there was an absolute decrease in the rural population of all the more densely populated agricultural regions of the country.

The diminishing population of rural New England has long been the subject of melancholy comment. During the last decade no less than 935 of its 1,592 cities, towns, and plantations, whose population was separately returned both in 1880 and 1890, lost inhabitants. Of these 935 no less than 814 were towns or plantations which in 1880, and of course in 1890, had less than 2,000 inhabitants, or in other words were mostly rural places. The aggregate population of the 1,246 towns, plantations, and "gores," which in 1890 had each less than 2,000 inhabitants, in 1880 and 1890 compared as follows:

1880 population	1,050,060
1890 population	977,830
Decrease in decade	72,230
Percentage of decrease	6·88

Certainly in Massachusetts, in which State I have carefully examined the returns of the towns at every Federal census, and in some of the other New England States probably, this decrease of the population of the smallest and most purely rural towns—that is, of those which had in 1890 less than 1,000 inhabitants each—has been going on steadily ever since 1840, and they now have less population than they had ninety years ago. The next larger towns, still purely or nearly purely rural, but more favorably situated, being those which had in 1890 between 1,000 and 2,000 inhabitants each, increased steadily and with a reasonable degree of rapidity until 1850. During the decade between 1850 and 1860 there was a barely perceptible increase, and since 1860 the decrease has been continuous. In the aggregate all the towns having less than 2,000 inhabitants each, comprising as they do 179 of the 351 towns and cities in the State, had a larger population in 1820 than they have to-day.

In the early days of the century, railroads there were of course none. Even canals as yet existed principally on paper. The cost of land carriage was on the average probably at least twenty-five times as great as it now is. Articles whose bulk was large as compared with their value, as is generally the case with agricultural products, could not profitably be carried great distances overland. Under ordinary circumstances, if they could not be consumed or reach navigable water within a hundred and fifty miles or less of the place of their origin, they were practically valueless. Under such conditions the proximity of most of the New England country towns to the seacoast and to the commercial and manufacturing centers gave them an enormous geographical advantage, which went far to compensate for the comparative sterility of much of their soil. Now, however, when it costs less to bring a barrel of flour or a bushel of wheat from Nebraska or the Dakotas than it did eighty years ago to wagon like articles a hundred miles, those advantages which were once so great have become of little practical importance. Were the decrease of rural population confined only to New England and to such portions of the other older States as had a soil below the average of productiveness, the phenomenon would have a very obvious explanation. It could be said that when a farm in the valley of the Mississippi or the Missouri produces with equal labor and capital twice as much as a similar farm east of the Hudson, and when it costs comparatively only a small fraction of the market price at Boston or New York to transport the Western product to those cities, the Eastern farmer must abandon the unequal struggle. But while the generally harsh and forbidding character of much of the New England soil is doubtless one of the reasons why most of its country towns have to-day less population than they had when the election of

Abraham Lincoln furnished the occasion for the long-contemplated secession of the cotton States; many of them less than when the embargo and the War of 1812 infuriated its Federalists almost to the point of armed resistance to the Washington government; and a few of them less than they had when the passage of the Stamp Act began the long struggle which was to terminate in the independence of America—it certainly is not the sole and is probably not the principal cause of this partial depopulation. The same thing is going on over extensive areas of the most fertile portions of the country. There are men still living who can remember when the "Genesee Country" filled the same place in popular imagination as a frontier wheat-producing district of marvelous fertility that is now occupied by the valley of the Red River of the North. Nor was it or is it only in one or a few great staples that the rich counties of central and western New York excelled. In all the products of the field, the orchard, the vineyard, the flock, and the dairy they occupied a high and in some the highest rank. Indeed, in the variety of its agricultural and pastoral productions New York is probably unsurpassed among the States, or surpassed by California alone. Yet with all these abounding resources for the support of a prosperous rural population, fifty of its fifty-five counties north of the Harlem have fewer inhabitants outside of their cities and towns than they had ten years ago. Of the five exceptions to the general rule of rural decrease, two, Westchester and Rockland, lie immediately north of New York city; two others, Franklin and Hamilton, include the most thinly settled portion of the Adirondack wilderness; and in the fifth, Schenectady, the increase during the decade has been just twelve, or at the rate of about one eighth of one per cent. The decrease of rural population has thus been as general in fertile New York as in sterile and rock-bound New England. The rural population of New York north of the Harlem in 1880 and 1890 compares as follows:

1880	1,894,795
1890	1,725,913
Decrease	168,882
Percentage of decrease	8·91

When the nineteenth century began, western New York was almost entirely destitute of white inhabitants. Yet so rapid are the movements of population in the United States—in which, what sixty years ago was a mere hamlet clustering around the frontier Fort Dearborn, is now a mighty municipality with a population larger than had any of the historic capitals of Europe a century ago—that most Americans would consider all the region from the Niagara to the Hudson as a portion of the older settled sections of the country. In the decades immediately succeeding 1820 the New York canal system gave many portions of the State advantages not possessed in equal degree, if at all, by any other equally productive and extensive section of the then settled area of the land. The development of the railroad system of the country has made the canals of far less relative importance to-day than they were sixty years ago. The lessened value of its exceptional transportation facilities and its consequent nearness to the ocean and the world beyond, might be thought to explain the decrease of population of rural New York, were it not that regions which never enjoyed those facilities, which are a thousand miles from the Eastern seaboard, and which were not thoroughly settled until after the railroad system had reached a considerable stage of development, show a similar decrease. The nine southeastern counties of Minnesota cover an area of 5,682 square miles—that is, they are together about one sixth larger than Connecticut. Only forty years ago they were an unsettled wilderness, and yet every one of the nine has fewer rural inhabitants than it had ten years ago. Outside of the cities and towns these counties had, in 1880, 149,622 inhabitants, and in 1890 but 138,259, a decrease of 11,363, or at the rate of 7·60 per cent, a ratio of decrease but slightly less than in rural New York. This decrease becomes doubly significant in the light of the fact that a similar loss has taken place over a very wide area of which this corner of Minnesota forms only the northwestern extremity. From the time a traveler down the Mississippi leaves St. Paul until he reaches a point more than fifty miles south of St. Louis, or during the journey between places which are over five hundred miles from each other in an air line, and very much farther following the bends of the river, there will only be once, and that while traveling less than twenty miles, when either on one bank of the river or the other, and usually on both, he will not be passing counties which had less rural population according to the eleventh census than were credited to them by the tenth. The distance back from the river to which this area of decrease extends ranges at different points all the way from twenty miles or less to more than two hundred. If the counties which had less rural population in 1890 than in 1880 be distinctly colored upon a map, it will appear that the Mississippi, from the thirty-eighth to the forty-fifth parallel, is the center of a very large tract composed entirely of such counties. This tract, while very irregular in outline, is composed entirely of contiguous counties, as the word contiguous at all events is practically construed by the modern disciples of Elbridge Gerry. It extends over portions of the five States of Minnesota, Iowa, Missouri, Illinois, and Wisconsin. It has an area of 81,020 square miles, or nearly a third more than that of all the New England States combined, and not ten per cent less than that of Great Britain. Of the 141 counties into which this tract is divided, no less than 138 have lost rural population since 1880; and the average increase in the three increasing counties, which form *enclaves* within it, has been less than three and three quarters per cent. The following is the result of a comparison of the rural population in 1880 and 1890 of the 141 counties as a whole:

Rural population 1880	2,582,620
Rural population 1890	2,402,876
Decrease	179,744

The percentage of decrease of rural population in this rich, fertile, and comparatively lately settled section of the country is 6·96, or about one fifth less than in New York. The decrease is especially general in the counties immediately bordering on the Mississippi River. For example, every Mississippi River county in Iowa has lost rural population. Of the sixteen counties on the west bank from Dakota County, Minnesota, to Clark County, Missouri, inclusive, there is not one which had more rural inhabitants in 1890 than in 1880; and of the seventeen on the east bank, lying between the northern boundary of Crawford County, Wisconsin, and the southern boundary of Randolph County, Illinois, there was but one. Speaking generally, southern and eastern Iowa lost rural population during the decade, while northern and western Iowa, still in 1880 comparatively thinly settled, have gained, and in some sections largely. In the State as a whole, however, there has been a decrease of such population in no less than forty-three out of its ninety-nine counties. Such a showing in a trans-Mississippi State not yet half a century in the Union is one well calculated to arrest attention.

Whether the prohibition laws, which have been in force during the greater part of the decade, have been unfavorable to the growth of this State or not, it is certain that their existence has not been the chief cause of the decrease just mentioned, for, if in prohibition Iowa 43 out of 99 counties have a diminished rural population, in Illinois, in which prohibition does not exist, the same fate has overtaken 60 out of its 102 counties, a still larger proportion of the whole. And Illinois is the principal farming State in the Union. Almost all the northwestern part of the last-named State has fewer rural inhabitants than in 1880. In some of its northern and central portions, the area in which there has been a decrease of rural population in the decade extends entirely across the State, from the Mississippi River to the Indiana border. If the southern boundary of Iroquois County, Illinois, lay five miles south, or the northern boundary of Warren County, Indiana, the same distance north of its actual position, the great

Mississippi area of decrease would form an unbroken continuation of a still larger contiguous territory of decreasing counties, extending from the eastern border of Illinois to Cape Cod, and from Alabama into the Maritime Provinces of the Canadian Dominion. The portion of this territory lying within the United States extends into fifteen States, covers an area of 174,500 square miles, or over a third more than that of the British Isles, and comprises 289 counties. Of these counties 276 have less rural population than they had in 1880. Of the thirteen increasing counties lying within the lines of this territory and surrounded by the decreasing counties, two are in the Adirondacks; eight of them comprise the suburbs of Cleveland, Cincinnati, Louisville, Indianapolis, Dayton, and Columbus; and in the remaining three the increase during the decade has been but thirty-two, or at the rate of less than one sixteenth of one per cent.

Taking the entire area together, the rural population in 1890 and 1880 compares as follows:

1880	6,542,070
1890	6,145,943
Decrease	396,127
Percentage of decrease	6·05

This tract, beginning in the province of New Brunswick, extends over all New England, except the northern portion of Maine and New Hampshire and the northeastern county of Vermont; over large portions of Ontario and Quebec; over all New York north of the counties of Rockland and Westchester; over northwestern New Jersey, and large areas of northeastern and northwestern and a small part of southwestern Pennsylvania; over the greater part of Ohio, except its northwestern and some of its eastern and southern counties; over a couple of West Virginia counties lying on the Ohio border; over all southeastern and much of central Indiana; over a number of the Ohio River counties of Kentucky, and thence over a long and in places comparatively narrow strip of central Kentucky and Tennessee into northern Alabama, in which State it includes four counties; finally coming to an end some thirty miles south of the Tennessee River. The New England States, with New York and the adjacent counties of Canada, form the compact portion of this tract. From the southern boundary of New York it stretches out in two arms, one to the east and the other to the west of the Alleghanies. The eastern arm is much the shorter of the two, and without a break reaches only to the southern boundary of Carbon County, Pennsylvania, on the one side, and to the Atlantic coast in Burlington County, New Jersey, on the other. The break here is, however, very short, it being not over five or six miles to the point at which another area of counties with decreasing rural population begins and extends down over Berks and Chester Counties, Pennsylvania, Salem County, New Jersey, the two northernmost of the three Delaware counties, and the three most northerly of the counties of the Eastern Shore of Maryland, comprising in all eight counties and some four thousand square miles of territory. This southern extension of the region of decrease last mentioned, both in Pennsylvania and on the Eastern Shore of Maryland, very nearly approaches the northern prolongations of still another district in which the rural population was less in 1890 than in 1880. The principal portion of this district lies in Virginia, in which State it comprises forty-five counties. On the south it extends into one of the border counties of North Carolina, and on the north stretches over southern and western Maryland up into central Pennsylvania. It has an area of 24,092 square miles, divided among sixty counties, of which Henrico County, Virginia, containing the city of Richmond, is the only one which has not less rural population than it had ten years ago. In Virginia, with two exceptions, all the decreasing counties lie east of the summits of the Blue Ridge range, and these decreasing counties include nearly the entire Piedmont and midland section of the State. Some—but by no means all—of the tide-water counties lying on or near the Chesapeake Bay, owing probably to the growth of the oyster and trucking industries, have gained population. The rate of decrease in this group of decreasing counties has been somewhat less than in most of the others. The rural population in 1880 and 1890 of the area referred to compares as follows:

1880	949,679
1890	902,413
Decrease	47,266
Percentage of decrease	4·98

The last two groups are apparently detached extensions of the eastern arm of the great northeastern decreasing district. The western arm of this district has a general southwest and northeast direction, roughly parallel to the trend of the Appalachian system and to the west of it. As before stated, a western offshoot or projection from this arm crosses the entire State of Indiana, and comes within five miles or less of connecting it with the great area of decreasing counties which has the Mississippi River for its center. In northwestern Ohio and northern central Indiana there is a tract in which the population outside of the cities, towns, and villages has increased during the last ten years. Many if not most of these counties lie in the region in which natural gas has been so extensively made available during the last ten years; but whatever be the cause, the rural or extra-urban population of this tract has increased, and it separates the great northeastern area of decreasing counties from a much smaller, but still an important and well-defined one, comprising twenty-five counties in southern Michigan, six in northern Indiana, and the northwesternmost county of Ohio. This tract, which therefore includes thirty-three counties in all, and covers an area of 18,373 square miles, or about equal to the combined area of Vermont and New Hampshire, is quite regular in its outline. It includes, with the exception of a couple of counties on the Lake Michigan shore, practically all the counties of the southern half of the lower peninsula. The counties in the immediate vicinity of Chicago, and which have gained, perhaps, as a result of the enormous growth of that city, separate this area of decrease central in southern Michigan from that of which the Mississippi River is the center.

The rural population of this area in Michigan, northern Indiana, and northwestern Ohio at the tenth and eleventh censuses compares as follows:

1880	775,053
1890	729,423
Decrease	45,630
Percentage of decrease	5·89

There are some clusters or groups of decreasing counties scattered over the cotton States. Thus, in northern Mississippi and southwestern Tennessee there is a group of some eight counties, each of which has lost rural population. This group is very nearly connected through northern Alabama with the great decreasing group of the Eastern and Central States. There is another group on the Mississippi and Big Black Rivers in Mississippi and Louisiana, several in central Georgia and Alabama, and a well-defined one in that part of Florida which adjoins southwestern Georgia. Compared, however, with the Northern and border States, the decrease in the far Southern States is by no means noteworthy.

There are in the far West counties which show the usual fluctuations of frontier communities, in which a too rapid boom is not infrequently followed by a period of depression in which emigrants are more numerous than immigrants. The decay of the mining industries of Nevada and the adjacent portions of California and Utah has caused a relatively very heavy decrease in the population of this region, a decrease which has been felt by the cities as well, though usually not to so great an extent as by the more isolated mining camps and the farming settlements dependent upon the mines for a market for their products. But with the exception of a few of the older counties of Kansas, in which the same influences have apparently been in operation as in the Central and Eastern States, there has of course been in the trans-Missouri States no decrease of rural population in the proper sense of the term.

East of the Missouri and north of the cotton States, nearly all the well-settled agricultural neighborhoods have fewer inhabitants than they had ten years ago. It is possible to travel from the Bay of Fundy to the southern bend of the Tennessee River, a distance of fifteen hundred miles, and not pass through a single county in which the rural population is not less than it was ten years ago; or go all the way from Boston to western Iowa, except for the space of about five miles, through counties with less rural population than they had in 1880.

The better adapted for farming a community east of the Missouri may be, the greater the apparent probability that it lost rural population during the last ten years. As a rule, in the older States it was only the mountain sections, and other regions containing mineral wealth or resources other than purely agricultural ones, which showed a gain of extra-urban population. Districts situated near great cities, and well adapted for early vegetables and fruits, have in some instances gained, but, as a rule, communities which depend upon farming as distinguished from trucking have fewer inhabitants than they had in 1880.

In that great section of country comprising New England, New York, Pennsylvania, Delaware, Maryland, the District of Columbia, Virgina east of the Blue Ridge Mountains, Ohio, Indiana, Michigan south of the forty-third parallel, Illinois, Wisconsin south of the forty-fourth parallel, Iowa east of the ninety-fourth meridian, and the southeast corner of Minnesota, there are some 726 counties, and of these no less than 450 have lost population since the tenth census was taken. Each of the New England States, New York, Maryland, Ohio, and Illinois had fewer rural inhabitants than it had in 1880. Pennsylvania is the only one of the older Northern States to show any substantial increase of extra-urban population, the gain during the decade being at the rate of about 7·29 per cent. In this State the growth has doubtless been due to other causes than the increase of classes directly dependent upon agriculture.

The general tendency to a loss of rural population is manifest in regions which differ in the character of their soil as widely as does a rocky and sterile hill town in New England from a rich prairie county in Illinois or Iowa, and whose climatic conditions are as unlike as are those of the Mississippi in the latitude of St. Paul and of the James at Richmond, Virginia, or as those of Vermont and Alabama. In some of the districts in which the loss is marked, hay and rye are the staple crops, in others wheat, in others maize, and in others tobacco. In the decreasing districts the average density of settlement, exclusive of the population of the cities and towns, varied in 1880 all the way from twenty-six to the square mile in Minnesota to nearly or quite sixty in New Jersey. The average density in the great Mississippi region of decrease was in 1880, 31 to the square mile, and in 1890, 29; in the Virginia group it was in 1880, 39, and in 1890, 37; in the Michigan group it was in 1880, 42, and in 1890, 39; and in the eastern group it was in 1880, 45, and in 1890, 42.

While probably every census has revealed more or less marked decreases in particular neighborhoods, at no previous census did so large a portion of the country show a loss of its rural population. Still, while the area over which the decrease extends is comparatively large, the tendency to a loss of rural population is by no means a new one. There are counties as far west as Illinois, which have been losing rural population for the last twenty years. As already stated, there are Massachusetts towns which have less population than they had at the close of the last great French War. There are Virginia counties which have fewer inhabitants than they had one hundred years ago. It is a curious circumstance that among these counties is Caroline, best known to persons who are not Virginians by its association with the name of the mover of the Resolutions of 1798. Colonel Taylor, who labored no less earnestly for the improvement of agriculture than for the maintenance of the strictest construction of the Constitution, seems by the result to have had even less success in the former than in the latter object of his desire. In the adjoining State of Maryland, the county of Charles, lying on the Potomac, a few miles below Mount Vernon, has to-day twenty-five per cent fewer inhabitants than it had when the proprietor of Mount Vernon was inaugurated first President of the United States.

While the country regions have been losing population or gaining it but slowly, the cities, towns, and villages have, as a rule, grown rapidly, except in Nevada. While individual cities have differed widely in their respective rates of increase, if the cities of the country be classified according to size, it will be found that large cities and small towns are alike growing rapidly, and that the difference in the rate of their growth is not very great. To this statement New England is an apparent though not a real exception. In the New England States the towns with between 1,000 and 2,000 inhabitants each in 1890, have actually lost population during the decade, while those with between 2,000 and 4,000 inhabitants have gained but little, and those with between 4,000 and 8,000 very much less than have places of a like grade in other portions of the country. The explanation, of course, is that, as before stated, these towns correspond to the townships and other local subdivisions in other States, and, as such, nearly all of them contain more or less rural population, while many of the less populous are purely rural. An accurate idea of the relative rates of growth of the different grades of places can therefore be obtained only by excluding the cities and towns of the New England States from the comparison. In the following table, the cities, towns, and villages of the country are classified according to the number of their inhabitants in 1890; the number of each class in 1890 is given, together with the aggregate population in 1890 and 1880 of the cities which in 1890 were in each class, the increase during the decade, and the percentage of that increase. In the column to the extreme right is given the percentage of increase of each class of cities, exclusive of those in the New England States:

Cities having a Population in 1890 of—	No.	Population, 1890.	Population, 1880.	Increase.		
				Number.	Per cent.	Per cent exclusive of New England.
Over 1,000,000..........	3	3,662,115	2,556,654	1,105,461	43·24	43 24
From 500,000 to 1,000,000.	1	806,343	566,663	239,680	42·30	42·30
" 250,000 " 500,000.	7	2,447,608	1,850,048	597,560	32·30	34·42
" 125,000 " 250,000.	14	2,464,458	1,501,573	962,885	64·12	66·99
" 75,000 " 125,000.	14	1,229,600	818,180	411,420	50·28	53·91
" 40,000 " 75,000.	35	1,819,686	1,141,150	678,536	59·46	68·85
" 20,000 " 40,000.	92	2,506,279	1,598,844	907,435	56·76	62·06
" 12,000 " 20,000.	107	1,659,353	1,105,913	553,440	50·04	56·53
" 8,000 " 12,000.	175	1,721,894	1,072,375	649,519	60·57	67·65
" 4,000 " 8,000.	457	2,514,911	1,769,513	745,398	42·12	52·51
" 2,000 " 4,000.	1,011	2,794,409	1,938,184	856,225	44·18	55·14
" 1,000 " 2,000.	1,799	2,515,369	1,855,979	659,390	35·53	58·81
Total cities and villages.	3,715	26,142,025	17,775,076	8,366,949	47·07	53·73

From the above table it appears that, as a rule, the cities which now have a quarter of a million or more inhabitants have not increased during the decade as rapidly as those having a smaller population. The difference would have been even much more marked than it is, if it had not been for the wonderful growth of Chicago. The ten cities, outside of New England, with more than a quarter of a million inhabitants each, have gained at the rate of 40·28 per cent during the decade, while the rate of increase in the 2,881 cities, towns, and villages having in 1890 from 1,000 to 250,000 inhabitants each, averaged 60.19 per cent, or nearly one half greater. Among the various classes of cities included in these 2,881 places, there was during the decade no important difference in the rapidity of growth perceptible, although, on the whole, the places with from 20,000 to 250,000 grew slightly, but only slightly, more rapidly than those having less than 20,000. Although the smaller cities considered together have grown as rapidly as have the larger, the difference among the respective rates of growth of the cities of the same class are likely to be greater in the smaller cities than in the larger. Among the smaller places, and especially among those with less than 4,000 inhabitants, instances of an actual decrease in population during the decade are not unusual. The contrary is true for the larger cities. During the decade, every one of the 101 cities which in 1880 had upward of 20,000 inhabitants, gained in population more or less rapidly. Of the 82 cities which in 1880 had between 12,000 and 20,000 inhabitants each, only three, and of the 110 having in 1880 from 8,000 to 12,000 inhabitants only six, have less population than they had ten years ago. But out of the 333 places which in 1880 had a population of from 4,000 to 8,000 each, no less than 40 suffered during the decade a net loss of inhabitants, and among the still smaller places the proportion of those whose population decreased was still greater. Taking all the cities together, however, their increase was so great and so general that only in the Dakotas, Idaho, Arizona, and Louisiana does the rural population constitute a larger percentage of the entire population than it did in 1880. In all but the last of these the total population in 1880 was very small, and during the decade the greater portion of the immigrants to them have not sought the cities.

For some reason the cities and towns of Louisiana have grown very slowly during the decade, but even in this State the proportion of urban to the total population has fallen but one tenth of one per cent.

Although four of the five States and Territories in which the urban population constituted in 1890 a less proportion of the aggregate number of inhabitants than in 1880 lie wholly or partially west of the Missouri, in some of the trans-Missouri States the growth of the cities has been phenomenally rapid. Thus, in Washington the urban population in 1880 was but 14,474, while in 1890 it was 152,033, or more than ten times as great. In 1880 Seattle, Tacoma, and Spokane Falls had but 4,981 inhabitants, and ten years later 98,765, or nearly twenty times as many. It is significant of the altered conditions of modern life that a larger proportion of the population of Washington—the serious settlement of which dates back but a little over forty years, which spreads over more than eight times the area of Massachusetts, and which is not yet a manufacturing State—resides in cities of over 8,000 inhabitants, than was the case in Massachusetts as late as 1840, nearly two centuries and a quarter after the Plymouth landing, and when it had long been the principal manufacturing State in the Union.

In the three Pacific States as a whole very nearly one half of the entire population reside in cities, the urban population num-bering 901,644, as against a rural population of 969,643. In this, as in some other respects, the conditions of life in California suggest resemblances to those existing in the Australian colonies. Australia, together with New Zealand and Tasmania, had in 1891 a population slightly less than that of the United States in 1790. This population is scattered over an area several times more extensive than was that of this country before Napoleon sold us Louisiana; and yet in Australia a larger proportion of the entire population resides in cities of 8,000 inhabitants or upward than is the case in the United States even to-day.

The ratio of urban to rural population is increasing rapidly over almost all the civilized world. In many countries large areas have recently experienced an absolute loss of rural inhabitants. The census of 1891 shows that the population of the urban sanitary districts of England increased since 1881 about fifteen per cent, as against an increase in the rural districts of less than four per cent. Some of the more purely rural counties of England show an actual decrease of aggregate population, as do no less than nine of the twelve counties of Wales and sixteen out of the thirty-three counties of Scotland. In the last-mentioned country the rural population of the entire kingdom is a fraction less than it was ten years ago. In Ireland the contrast is still greater. Out of its thirty-two counties there are only two which have not less population than in 1881. These two are Dublin and Antrim, containing the cities of Dublin and Belfast respectively. The sixteen Irish cities and towns with 10,000 inhabitants or over have increased on the average at the rate of something over six per cent, while the rest of the country has suffered a loss of nearly twelve per cent. In France the increase of total population in the five years from 1886 to 1891 was but 124,289, while the gain in the population of the fifty-six cities having over 30,000 inhabitants was 340,396. Outside of these cities there was an actual decrease of 216,107. In Germany two thirds of the total increase of population between 1885 and 1890 was in the 150 places having over 20,000 inhabitants each, although these places contain not more than one fifth of the entire population of the empire.

Something over a century ago Jefferson, in his Notes on Virginia, arguing against the establishment of manufactures in this country, declared that, "generally speaking, the proportion which the aggregate of the other classes of citizens bears in any State to that of its husbandmen is the proportion of its unsound to its healthy parts, and is a good enough barometer whereby to measure its degree of corruption." Popular feeling almost everywhere seems to view with something of Jefferson's apprehension that change in the proportion of urban to rural population now so rapidly going on. In almost all countries those who desire to change existing systems of taxation try to enlist in their behalf this popular feeling by ascribing the decline of rural population to the operation of the fiscal machinery they dislike. Thus, in free-trade England, "fair-traders" assert that some scheme of retaliatory duties is required to arrest the depopulation of the rural districts. In France an extremely protective tariff has recently been adopted, largely at the demand of the agricultural classes. In the United States, on the other hand, those who are opposed to protective taxes are equally positive in their assertions that such taxes are the principal cause of the decrease of population in so many fertile sections. Doubtless, like other local conditions, tariff changes may help or hinder the operation of the general causes which are at work the world over. Those causes, however, were not set in motion by legislation, and could not be permanently checked by it, unless it should take so drastic a form as to be fatal to the material welfare of the whole community.

That the urban shall grow more rapidly than the rural population is, under present conditions, an economic necessity. The generally low prices of agricultural products during the last few years unite with most other available data to show that the supply of such products is increasing at least as fast as and probably faster than the increase in aggregate population. In this country, although the census of 1890 showed an increase of but twelve per cent in the rural population, and of less than twenty-five per cent in the aggregate population, the average production of wheat for the decade preceding the census of 1890 was forty-four per cent greater than that for the decade preceding the census of 1880; that of corn forty-three per cent greater, and of oats eighty-five per cent greater. In the cotton belt, the only agricultural portion of the older States in which there has been any considerable increase of rural population, we see in the great overproduction of cotton for several years in succession what would necessarily happen in other staple products if as large a proportion of the population as formerly attempted to earn their living by tilling the soil.

In a neighborhood in which all the tillable land was taken up thirty years or more ago, as is the case in all or nearly all the counties of the older States in which the rural population has diminished, there are general causes at work to bring about the result. The constant and steady improvement in agricultural machinery enables fewer hands than were required thirty years ago to cultivate the land with equal efficiency. To employ the same number of men as formerly, closer cultivation would be necessary. Perhaps, because such closer cultivation will not pay when its products have to be sold in competition with the more easily raised crops of the trans-Mississippi or trans-Missouri

States, or perhaps because the conservatism which is so marked a trait of agricultural populations makes it exceedingly difficult to bring about any radical change in agricultural methods, higher farming has not made much progress. It must also be remembered that both in Europe and the United States the birth-rate is diminishing. One of the results of this diminution is that the children constitute a smaller proportion of the entire population than formerly, and consequently a total population of the same aggregate number contains more workers.

Another cause of decrease in the aggregate population of rural communities, and one perhaps as potent as either of those already mentioned, is the ever-increasing competition of factory-made goods with the products of the handicrafts. There must be fewer and fewer country tailors, shoemakers, blacksmiths, carpenters, and other artisans who can earn their living in competition with the machine-made goods which the steadily decreasing cost of railroad transportation enables the great factories in the manufacturing cities and towns to send into every neighborhood and sell more cheaply than the isolated mechanic working with his own hands or with simple and inexpensive machinery possibly can. Those who are forced to give up the attempt to earn their bread by working at their trade in their old homes among their neighbors must seek employment in the cities. The whole tendency of the factory system, combined with the cheapening of transportation rates, is to draw away from the country districts almost all the population not directly engaged in tilling the soil. The social and intellectual attractions of city life, especially for the brighter and more active-minded of the country youth, are unquestionably powerful factors in building up the cities at the expense of the country districts. The two last-named causes—namely, the diminution of the number of rural handicraftsmen in all localities easily accessible by railroad from large cities, and the attractiveness of city life to portions of the country population, when city life is brought within the range of their observation—are doubtless chiefly responsible for the fact that the decrease of the rural population has been most general in precisely those portions of the country in which cities and towns are most numerous and in which the railroad facilities are the best.

In this country it is possible that the actual decrease in rural population during the decade was not so great as the census would indicate. To properly fill up the schedules of the eleventh census required so much work upon the part of the enumerators that the fees allowed them in country districts were in many, if not in most cases, utterly inadequate to give them a reasonable compensation for their work. Baltimore County, Maryland, is a very thickly settled agricultural region, and yet in this county a number of intelligent and industrious enumerators working from ten to twelve hours a day were not able to average a daily wage of more than two dollars each, out of which they had to provide a team and to pay its expenses and their own while away from their homes. Under such conditions it is not impossible that some of the less conscientious enumerators may have slighted remote corners of their districts. As the complaint of the inadequacy of the pay was quite general, and entirely justifiable, it is possible that there were considerable omissions in many rural neighborhoods.

AN AGRICULTURAL REVOLUTION.

By Prof. CLARENCE M. WEED.

DURING the last half-century the agriculturists of the United States have constantly suffered from the attacks of two classes of organisms, which have disputed with them the possession of their crops. These organisms are, first, the noxious insects; and, second, the parasitic fungi. To these tiny foes American agriculture yields annually many million dollars' worth of her choicest products. They form an omnipresent host of tax-gatherers, taking possession of the farmer's crops and enforcing their onerous demands without process of law, unless preventive measures are vigorously prosecuted. They are no respecters of persons: like the rain, they fall upon the fields of both the just and the unjust.

The authorities best able to judge have estimated the annual loss in the United States due to these little pests at more than half a billion dollars. Noxious insects, according to Dr. C. V. Riley, the distinguished entomologist of our National Department of Agriculture, occasion losses in the United States which are "in the aggregate enormous, and have been variously estimated at from $300,000,000 to $400,000,000 annually," and parasitic fungi —the rusts, smuts, blights, mildews, rots, and similar maladies of growing plants—according to competent authorities, cause an equal or greater loss. In single States and single seasons the damage is often frightful in extent. During some of the great chinch-bug epidemics the loss in Illinois occasioned by this one insect has amounted to over $73,000,000 a year; and in seasons not marked by an outbreak of such a great crop pest the injury is much more severe than is ordinarily supposed. The official entomologist of the State just named, Prof. S. A. Forbes—after years of careful field observation and statistical study—has recently expressed his belief that "the insects of the State of Illinois derive as large a profit from the agriculture of this great agricultural State as do the farmers themselves."

Fortunately, however, much progress has recently been made in a knowledge of efficient means of preventing this vast drain upon our productive system. By the introduction of a simple mechanical contrivance for the application of insecticides and fungicides, the methods of combating these foes have been revolutionized; and in many localities where the production of special crops had been abandoned new life has been put into their development. This contrivance is commonly called the spraying machine. It consists essentially of a force pump and spray nozzle connected with a reservoir, by means of which certain substances that have a destructive effect upon insect and fungous life may be rapidly and evenly distributed over the outer surfaces of trees, shrubs, vines, and herbaceous plants.

FIG. 1.—CODLING MOTH: *a*, injured apple; *b*, place where egg is laid; *e*, larva; *d*, pupa; *i*, cocoon; *g*, *f*, moth; *h*, head of larva. (After Riley.)

In America the spraying machine seems to have first come into general use to prevent the injuries of the codling moth or apple worm. This is a very destructive and widely distributed insect, for which there had before been known no remedy that can compare with spraying in cheapness and efficiency. These worms hatch from eggs laid in the calyx ends of the newly formed apples by a small, chocolate-colored moth (represented at *f* and *g*, Fig. 1). These eggs are deposited in spring or early summer, from the time the young apples are as large as peas until they attain the size of small hickory nuts. The eggs are placed on the outside of the fruit, and the resulting worms nibble at the skin, finally biting through and eating toward the core. They continue feeding for three or four weeks, when they become three fourths of an inch long, whitish or pinkish-white in color, and of the general form shown in Fig. 1, *e*. They are now full grown as larvæ, and leave the apples to spin, in some temporary shelter, slight silken cocoons (*i*), in which they transform to pupæ (*d*), to change a fortnight later into full-fledged moths. These moths deposit eggs about midsummer for a second brood of worms.

The earlier preventives of codling-moth injury included such partially effective measures as banding the trees with wisps of hay or loose cloth, to entice the larvæ to spin their cocoons in them, and the feeding of fallen fruit to stock. A serious objection to these methods lay in the fact that the worms were only destroyed *after* they had done their injury. But now, thanks to the spraying machine, the fruit-grower can place in the calyx ends of the young apples a few particles of poison, which as a rule will kill the newly hatched worms before they enter the fruit. For this purpose three or four ounces of London purple or Paris green are thoroughly mixed with a barrel of water. The apple trees are sprayed with this mixture just after the blossom petals have fallen off. The poison particles are thus distributed over the tree in a fine mist, and when the water in which they are suspended (not dissolved) evaporates, they are left high and dry upon the leaves and fruit, there to remain a menace to insect enemies for several weeks. In the course of time the combined action of rain

Fig. 2.—Plum Curculio: *a*, larva; *b*, pupa; *c*, beetle—magnified; *d*, plum showing crescent mark. (After Riley.)

Fig. 3.—Apple injured by Curculio.

and dew, wind and sunshine dissipate their poisonous properties. By thus destroying the first brood of worms one is saved the trouble of fighting the second brood.

For many years it has been very difficult to produce plums and other stone fruits on account of the injuries of the plum curculio. The adult of this species is a small, hard-shelled beetle (Fig. 2, *c*), which appears in the orchard early in spring, and feeds upon the foliage and flowers until the fruit is well formed. It then attacks the young plums, gnawing at them to satisfy its hunger, and cutting crescent-shaped holes (*d*) in the skin for purposes of oviposition. The eggs hatch into minute grubs that feed upon the pulp for a few weeks, ruining the plums and causing them to fall to the ground. The grubs (*a*) then leave the fallen fruit, enter the soil a short distance, change to pupæ, and later again change to adult beetles. There is but one brood each season, the insects wintering over mostly as beetles.

Besides stone fruits this insect attacks apples and pears, [illegible] ng a dwarfing and malformation that are very vexatious to the horticulturist. An apple thus damaged is shown in Fig. 3.

The eggs of the curculio are deposited beneath the skin of the fruit, and the larvæ remain concealed until full-grown. Consequently the early stages of the insect can not be reached by spraying. Fortunately, however, the parent beetles can be killed before many eggs are deposited, by sparsely coating the foliage and fruit with poison from the spraying machine, and thus the plums will be saved. The practicability of this has been proved repeatedly by commercial orchardists.

In addition to the insects affecting orchard fruits, there are hosts of enemies to the foliage. Nearly all of the latter, fortunately, are also open to destruction by means of the spraying machine. The canker worm is one of the most destructive of these foliage pests; at occasional intervals during the last century it has denuded thousands of orchard and shade trees in many parts of Canada and the United States. Its different stages are shown in Fig. 4. The damage is done by the worms or larvæ which hatch from masses of small cylindrical eggs (*e*), usually deposited upon the bark of the trees. These larvæ feed upon the parenchyma of the leaves, and sometimes cause a badly infested orchard to appear brown and seared, as if scorched by fire. They continue feeding for several weeks before becoming full-grown. Then they descend to the ground, burrow into the soil a short distance, and spin silken cocoons within which they change to the pupa or chrysalis state, remaining in this condition a few weeks, when the moths come forth. The two sexes of these moths differ greatly: the male (*a*) has large, well-developed wings, while the female (*b*) is wingless. The latter is of an ash-gray color. On emerging from the chrysalis she crawls to the base of the tree and ascends the trunk some distance; here the male finds her, and, after mating, she deposits her eggs on the twigs or branches of the tree.

FIG. 4.—CANKER WORM: *e*, eggs; *f*, larva; *g*, pupa; *a*, male moth; *b*, female moth. (After Riley.)

The canker worm, like nearly all similar leaf-eating caterpillars, is so easily destroyed by spraying that, while in years past it was greatly dreaded by orchardists, it now inspires little fear.

The three insects above mentioned are all examples of those having biting mouth-parts, and which in consequence ...w biting piece by piece the tissues of leaf, stem, ... account that they are open to destruction by placing particles of poison upon the surface of the food-plant. A large proportion of our injurious insects have such biting mouth-parts, but there is also an important class which have, instead of jaws, a pointed beak that they push into the cells of the plant and suck out the sap. Insects of this kind can not be destroyed by coating the food-plant with particles of poison, because the particles will not be taken into the alimentary system. Consequently one must use against them some insecticide which kills by contact. There are several such insecticides in common use, the most important perhaps being an emulsion of kerosene, soap, and water, called the kerosene emulsion. It is usually prepared by adding two parts of kerosene to one part of a solution made by dissolving half a pound of hard soap in a gallon of boiling water, and churning the mixture through a force pump until the whole forms a creamy mass, which will thicken into a jelly-like substance on cooling. The emulsion thus made is diluted before using with nine parts of cold water, and is then sprayed directly upon the offending insects, killing them by simple contact. Among the more important pests against which this insecticide is used, I may mention the aphides or plant lice, the chinch-bug, the various cabbage worms, the lice of domestic animals, etc.

These examples will perhaps suffice to illustrate how valuable an adjunct the spraying machine has become in preventing the injuries of the hordes of destructive insects that overrun our farms, orchards, and gardens. Turning now to the other class of noxious organisms—the parasitic fungi—we shall find that it plays an equally important *rôle* in their subjection.

As the first illustration under this heading we will take the downy mildew or brown rot of the grape, a disease which for many years has troubled the vineyardists of the Eastern half of the United States, and has proved especially destructive in the great fruit belt of northern Ohio, along the southern shore of Lake Erie. It has often destroyed nearly the entire crop, and several times has threatened to ruin the vineyard industry over a wide area. Fortunately, however, this disaster has been averted by the timely introduction of the spraying machine.

FIG. 5.—SECTION OF LEAF SHOWING MYCELIUM OF FUNGUS. Magnified. (After Farlow.)

The brown rot of grapes is a diseased condition of the fruit caused by the presence of a minute parasitic plant—a fungus—that develops by absorbing the tissues of its host. It attacks not only the fruit but also the leaves and young shoots, on which it often appears as a whitish, mildew-like covering, which has given the disease its other common name of downy mildew. This fungus reproduces by means of minute particles called spores, corresponding in function to the seeds of higher plants. If one of these spores lights upon a moist leaf, its inner contents divide into a number of distinct particles, which soon escape through an opening in the spore wall; then each particle swims about in the film of water for a short time—resembling a little animal—when it becomes quiet and sends out a minute tube which penetrates the skin of the leaf. It then continues to develop inside the leaf, pushing about between the cells, and forming the mycelium or vegetative portion of the fungus. As there is little nourishment to be found between the cells, this mycelium develops minute processes, which push through the cell walls and absorb the cell contents. A small section of an affected leaf, greatly magnified, is represented at Fig. 5, the unshaded double-walled spaces showing the leaf cells, the shaded part between the walls the mycelium of the fungus, and the projections *a*, *a*, the processes or suckers that penetrate the cells. When these vegetative portions of the fungus have developed in the leaf to a certain extent, they send out through the breathing pores or stomata their fruiting branches, which bear upon their tips the small oval spores (Fig. 6). These fruiting branches form the so-called mildew on the plant, and, as they only appear under certain atmospheric conditions, the mycelium may exist in the vine for some time before this outward manifestation of its presence is seen. On this account a whole vineyard sometimes appears to be invaded by the mildew in a single night.

FIG. 6.—FRUITING BRANCHES. Greatly magnified.

From the above description it will be readily seen that this fungus can not be successfully combated after it has established itself within the tissues of the host. To prevent its injuries one must also prevent its ingress to the plant. Fortunately, this can be done by coating the green parts of the vine with some substance having a destructive effect upon the spores of fungi. The salts of copper have such an effect, and in consequence they have come into general use as fungicides. They were first experimented with on a large scale in the vineyards of France, and gave such factory results that they were adopted in a practical way by In America this use for them has hardly been known for more than a decade; yet, thanks to the remarkable series of investigations and experiments carried on by the Division of Vegetable Pathology of the Department of Agriculture—at first under the direction of Prof. F. Lamson-Scribner, and later that of Mr. B. T. Galloway—assisted to a considerable extent by several of the State experiment stations, their efficacy is already well attested, and they are in practical use over a large territory. The fungicides most commonly employed are the Bordeaux mixture, a combination of copper sulphate, lime, and water; *eau céleste*, a combination of copper sulphate, ammonia, and water; and various solutions of carbonate of copper. These fungicides are sprayed upon the plant early in the season, before the ingress of the disease-producing fungus, in such a way that after the water evaporates the leaves and stems will be coated with minute particles, usually crystals, of a salt of copper. These tiny sentinels stand guard over the plant; when a fungus spore falls upon the leaf and sends out its germinating tube, the latter comes in contact with the copper crystal and is destroyed.

The fungicide generally used for the downy mildew of grapes is *eau céleste*. It is first applied in spring, a few days before the vines blossom. One or two, and rarely three, additional applications are afterward made at intervals of about two weeks. In 1890 I made a special investigation of the results of spraying against this disease in northern Ohio, visiting many of the vineyards personally and sending out numerous letters of inquiry. As a result I was able to publish in the Bulletin of the Ohio Experiment Station (Vol. III, page 262) the following paragraph:

"The early part of the season of 1890 was peculiarly favorable to the development of downy mildew, and consequently an excellent opportunity was offered to test the value of *eau céleste* as a preventive. It has stood the test in a remarkable manner, and the efficiency of the preventive, when properly applied, has been proved beyond question. All accounts agree in this respect, and show that while the crops on the unsprayed vineyards averaged from one half a ton to a ton per acre, the sprayed vineyards yielded two to three tons per acre. Such results need no comment: they speak for themselves."

For many years pear trees, both in the nursery and orchard, have been seriously affected by a fungous disease that causes the leaves to drop during the summer prematurely, sometimes as early as June or July. It also often develops upon the young pears, causing a spotting and cracking of the fruit. The mycelium of this fungus grows between and through the cells of the pear leaf, causing circular brown spots to appear upon the surface; these spots gradually enlarge as the mycelium spreads through the tissues, and, finally, the whole surface being affected, the leaf withers and falls off. By means of fungicides and the spraying machine, horticulturists are now able to prevent this disease completely. A large number of experiments in controlling it have been remarkably successful, and the difference between sprayed and unsprayed trees has been graphically illustrated by Mr. Galloway at Fig. 7, the engravings being faithful reproductions of photographs from Nature. Recent experiments have proved that the so-called apple scab—a disease which ruins a large percentage of the apple crop every year—may also be prevented by spraying

TREATED. UNTREATED.

Fig. 7.—Pear Leaf-blight Experiment.

with fungicides; and many other of the most destructive plant diseases are already under control, while experiments and investigations are continually progressing, with a view of bringing into subjection those which are yet out of reach.

It was naturally to be expected that the fruit-consuming public would object at first to purchasing fruit which they knew had been sprayed with poison. This is shown in the recent "grape scare" in New York city, and the present attitude of certain English journals toward the importation of American apples. But when the spraying, with either the insecticides or fungicides now

Fig. 5.—Method of Spraying Orchards with Double-acting Pump and Vermorel Nozzles. From Annual Report of Connecticut Agricultural Experiment Station for 1890.

commonly in use, is done with proper reference to the time, methods, and conditions of treatment, there is no danger to the consumer. Both practical experience and chemical tests have repeatedly shown that apples sprayed early in the season with Paris green or London purple retain none of the poison at the time of ripening. The most recent demonstration of this appears in the last report of the experimental farms of Canada. A peck of Rhode Island greening apples that had been sprayed twice with Paris green (one pound to two hundred gallons of water) were carefully gathered, without rubbing, and tested for arsenic. "The process to which they were submitted is one that affords extremely accurate results, and is considered the most delicate of all for the detection of arsenic. It is capable of revealing the presence of one fifty-thousandth part of a grain of arsenic. If twenty-three thousand bushels of apples contained two and a half grains of arsenic, the minimum fatal dose for an adult, the poison could have been detected by this method." Notwithstanding the most careful analysis no traces of poison were found; and, in conclusion, the chemist states: "I am of the opinion that further experiments of this nature would only serve to corroborate this negative result, and to prove that there are no grounds on which to base a suspicion that our sprayed apples are poisonous. The insoluble character of this poison precluding its assimilation by the apple, if such were possible, the infinitesimal part of Paris green that can remain on the apple, the frequent rains subsequent to the spraying, . . . all go to substantiate the argument that there is not the slightest danger of poisoning in using sprayed apples."

There is abundant evidence of a similar nature concerning the use of copper salts on grapes. In France, where a large proportion of the grape crop is converted into wine, elaborate investigations have shown that practically none of the copper salts are present in wine from sprayed vineyards. Prof. B. Fallot, of the School of Agriculture at Montpellier, in recording the results of one of these investigations, says: "The figures obtained have proved once more that wines, after the grapes have received numerous treatments with large quantities of salts of copper, contain scarcely a trace of this substance, and are entirely harmless."

Such is a meager and imperfect outline of this most recent improvement in the art of agriculture, which I have ventured to call an agricultural revolution. This improvement has been brought about by the combined efforts of the entomologist, the botanist, the chemist, the mechanician, and the agriculturist. Every step forward has been the result of careful study and experiment, and the whole subject is a striking illustration of the practical benefit agriculture may derive from scientific investigation and systematic experimentation.

GHOST WORSHIP AND TREE WORSHIP.

By GRANT ALLEN.

II.

PROVIDED with this universal master-key, then, we can now proceed to unlock many intricate puzzles of tree and plant worship which have hitherto baffled us. How full of meaning from our present standpoint, for example, is Mr. Turner's statement that at a certain spot in the island of Savaii there was "an old tree inland of the village, which was a place of refuge for murderers and other capital offenders! If that tree was reached by the criminal he was safe, and the avenger of blood could pursue no farther, but wait investigation and trial. It is said that the king of a division of Upolu, called Atua, once lived at that spot. After he died, the house fell into decay; but the tree was fixed on as representing the departed king, and out of respect for his memory it was made the substitute of a living and royal protector."* Not less striking is the case of the large tree, *Hernandia peltata*, in which "a family god of the same name" (as the native one of the tree) "was supposed to live; and hence no one dared to pluck a leaf or break a branch." In all these relatively primitive cases it is noticeable that it is a *family god* who is believed to inhabit the tree. We stand as yet quite close to the original form of worship which is almost exclusively domestic and directed straight at the heads of the family ghosts. After all this, it is interesting to read that on the closely related Savage Island the kings—who would of course be the descendants of such divine ancestors, and therefore themselves both gods and priests—"were supposed to cause the food to grow"; and that "the people got angry with them in times of scarcity, and killed them; and, as one after another was killed, the end of it was that no one wished to be king."† Readers of The Golden Bough, however, will be more likely to suspect that the kings were sacrificed on the same principle as the Rex Nemorensis, and that at last the royal stock got exhausted by too rapid using up of the whole available supply of divinity. Indeed, the proper keeping up of the king-god's family, in cases where godship has to pay for its dignity by the unpleasant incident of final sacrifice, willing or unwilling, must be an endless source of anxiety and trouble to primitive politicians. Where the safety of the crops and of the tribesmen themselves depends entirely upon a single life, a very painful state of tension must often exist, and the authorities must frequently

* Turner, Samoa, p. 65.

† Ibid., p. 305.

feel the strain imposed upon their consciences harder than they can bear.

One of the most striking pieces of evidence I have been able to obtain, however, is that of the Tanese in the New Hebrides, who, says Mr. Turner, in a passage I have already partly quoted, "have no idols. The banyan tree forms their sacred grove or temple for religious worship. . . . The spirits of their departed ancestors were among their gods. Chiefs who reached an advanced age were after death deified, addressed by name, and prayed to on various occasions. They were supposed especially to preside over the growth of the yams and the different fruit trees. The first fruits were presented to them, and in doing this they laid a little of the fruit on some stone" (query, a gravestone ?) "or shelving branch of the tree, or some more temporary altar of a few rough sticks from the bush, lashed together with strips of bark, in the form of a table with its four feet stuck in the ground. All being quiet, the chief acted as high priest and prayed aloud thus: 'Compassionate father, here is some food for you; eat it; be kind to us on account of it.' And instead of an amen, all united in a loud shout." *

In Fiji, once more, the first fruits of the yam harvest are presented to the ancestors in the Nanga or sacred stone inclosure; and no man may taste of the new crop till the presentation has been made, a trait found also among other savages. The yams thus offered are piled up in the inclosure, and no one is allowed to touch them under pain of severe ghostly punishment. A mission teacher told Mr. Fison that when he visited the spot he saw among the weeds that grew there numerous yam vines which had sprung from the piles of decayed offerings—a most suggestive fact in the light of the origin I conjecturally assign to cultivation.†

In all these cases, and many others that might be quoted, it is to ancestral spirits as such that the offering is made. But often our authorities mention gods rather than ghosts, though the distinction between the two is probably but a small one. Among the Basutos, for instance, when the corn has been thrashed, it is left in a heap on the thrashing-floor, and can not be touched till a religious ceremony has been performed to sain it. The owners bring a new vessel, never used, to the spot, in which they boil a little of the corn as a sacrificial duty. Then they throw a few handfuls on the heap, saying: "Thank you, gods; give us bread to-morrow also." When this has been done, the rest may safely be eaten.‡ Many other cases are recorded by Mr. Frazer in the appendix to The Golden Bough.

* *Op. cit.*, p. 319.

† Rev. L. Fison in Journal of the Anthropological Institute, vol. xiv, p. 27

‡ Casalis, The Basutos, p. 252.

But if any doubt exists that these gifts are in every case thank-offerings to the ghosts or ancestors who caused the crops to grow, it will be removed by the consideration that often the first fruits are offered not to spirits or gods at all, but to the divine king himself, who is the living representative and earthly counterpart of his deified ancestors.

In Ashantee a harvest festival is held in September, when the yams are ripe. During the festival the king eats the new yams, but none of the people may eat them till the close of the festival, which lasts a fortnight. During its continuance the grossest liberty prevails; theft, intrigue, and assault go unpunished, and each sex abandons itself to its passions. The Hovas of Madagascar present the first sheaves of the new grain to the sovereign. The sheaves are carried in procession to the palace from time to time as the grain ripens. So in Burma, when the *pangati* fruits ripen, some of them used to be taken to the king's palace that he might eat of them: no one might partake of them before the king.*

These cases, with many others of like sort which I forbear to quote, strikingly display the exact equivalence of the king, the ghost, and the god in the savage mind; for we find what is offered here to the living chief is offered there to his dead predecessor, and yonder, again, to the great deity who has grown slowly out of him. The god is the dead king; the king is the living god, and the descendant of gods, his deified ancestors.

Almost equally to the point is a statement of Mr. Macdonald's about the Blantyre negroes. "When there is no rain at the proper season," he says, "there ensues much distress. Famine is dreaded above all other evils. After private offerings have all failed, the chief of the country calls a national meeting for supplication. Much beer is brewed and offered to the spirit. The chief addresses his own god; he calls on him to look at the sad state of matters for himself, and think on the evils that are impending. He requests him to hold a meeting with all the other gods that have an interest or influence in the matter. . . . After the supplication there is a great dance in honor of the god. The people throw up water toward the heavens as a sign that it is water that is prayed for." [Say rather, as a sympathetic charm to make the rain follow.] "They also smear their bodies with mud or charcoal to show that they want washing. If rain do not come, they must wash themselves in the rivers or streams. If rain fall, they are soon washed in answer to their prayers. When the good crops follow, they present as a thanksgiving some the first heads of maize and some pumpkins." †

* The Golden Bough, vol. ii, p. 374.

† Africana, vol. i, p. 89.

This striking passage, remarkable enough in itself, becomes all the more important when we remember who are the gods to whom such prayers are offered and such thanksgivings due. They are, as Mr. Macdonald himself informs us, the deified relatives of the chief. "The chief of a village," says this acute observer, "has another title to the priesthood. It is his relatives that are the village gods. Every one that lives in the village recognizes these gods; but if any one remove to a new village, he changes his gods. He recognizes now the gods of his new chief. One wishing to pray to the god (or gods) of any village, naturally desires to have his prayers presented through the village chief, because the latter is nearly related to the village god, and may be expected to be better listened to than a stranger." *

Almost equally explicit as to the true nature of primitive ghosts and primitive tree worship is Sir William Hunter. "A Bengal village," he says, "has usually its local god, which it adores either in the form of a rude unhewn stone or a stump, or a tree marked with red lead." [Probably a substitute for the blood of human victims with which it was once watered.] "Sometimes a lump of clay placed under a tree does duty for a deity; and the attendant priest, when there is one, generally belongs to one of the half-Hinduized low castes. The rude stone represents the non-Aryan fetich; and the tree seems to owe its sanctity to the non-Aryan belief that it forms the abode of the ghosts or gods of the village." †

Omitting the mere guess-work about the fetich (whatever that may mean), and the gratuitous supposition, hazarded out of deference to the dying or defunct creed of Max-Müllerism, that ancestor worship must necessarily be a "non-Aryan" feature, this lucid account shows us the cult of the sacred tree in a very simple and early form as mere ordinary worship of the ancestral ghosts in the place where they are believed to make their home, without complications of any sort.

From these *naïve* and primitive types of sacred tree to the dark groves of cedar or cypress that surrounded the fetich-stone shrines of civilized Hellas is not surely a very far cry. We are already well on the track of the groves of Artemis, well within sight of the "opaca silvis redimita loca deæ," where Phrygian votaries worshiped with awful rites the mysterious goddess who rules over Dindima's height. Existing savages or low-caste Orientals thus give us the keynote that enables us to understand these dark places of antique usage and antique superstition.

Even in the midst of our own struggling civilization we shall not look in vain for obvious traces of this earliest and crudest

* Africana, vol. i, p. 64. † Imperial Gazetteer of India, article "India," s. v. "Religion."

form of tree worship, where the ghost itself is actually supposed to inhabit the branches of the sacred pine or the ancestral poplar. "The peasant folk lore of Europe," says Mr. Tylor, "still knows of willows that bleed and weep and speak when hewn; of the fairy maiden that sits within the fir tree; of that old tree in Rugaard forest that must not be felled, for an elf dwells within; of that old tree on the Heinzenberg near Zell, which uttered its complaint when the woodman cut it down, for in it was Our Lady, whose chapel now stands upon the spot. One may still look on where Franconian damsels go to a tree on St. Thomas's day, knock thrice solemnly, and listen for the indwelling spirit to give answer by raps from within what manner of husbands they are to have."* These cases fall at once into place if we recollect that elves and fairies are mere minor varieties of ancestral spirits, and that Our Lady often replaces for modern votaries the older and pre-Christian divinities of very ancient origin.

Other instances collected by Mr. Tylor are hardly less obviously explicable on similar principles. Here are a few select cases from savage peoples. The North American Indians of the far West will often hang offerings on trees, "to propitiate the spirits." Darwin, in the Voyage of the Beagle, describes the loud shouts with which the Indians of South America will often greet some sacred tree, standing solitary on some high part of the Pampas, a landmark visible from afar, and therefore, one might almost be inclined to guess from analogy, occupying the summit of some antique barrow.† Libations of spirits and maté were poured into a hole at its foot to gratify the soul of the indwelling deity. So, too, the New-Zealanders hang an offering of food on a branch at a landing place, or throw a bunch of rushes to some remarkable tree as an offering to the spirit that dwells within it. And in all such cases we must remember that to the savage mind the word spirit still means what it has half ceased to mean with us through long misuse—the actual ghost or surviving double of a departed tribesman. Worship, it seems to me, lies at the very root of religion, as distinguished from mere mythology; and the basis or core of worship is surely offering—that is to say, the propitiation of the ghost by just such gifts of food, drink, slaves, or women as the savage would naturally make to a living chief with whom he desired to curry favor.

I do not wish to deny, however, that in later stages of evolution the worship or reverence once paid to the ghost or spirit may come to be envisaged in the minds of devotees as worship or reverence paid to the actual trunk or to some vague sanctity of the surrounding forest. Thus the Yakuts of Siberia hang iron, brass,

* Primitive Culture, vol. i, p. 221.

† Darwin, Voyage of the Beagle, p. [illegible]

and shiny trinkets on any very large and conspicuous tree; they sacrifice horses and oxen under its spreading branches, fixing the heads on the boughs; and they chant extemporized songs to the Spirit of the Wood, to whom they dedicate offerings of horsehair, an emblematic devotion of their most valued possession.* Yet even here we see from the essentially religious act of sacrifice that a ghost is supposed to reside in the tree; and it would take a very delicate investigation indeed to show that in any particular case under examination *no* interment ever took place under the sacred tree. Whenever we see a shaped stone standing at the head of a little mound or diminutive barrow, we naturally infer that a burial has taken place there; whenever we see a sacred tree, unless grave reason exist to the contrary, we naturally infer a ghost and an interment. For the case stands thus: We know that in many instances savages inter their dead under the shade of great trees. We know that such trees are thereafter often accounted sacred. We know that young shrubs or bushes are frequently planted on graves in all countries. We know that whatever comes up on or out of the grave of a relative is counted as an embodiment or representative of the ghost within it. The presumption is therefore in favor of any particular sacred tree being of funereal origin and significance; and the *onus* of proving the opposite lies with the person who asserts some more occult and less obvious explanation.

Even where newly grown trees acquire a factitious or artificial sanctity, one can still see through the account some abiding relic of the same antique funereal origin. For instance, we learn that when our old friends the Kandhs settle a new village, a sacred cotton tree must be planted with solemn rites, and beneath it is placed the stone which enshrines and embodies the village deity.† Now, what is this stone? Possibly, to be sure, a mere casual bowlder, picked out at haphazard; but far more probably, as all analogy would show, the holy monolith or headstone of some ancient chief of the parent village. Nothing is more common than for migrating people to carry with them their sacred stones, their country's gods, their lares and penates, their ark, their teraphim; nothing more common than to take up the bones of their Josephs out of Egypt for interment in the new land which their lords and gods give them. In any case, however, be this as it may, the performance under the cotton tree is clearly on the very face of it a mimic interment. Considering what we know in other ways of the Kandhs, it would not surprise one to learn that a guardian deity used once to be provided for the new village by

* Tylor, Primitive Culture, vol. i, p. 224, quoting Castrén.
† Ibid., p. 225.

the simple process of slaughtering a superfluous meriah at the stone, exactly as in mediæval Europe, and long before a guardian spirit was provided for a bridge, a town wall, or any other important building, by immuring a human victim alive into the solid masonry—a curious and horrible superstition to which I shall have occasion to recur more fully further on in my argument.

Rome herself had such a sacred foundation tree—the holy fig of Romulus—whose very name connected it at once with the origin of the city; and so closely was it bound up in the popular mind with the fortunes of the state, that the withering of its trunk was regarded in the light of a public calamity. So, too, to this day, London has still her London Stone, which probably dates back to the earliest ages of the Roman town, or of the little Celtic village that once preceded it. This London Stone was for ages considered as the representative and embodiment of the entire community. Proclamations and other important businesses of state were transacted from its top; the defendant in trials at the Lord Mayor's court was summoned to attend from London Stone, as though the stone itself spoke with the united voice of the assembled citizens. Of the similar sacred stone at Bovey Tracey in Devonshire, Ormerod tells us that the mayor, on the first day of his tenure of office, used to ride round it and strike it with a stick. According to the Totnes Times of May 13, 1882, the young men of the town were compelled on the same day to kiss the magic stone, and to pledge allegiance in upholding the ancient rights and privileges of Bovey.* In these two cases we can clearly observe that stone and tree alike are regarded as the embodiment of the city, town, or village; and, as I believe, they derive their sanctity from the foundation god or spirit, who, as I shall have occasion to show hereafter, was probably killed on the spot, to provide a specific or artificial deity for the new creation.

Elsewhere we get still clearer evidence that it is the ghost, not the mere tree, to whom the adoration of the worshipers is primarily offered. "A clump of larches on a Siberian steppe," says Mr. Tylor, "is the chosen sanctuary of a Turanian tribe. But beneath it stand gayly decked little idols in warm fur coats, each set up under a great tree, on whose branches hang offerings of reindeer hides and household goods." † Clearly these idols represent the ancestral spirits protected from the rigor of the climate, as in life, by their thick fur coverings, and supplied by their relations with all that is necessary to make existence comfort-

* See Gomme, Village Community, p. 218; Ormerod, Archæology of Eastern Dartmoor, p. 11; and an article on London Stone by myself in Longman's Magazine.

† Primitive Culture, vol. ii, p. 224.

able for them in the new world they are supposed after death to inhabit.

Even more striking and conclusive, from our present point of view, is another of Mr. Tylor's well-selected cases. "In Esthonian districts," he says, "within the present century, the traveler might often see the sacred tree, generally an ancient lime, oak, or ash, standing inviolate in a sheltered spot near the dwelling-house; and old memories are handed down of the time when the first blood of a slaughtered beast was sprinkled on its roots that the cattle might prosper, or when an offering was laid beneath the holy linden, on the stone where the worshiper knelt on his bare knees, moving from east to west and back, which stone he kissed thrice when he had said, 'Receive the food as an offering!'" * To this case I say confidently, "Either ancestral spirits or the devil." Within the last two hundred years, indeed, there were old men in Gothland who would still go to pray under a great tree, as their forefathers had done in their time before them.

That single sentence of Mr. Duff Macdonald's already quoted, tells us more about the meaning of all these rites than pages of conjectural talk as to indwelling divinities. "It is the great tree at the veranda of the dead man's house," says this acute and original observer, "that is their temple; and if no tree grow there, they erect a little shade, and there perform their simple rites." † Mr. Macdonald has lived long among the people whose faith and practice he so clearly describes. He thoroughly understands their ideas and point of view; and I confess I attach a great deal more importance to his trained evidence in such a delicate matter than to a vast amount of uncertain classical argument. Moreover, the Blantyre negroes are still in the most primitive stage of religion; the process of god-making goes on among them to this hour as an every-day occurrence. We catch the phenomenon of the manufacture of deity in the earliest stages of its evolution.

On the whole, then, I think all the evidence is congruous with the theory that tree worship originated in ancestor worship or ghost worship, and with no alternative theory whatsoever. This is the hypothesis that fits all the facts, harmonizes all the discrepancies, and reduces to a plain meaning all the seeming absurdities of strange savage creeds and still stranger ceremonies. And to say the truth, no other hypothesis as to the origin of worship has ever been offered. Mr. Spencer's ghost theory, independently arrived at almost simultaneously by Mr. William Simpson, alone gives us a real explanation of the facts under notice. We find ourselves face to face at the outset with the very curious phenomenon of early races who people the whole world with imagi-

* Primitive Culture, vol. i, p. 224. † Africana, vol. i, p. 59.

nary or nonexistent beings of a most shadowy description, and who treat these queer creatures of their own fancy with such respect and tenderness that they actually offer to them food and drink, and all the other things the savage holds most dear, out of pure apparent superabundance of philanthropy. Why on earth should they take the trouble to begin making presents of food and drink to mere wood-spirits or oreads with whom they had no earthly connection or interest of any sort? Here, as elsewhere, *c'est le premier pas qui coûte.* The offerings made to tree-spirits are precisely the same in kind as the offerings made to dead relations. Dead relations are buried under trees; the nearer we get to primitive customs, the more do we see that the tree-spirit *is* the ghost, and the more does everybody who has anything to do with him recognize and admit the patent fact. It is only when we have moved very far away from primitive usage and primitive modes of thought, that we begin to find tree-gods whose ghostliness is uncertain, and tales about their origin in which their former humanity is ignored or forgotten. The lowest savages never seem to harbor the faintest doubt that the gods whom they worship in tree or stone or temple are nothing more or less than their own ghostly ancestors.

Again, all the prerogatives which Mr. Frazer assigns to sacred trees* are also prerogatives of the deified ancestor. Thus, trees or tree-spirits are believed to give rain and sunshine. But we saw this was precisely the function of the ancestral ghosts among Mr. Duff Macdonald's Blantyre negroes, as indeed it is in endless other cases which I need hardly recall to the anthropological reader.† Once more, tree-spirits make the crops grow. Of this belief Mr. Frazer gives many interesting examples. Among the Mundaris, "the grove deities are held responsible for the crops, and are especially honored at all the great agricultural festivals." Swedish peasants stick a leafy branch in each furrow of their cornfields, believing that this will insure an abundant crop. Among the tribes of Gilgit in India, the sacred tree is a species of cedar—as usual an evergreen—and at the beginning of sowing, the people mix their seed-corn with sprigs of this holy conifer, and smoke it all above a bonfire of the sacred cedar wood. But all this goes on all fours with the common belief, on which I need not further enlarge, that it is the deified ancestors who make the earth bring forth her increase, and that all crops are the immediate gift of the "compassionate father," to whom the savage prays for the simple boons which make up all his happiness. Furthermore, the tree-spirit causes the herds to multiply, and blesses women with many

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* The Golden Bough, vol. i, p. 66.

† See Herbert Spencer, Principles of Sociology, vol. i, part i, *passim*.

children. But this is a natural function of the ancestral ghosts, who, as the fathers of the tribe, are often—nay, one may even say habitually—envisaged under phallic guises. It is also a well-known function of the sacred stones, which originate in standing stones or grave slabs (as I have endeavored to show elsewhere), and which are universally regarded as of phallic potency. Indeed, to this day barren women in Brittany go to pray at ancient monoliths (thinly Christianized by having a small cross stuck on top) for the birth of children, which, says the Hebrew poet appositely, "are the gift of Jahveh."* Thus every one of the attributes claimed for the tree-spirits turns out on examination to be also an attribute of the ancestral ghost.

There are, I think, three main objects of human worship all the world over. The first is the ghost, or actual soul of the dead man, which gets sublimated or magnified in course of time into the spirit or shade, and then into the god. The second is the sacred stone. The third is the sacred tree. And these three are one. The ghost is the core and central reality of the whole vast superstructure of faith and practice. The sacred stone derives its sanctity from standing at the head of the dead man's grave. The sacred tree owes its position equally to its identification with the spirit of the chief or father who lies buried beneath it. In the striking and almost prophetic words of a great poet, God is indeed "the shade cast by the soul of man." †

How easily these three forms of primitive godhead run into one another has already been abundantly pointed out in many departments. The whole of The Golden Bough is from one point of view one long exposition of the interchangeability of the man-god and the tree-spirit or corn-spirit—an interchangeability which may surprise us the less when we remember that to this day one half of Christendom confidently identifies its own man-god with a piece of consecrated wheaten wafer. Mr. Frazer shows us how the slain god and the corn or the tree absolutely merge in the minds of their worshipers, so that at last it becomes almost impossible to separate them in thought one from the other. I believe the same thing to be true of sacred stones. Men worshiped stones, identified stones with their fathers, talked of themselves as descended from stones, looked upon the stones with affection and reverence, prayed to them, made gifts to them of wine and ghee, of milk and honey, till they almost forgot there was ever any difference at all to speak of between stones and humanity. The Laches,

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* Priapus, the garden god, is a phallic deity: the ark of Khem represents a garden, and Khem himself is always phallic. Fertility, I take it, is the common note of all these conceptions.

† Swinburne, Songs before Sunrise.

says Piedrahita, "worshiped every stone as a god, as they said that they had all been men." Arriaga tells us the ancient Peruvians paid honor to "very large stones, saying that they were once men." In the American Report of the Bureau of Ethnology for 1880, several stories are told as to the metamorphosis of men into stones from the Iroquois legends. According to Dorman, the Oneidas and Dakotas claim descent from stones, to which they ascribe both sense and animation. What is all this but early men's way of expressing the fact that these stones which they worship represent the ghosts of their deceased ancestors? Sometimes, indeed, we get an interesting connecting link, as in Arriaga's pregnant statement that the Marcayoc or idol worshiped in Peru as the patron of the village "is sometimes a stone and sometimes a mummy"; in other words, it depended upon circumstances whether the people reverenced the body itself or the gravestone that covered it."*

And if men become stones, so too do stones give birth to men. We get a classical instance of this in the legend of Deucalion. Beside the road, near the city of the Panopæans, lay the stones out of which Prometheus made men. Manke, the first man in the Mitchell Island, came out of a stone. On Francis Island, says Mr. Turner, "close by the temple there was a seven-feet-long beach sandstone slab erected, before which offerings were laid as the people united for prayer"; and the natives here told him that one of their gods had made stones become men. "In Melanesia," says Mr. Andrew Lang, "matters are so mixed that it is not easy to decide whether a worshipful stone is the dwelling of a dead man's soul, or is of spiritual merit in itself, or whether the stone is the spirit's outward part or organ." And, indeed, a sort of general confusion between the stone, the tree, the ghost, and the ancestor at last seems to pervade the mind of the savage everywhere. "The curious anthropomorphic idea of stones being husbands and wives," as Mr. Tylor calls it—an idea familiar to the Fijians as to the Peruvians and Lapps—is surely explicable at once by the existence of headstones to men and women, and the confusion between the mark and the ghost it commemorates.

I have introduced this question of the sacred stone at so great length, mainly because of the close analogy which subsists between it and the similar question of the sacred tree. For, just in like fashion, Mr. Galton tells us how on one of his South African wanderings he passed "a magnificent tree. It was the parent of all the Damaras. . . . The savages danced round and round it in great delight."† But I also wish to point out how the general

* Arriaga, Extirpacion de la Idolatria, p. 89.

† Galton, Narrative of an Explorer, pp. 188, 204.

interchangeability of all the various forms of the ghost extends even to what might seem the impossible cases of the sacred stone and the corn-spirit. At first sight it would almost look as if there could be no conceivable community of any sort between these two very distinct and unlike manifestations of the ancestral ghost or the slain man-god. Yet in Mr. Gregor's Folk Lore of the Northeast of Scotland, I find the following very interesting passage, which clearly shows the occasional equivalence of the two ideas: "It was believed by some that a very mysterious animal, which when met with by the reapers among the corn had the appearance of *a gray stone*, but which could change its shape, lived among the corn. When met with, a small quantity of the crop was left standing around it, and the ears of grain only were cut off. This animal looks like the hedgehog."* Readers of The Golden Bough will be very familiar with this "mysterious animal," which is in point of fact nothing more or less than the corn-spirit itself, hiding, as it were, in its own vegetal embodiment.† The rye wolf, the harvest goat, the cock, pig, and horse, are all various avatars of this polymorphic spirit; and now, in the interesting Scotch case above quoted, we find him similarly and unexpectedly equated with a gray stone.

There is one more point of considerable importance to which I wish to call attention in passing, before I quit this part of my subject, and that is the question of the immolation of the man-god as a deliberate mode of producing a corn-spirit or guardian soul of vegetation for the growing crops. Of the practice itself there can not now remain the slightest doubt after the brilliant demonstration given by Mr. Frazer in his epoch-making work. But it may have seemed a hard saying to some when I attributed these immolations to the definite desire to manufacture artificially an indwelling spirit for the growing corn. Nevertheless, such definite manufacture would seem much less curious to primitive man than to his modern and more squeamish or humane descendants. We must recollect that the chiefs or kings of primitive peoples, being the offspring of the deified ghosts who form the tribal gods, are therefore necessarily divine. That kings are gods, Mr. Frazer has now abundantly shown us; and we learned from Mr. Loftie how the divinity of the Pharaoh formed a prime element in the faith of the pyramid-builders in Egypt. Now, this being so, nothing is more natural, when you want a departmental god for any particular purpose, than to release before its time one of these divine souls from its fleshly tabernacle, and turn it loose upon space to perform whatever work you may happen to require

* Rev. Walter Gregor, Folk Lore of the Northeast of Scotland, p. 181.

† The Golden Bough, vol. i, p. 404, *seqq.*, and vol. ii, pp. 1–67.

of it. We must remember in this connection that primitive men really *believe* in the world and the life beyond the grave. To them it is all very ordinary reality. Thus, slaves are sacrificed on the tombs of their masters to bear them company in their ghostly life. "The practice of sending messengers to the world beyond the grave," says Mr. Macdonald, "is found on the west coast. A chief summons a slave, delivers to him a message, and then cuts off his head. If the chief forgets anything that he wanted to say, he sends another slave as a postscript." Nor are all the victims unwilling sufferers. Wives perform suttee of their own accord on the pyres of their husbands; young men offered themselves voluntarily for the fatherland to Baal; Marcus Curtius devoted himself by leaping into the gulf in the forum.

A curious analogy elsewhere will make this point, I hope, both clearer and more certain. It is a practice with early or undeveloped races to supply an artificial guardian god or spirit for a building, in precisely the same way as I suppose the guardian god or spirit for the growing crops to have been supplied by agriculturists—namely, by killing a human victim, whose blood was sometimes actually used as cement for the walls, so that his ghost might, as it were, be implicitly bound up in the very stones and fabric of the building. There is a legend current in Scotland, says Mr. Tylor,* that the Picts bathed their foundation stones with human blood; and St. Columba, not much more advanced in thought than his heathen contemporaries, "found it necessary to bury St. Oran alive beneath the foundation of his monastery." As the chronicler phrases it, "Columbkille said to his people, 'It would be well for us that our roots should pass into the earth here.' And he said to them, 'It is permitted to you that some one of you go under the earth to consecrate it.'" Oran accepted the sacrifice.† Even in modern Europe such usages survived late. When the broken dam of the Nogat had to be repaired in 1463, the peasants, being advised to throw in a living man, are said to have made a beggar drunk and utilized him for the purpose. Thuringian legend declares that to make the castle of Liebenstein fast and impregnable, a child was bought for hard money of its mother and walled in. Notice here the analogy to Kandh custom with the meriahs. The child was eating a cake while the masons were at work and it cried out, "Mother, I see thee still"; then after a little time, "Mother, I see thee a little still"; finally, as they put in the last stone, "Mother, now I see thee no more." The wall of Copenhagen, says Mr. Tylor, to whom I am indebted for most of these cases, sank as fast as it was built; so they took an innocent little girl, and set her at a table with toys and eatables; then, while she

* Primitive Culture, vol. i, p. 104.

† Reeves's Life of St. Columba, p. [illegible]

played and ate, twelve master masons closed a vault over her; and with clanging music the wall was raised, and stood firm ever afterward. In Italy, again, the bridge of Arta fell in time after time till they walled in the master builder's wife, the last point being a significant detail, which brings us very near to the sacrificial savage pattern. At Scutari, in Servia, once more, the fortress could only be satisfactorily built after a human victim was walled into it; so the three brothers who wrought at it decided to offer up the first of their wives who came to the place to bring them food. And so, too, in Welsh legend, Vortigern could not finish his tower till the foundation stone was wetted with the blood of a child born of a mother without a father—a common trait in the generation of man-gods.

In Polynesia, where we always stand nearer to the roots and beginning of things, Ellis heard that the central pillar of one of the temples at Maeva was planted upon the body of a human victim. Among the Dyaks of Borneo, a slave girl was crushed to death under the first post of a house. Even in Japan, a couple of centuries since, when a great wall was to be built, "some wretched slave would offer himself as a foundation." Observe here, too, the further important fact that the immolation in this case was apparently quite voluntary. Mr. Tylor, indeed, treats all these instances as though the victim were offered up to appease the earth-demons; but one of his own authorities, Mason, was told by an eye-witness that, at the building of the new city of Tavoy in Tennasserim, "a criminal was put in each post-hole to become a protecting demon." Here we have, I think, the more probable explanation, an explanation which exactly accords in every point with the principles and practice of the Kandhs and the other human-sacrificing savages.

In October, 1881, the king of Ashanti put fifty girls to death, that their blood might be mixed with the mud used to repair the royal palace, injured by an earthquake. "Some years ago, the piers of a railway bridge under construction in central India were twice washed away, when nearly finished, by the floods, and a rumor spread abroad among the Bheels of the neighboring jungles that one of them was to be seized and sacrificed by the engineers, who had received such manifest proof of mysterious opposition to their work." * Schrader says that when the great railway bridge over the Ganges was begun, every mother in India trembled for her child.† Mr. Baring-Gould has contributed a striking article on this subject to Murray's Magazine for March, 1887; and he differs from Mr. Tylor in attributing the practice of immolation (rightly, as I believe) to the desire to produce a protecting spirit

* Sir A. Lyall, Asiatic Studies, p. 19. † Clodd, Childhood of Religion, p. 288.

for the edifice to be erected.* Ubicini well defines a *stahic* as "the ghost of a person who has been immured in the walls of a building in order to make it more solid." †

It is not houses alone, however, that are thus protected by an artificially made guardian. The vikings used to "redden their rollers" with human blood. That is to say, when a warship was launched, human victims were bound to the rollers over which the galley was run down to the sea, so that the stem was sprinkled with their blood.‡ The last trace of such consecration among ourselves is the breaking of a wine-bottle over the ship's bows. Captain Cook found the South Sea Islanders similarly christened their war-canoes with the blood of human victims.

Furthermore, as the position of protecting spirit is rather a dignified and beatified one than otherwise, it is kept reasonably enough in the family of the king, the founder, or the master builder. This is a common trait in all stories of these human sacrifices, and it helps to bring them into line with the similar stories of corn-spirits and self-immolated gods. For it is the dearly beloved son that is especially chosen for such self-immolation. Thus, we read in the Book of Kings that when Hiel the Bethelite built Jericho, "he laid the foundation thereof in Abiram his firstborn, and set up the gates thereof in his youngest son Segub." And may we not put down in the same category the case of Remus, represented in legend as brother of Romulus, the founder of Rome?

To sum up, then, I would say in one word, while I accept in all their main results Mr. Frazer's remarkable conclusions, I believe that, in order to understand to the very bottom the origin of tree worship, we must directly affiliate it upon primitive ancestor or ghost worship, of which it is an aberrant and highly specialized offshoot.

[*Concluded.*]

According to the English journal Iron, Lieutenant Apostolow, of the Russian navy, has some marvelous plans for expediting ocean navigation. He recently exhibited to some naval officers in Odessa a new style of ship, having no screw or paddle, but instead, "a kind of running electrical gear right round the vessel's hull under the water-line, and a revolving mechanism which will propel the ship from Liverpool to New York in twenty-eight hours." To those who are too timid to undertake this voyage, he offers the alternative of a submarine passage, "without rock, roll, or vibration, and with a good supply of oxygen and hydrogen during the short voyage."

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* See also Grimm, Teutonic Mythology, vol. ii, p. 844, and Folk Lore Record, vol. iii, p. 282.

† Ballades et Chants Populaires de la Roumanie, p. 198.

‡ Vigfusson and Powell, Corpus Poeticum Boreale, vol. i, p. 410.

THE STORY OF A COLONY FOR EPILEPTICS.

BY EDITH SELLERS.

SOME twenty-seven years ago, a number of gentlemen interested in social and philanthropic questions met together at Bielefeld, in Westphalia, to consider what could be done to alleviate the sufferings of epileptic patients, and prevent their being a burden to themselves and to their fellows. Epilepsy was at that time alarmingly prevalent in North Germany, no less than one tenth per cent of the population being afflicted with the disease. There was hardly a village but had its epileptics, men, women, and children, who passed their days just waiting for the coming of those awful paroxysms, which rendered them at once the terror and the derision of their neighbors. Many of these people were full of life and energy, willing, nay, eager to work, for, as they well knew, in steady work lay their one chance of warding off the doom that threatened them. Every day epileptics sit with folded hands brings them the nearer to hopeless idiocy. It is this that renders their fate so infinitely pathetic. Work they must, unless they are to become insane; and there is no work for them to do! Masters do not care to run the risk of employing men who, at any moment, may be stricken helpless. Thus thousands are compelled to pass their days in enforced idleness, an idleness fraught with disaster to themselves, and with the loss of much good service to the community. It was to put an end to this state of things, so far at least as Westphalia was concerned, that the Bielefeld committee began its work. The problem its members had to face was how to arrange a condition of life under which the labor of epileptic patients might be rendered economically productive. This they set to work to solve in an eminently practical fashion, by opening a labor home for epileptics. This home, Bethel as it is called, has now developed into one of the most important labor colonies in Europe. What gives a special interest at present to Bethel is that a committee has just been formed for the purpose of establishing a similar institution in England.

Bethel was started in a very humble way. A small farm was bought at Sparenberg, near Bielefeld, with money raised by voluntary subscriptions, and there the first patients were installed. A committee of management was appointed to watch over the working of the Home, which was placed under the direction of Herr Unsöld, a kindly, energetic man, a practical farmer, too, as well as a skillful organizer. There were at first only four patients, but before many weeks had passed the house was full. The inmates all lived together as one family, and cultivated the land attached to the homestead. The discipline maintained was of the least irksome kind, the men being allowed as much as possible to go their own way, so long as they obeyed the doctor's orders. Steady work and regular hours were, however, insisted upon, and the patients were required to pass the greater part of their time in the open air. They were supplied with light, nourishing food, and a moderate quantity of tea and coffee. No intoxicants were allowed to be brought to the farm, and only a limited amount of tobacco. The men were carefully guarded from everything that could excite or irritate them; and, at the same time, infinite trouble was taken to render their lives as bright and cheerful as possible. The beneficial effects of this *régime* were soon apparent. The physical and mental condition of the patients improved rapidly, and the attacks to which they were liable became less frequent and less severe. The fact of all around them being subject to the same misfortune as themselves, seemed to deprive that misfortune of half its terrors; a fit became merely an unimportant episode in life when it no longer rendered him whom it befell a pariah among his fellows.

The fame of the Labor Home, and of the good work being done there, soon spread through North Germany, and applications for admission arrived from all parts. By 1870 the success of the undertaking was so marked that the committee of management felt justified in reorganizing it on a much more extensive scale. An appeal for funds having been liberally responded to, a small estate adjoining the old homestead was bought, and on it a building was erected large enough to receive one hundred and eighty patients. The new home was placed under the care of the Westphalian Brotherhood, an order of laymen who devote themselves entirely to practical philanthropic work. So far the institution had been reserved entirely for men; it was now, however, resolved to admit both women and children. The new departure was not an unqualified success. Female epileptics are, oddly enough, much more difficult to manage than male: they are more passionate and less tractable; they seem, too, less able to grasp the fact that rules must be obeyed. Their somewhat flighty ways made them a disturbing element in Bethel; and it soon became evident that they must not be allowed to remain there in the same building as the men. Difficulties also arose in connection with the children, owing to the impossibility of keeping them apart from the older patients, some of whom were by no means desirable companions for them. A brief experience showed, too, that many disadvantages result from clubbing together in the same house a large number of patients of different ranks in life and in different stages of their common disease. The patients are required to contribute to the expenses of the Home according to their means. This necessitates their being divided into classes; and it was found very difficult, when they were all living together, to provide first and second class patients with the comforts for which they paid, without exciting the jealousy of the third-class patients, many of whom are admitted free. And, what was much more serious, it was proved that people subject only to occasional attacks suffered severely from being brought into close contact with those who were already sunk in idiocy. Thus, there were strong reasons for making a radical change in the organization of the Labor Home; and, after much anxious consideration, its managers, principally by the influence of Dr. von Bodelschwingh, decided on a bold move. They resolved to give up the large new house entirely to the female patients, and to provide other homes for the boys and the men.

On one side of the Bethel estate the great Teutoburgian Forest stretches for miles away, forming a barrier, as it were, between it and the outside world. The forest is traversed by little valleys, each separated from its fellows by high ridges densely covered with trees. Before the colony was started the only human habitations to be found in these valleys were a few small homesteads and some Jäger-huts. Although, here and there, little patches had been cleared, no serious attempt had been made to bring the forest land under cultivation, the amount of labor required for the work being too great for any ordinary capitalist to be willing to undertake it. The Bethel institution, however, occupies a different position from that of an ordinary capitalist; its difficulty is to provide work for its workers, not workers for its work. Thus the forest offered it the very thing it stood most in need of—an almost boundless field for the employment of the unskilled labor of its epileptic patients. The land was supposed to be of little value; the managers of Bethel, therefore, secured upon easy terms the two valleys which lay nearest their estate, together with the houses and other buildings which stood there. Hither, by degrees, they transferred all their male patients. In compliance with the strongly expressed wish of the men, instead of building a few large houses for them to live in, it was decided to utilize the little homesteads which were already there and to erect others of a similar kind. The patients themselves were set to work, and soon quite an important village sprang up. There are cottages for the old, for the young, and for the middle-aged; for the mentally or physically feeble, and for the mentally or physically strong. Some are reserved entirely for imbeciles, while others, remote from the rest, are set aside for the hopelessly insane. There are, in fact, homes for people in all stages of the disease, homes, too, for people of all ranks and stations; for one of the great advantages of the cottage system now in force in Bethel—

the whole colony is Bethel—is that it admits of the most minute classification of patients. Each house is, to a certain extent, autonomous, the ten or twelve persons who live in it forming, as it were, a separate family. At the head of it is a House Father, generally a Westphalian Brother, who passes his whole time with the patients, working with them, and throwing himself heart and soul into their interests.

Meanwhile, Dr. von Bodelschwingh and his colleagues had been compelled to grapple with another serious difficulty. As the colony increased in size it became evident that, if it were to continue a success, other occupations besides agriculture must be provided. Some of the patients were too weak physically to bear the fatigue and exposure of an out-of-door life in winter; others, especially the artisans, manifested a decided distaste for the work. As it is of the utmost importance that epileptics should have congenial occupation, it was decided to open workshops, so that the men might be able to practice the special craft in which they had been trained, or for which they had the most natural aptitude. One by one various industries have been established in the colony. In very early days a regular building department was organized, and attached to it are now workshops for painters, joiners, locksmiths, and cabinet-makers, as well as a brick-kiln and a saw-mill. Shoemakers' and tailors' shops have also been opened. A linen mill, too, now gives occupation to a number of the colonists, while the printing office and the book-binding works are the pride of the whole place. Thus, when an artisan now arrives in Bethel he can at once be set to some work to which he is accustomed, a fact which contributes not a little to his happiness, for an epileptic, after a certain age, seems almost incapable of turning his hand to a new occupation. Most of the things made are consumed in the colony, but if there is any surplus stock it is sold in Bielefeld. The organizing of these industries was no easy task. An attempt was made at first to employ as overseers in the workshops such of the patients as were skilled artisans, but it proved a failure. Epileptics are, as a rule, lacking in initiative; and they have neither the patience nor the self-control necessary for directing the labor of others, especially when these others are themselves of defective intellect. It therefore became necessary to appoint a paid overseer for each factory, an arrangement which has materially increased the working expenses of the colony. From first to last, in fact, these workshops have proved a somewhat costly experiment. In spite of the most rigid economy in their management, not only are they now worked at a loss, but there is no prospect of their ever becoming self-supporting. One serious expense in connection with them is the salaries of the labor overseers, another is the enormous amount of raw material that is wasted. It must not be forgotten that a number of the people employed, even the most skilled among them, are at times quite irresponsible for their actions. A man may do good steady work for months, and then, for some inexplicable reason, suddenly seize the coat he is sewing or the book he is binding and tear it into atoms. Work done under such conditions can never be lucrative. But although financially the workshops are a failure, in every other respect they are a decided success. They give variety and interest to life in the colony, and they have indirectly a most beneficial effect upon the *morale* of the patients, many of whom have become much more alert and mentally vigorous since they have been working at their old trades.

Agriculture, however, is, and always must be, the staple industry of the colony; and as agriculturists these epileptics are certainly doing good work—work, too, which from year to year tends to become more productive. They have already cleared and brought to a state of high cultivation much of the land they possess in the forest, and they have completely transformed the great Senne. Until they took it in hand this marshy common produced nothing but thistles and heather; now it yields fairly good crops of barley, oats, and potatoes. Parts of it have even been turned—and with the best results—into vegetable gardens, flower gardens, and fruit orchards. Market gardening is undoubtedly the most profitable industry carried on in the colony. It is, too, the calling for which the majority of male epileptic patients show the most marked preference. Men who are dead to all other emotions seem to derive intense delight from their own special allotments. They will work in them from morning until night, and there is neither bound nor limit to the care they bestow on them. They watch over their plants and seedlings with infinite tenderness, and talk about their early vegetables and first strawberries with enthusiasm. The crops they obtain are surprisingly good considering the soil they have to deal with. Not only do they supply the entire colony with the fruit and vegetables it requires, but they carry on a thriving trade with the manufacturing towns in the neighborhood. For fifty miles around the fruit and the flowers raised in the Bethel hothouses are in great request. In connection with the flower garden, a large building is set aside for drying seeds and storing bulbs, a most profitable undertaking. The colonists, in addition to raising their own vegetables, grow their own corn, feed their own cattle, and make their own butter and cheese. Their well-stocked farms are most delightful places, and the dairies attached to them are perfect models of what dairies should be.

One of the most difficult tasks which fall to the lot of the managers of Bethel is that of providing suitable occupation for the women. There are few things female epileptics are capable of doing. They can wash, clean, and sew, though only under supervision; but they dislike gardening, and cooking is entirely beyond their power. They can not be relied upon to lay tables, or to do anything, in fact, which requires memory or attention. Their helplessness, however, is evidently merely the result of previous neglect; for the young girls who are trained at Bethel exhibit comparatively few of the defects which characterize the women who go there later in life. First and second class female patients are now lodged in large cottages, but the third class still remain in the great building which was originally assigned to them. The first floor of it has been turned into a sort of restaurant for the whole of the colony, six hundred of the patients dining there every day, and the food for all the houses in the immediate neighborhood being cooked there. The women and girls are entirely under the care of the Deaconesses, some fifty of whom are stationed in the colony.

The pleasantest part of Bethel—the one, too, in which perhaps the most valuable work is being done—is that set aside for children. The brightness and gayety which prevail there are simply indescribable. Far from being depressed by their affliction, the little patients seem to look at life through glasses of even brighter rose than healthy children. They are more excitable, more keenly alert, more easily moved by every passing emotion. They literally dance with delight at the merest trifles, and make their playground ring with peals of the merriest laughter. Not but that there are specks in the sunshine even there, for on one and all the fell disease casts its shadow. There are wild outbursts of grief just when the games go most gayly, heart-breaking sobs of which no one knows the cause. In the midst of a class, a bright, intelligent girl falls to the ground a shrieking maniac; a boy, beaming with light-hearted fun, lifts his bat, and in a trice he is a thing strong men might shrink from. Wherever these children may be, whether at work or at play, some guardian must always be at hand, for no one knows the moment at which they may be stricken. About one hundred and fifty children are now attending the schools in Bethel. There they are thoroughly well taught according to their capacity. Some of them learn with quite marvelous quickness; but, unfortunately, they forget what they learn with equal speed. The greatest care is taken in cultivating any talent they may possess; and special importance is attached to their acquiring dexterity in the use of their fingers. When they have passed through the ordinary course of study, they are sent to a sort of technical school, where they are regularly trained for some handicraft which will enable them later to take their place as self-supporting colonists.

It is noteworthy that none of the children who have been brought up in Bethel have ever lost their reason, at least not so long as they have remained in the institution. Indeed, the medical statistics prove that not three per cent of the epileptic patients, of all ages, who take up their permanent residence in the colony, become insane. Unfortunately, thirty per cent of them are already imbecile when they arrive, and of these very few recover their senses. This success in warding off insanity is not so much the result of any special medical treatment the patients receive in Bethel as of their being kept steadily at work and being preserved from all unwholesome excitement. But cheering as the medical reports on the condition of the patients are in one respect, in another they are decidedly depressing. The investigations into the causes and symptoms of epilepsy which have been carried on in Bethel have led to the adoption of remedies by which the sufferings it entails are materially lessened, but, so far at least, no cure for the disease has been discovered. By submitting to the conditions of life as arranged in the colony, epilepsy may be rendered dormant for years; those suffering from it may, for all practical purposes, become as able as their fellows; but the taint of the disease still remains. Worry or excitement may at any time lead to a return of the disorder. Out of 3,300 patients treated in Bethel, only 228 were dismissed as cured, and even of these several were obliged later to return to the institution.

Great hopes are entertained by the managers of Bethel that in time the colony may become self-supporting. So far, however, its expenses have been twice as great as its regular income. During the year 1890 there were 1,277 patients in Bethel, 1,073 of whom were there on January 1, 1891. Of these, the first class paid one hundred pounds a year, the second class fifty pounds, and the third class twenty-one pounds a year or less. These terms include board, lodging, and medical attendance for all classes, as well as clothing and washing for the third class. Only twenty-five per cent of the patients belong to the first and second classes, and the remaining seventy-five per cent to the third class. Although theoretically the terms for the lowest class are twenty-one pounds a year, as no one is refused admittance merely because he can not pay the fees, the majority of those belonging to it pay considerably less, and many of them nothing at all. During the year 1890 the patients, roughly speaking, paid on an average twelve pounds per head, whereas they cost on an average twenty-five pounds per head. The working expenses of the colony for that year were £31,155, while the fees paid by the patients amount only to £12,351. To this amount must be added the value of the articles produced in the colony and sold—viz., £3,452. At the end of the year there would thus have been a deficit of £15,352, if outside aid had not been given. The Provincial Stände, which send their pauper imbeciles to Bethel, however, voted a contribution of £2,838, and £12,260 was raised by voluntary subscriptions. Three thousand four hundred and fifty-two pounds does not, of course, represent the full value of the work done by the colonists in the course of a year. Their labor is in a great measure embodied in the real property now held by the institution, in the two thousand acres of land which have been brought under cultivation, and the various houses and other buildings which have been erected in the colony, together with their furniture, etc. Much of this real property is the produce of epileptic labor, and its value is estimated at £133,429. If Bethel had restricted its enterprise to farming and market gardening, its balance-sheet would no doubt be more satisfactory reading; but, on the other hand, its usefulness as an institution would have been impaired. The colony was established as a philanthropic experiment, and as such it is a brilliant success. Those responsible for its management have acted wisely in choosing to postpone indefinitely the day of its economic independence, rather than sacrifice, in the slightest degree, the interests of the sufferers under their care.

The colony is at present in a most flourishing state, and it is increasing in size and usefulness from year to year. The village itself is charming, with its quaintly formed, bright-colored houses, which stand out in bold relief from the dark forest behind them. The Church, the headquarters of the Westphalian Brothers, and Sarepta, the home of the Deaconesses, are quite imposing buildings; and there are also public baths, a hospital, a museum, and even a savings-bank. Hermon and Bethany, the cottages reserved for first-class patients, are most attractive abodes; they stand in the midst of beautiful gardens, and have lawn-tennis courts attached. It is, however, the air of general prosperity about the place which renders it so delightful. All the people are well clothed—well fed, too, as one may see by their faces. All sorts and conditions of men are there, all hard at work—at work, too, with their hands, be they princes or beggars. That is the law as of the Medes and Persians: there is no "leisured" class in Bethel. It is this incessant work and bustle that makes the village so cheerful. The people have no time to brood, no time to wonder why their lot should be cast thus apart from their fellows. Considering their condition, it is startling to note the expression of content—nay, happiness—on the faces of many of these colonists; even the imbeciles among them seem at least to have found rest. Of course, it is not always thus; ghastly scenes are witnessed from time to time; and here and there—but only in those hidden nooks remote from other dwellings—one comes across a something that is hardly human. These eleven hundred colonists form a wonderfully united little community. The sense of their common affliction seems to draw them very close together, while the knowledge of their own dependence teaches them to be ever ready to give a helping hand—to give it, too, gently, tenderly. Epileptics have a terrible cross to bear at the best; but in Bethel it is lighter than elsewhere. In the world such people are burdens on the labor of others, pariahs whom all men shun; in their own colony, however, they are respected citizens doing good work in the world, and living upon terms of equality and sympathy with their fellows.—*The Contemporary Review.*

THE BROOKLYN ETHICAL ASSOCIATION.

By LEWIS G. JANES, M. D.

THE philosophical evolutionist looks for the regeneration of society and the advancement of civilization by means of the voluntary action of individuals, rather than by the multiplication of state agencies. Society, to him, is not an artificial mechanism, held together by legal compulsion, but an organic growth, depending for its strength and utility upon the intelligent volition of its constituent units. To effect results, however, the units must not illustrate an individualism which is antagonistic and repellent, but an individualism inspired by the social sentiment—the desire and purpose to co-operate voluntarily in all wise efforts for the common good.

As the coercive functions of the state decline, and the divorce of church and government becomes more complete, efforts for the moral and social improvement of the people are relegated more and more to the control of voluntary organizations. This is especially true as the importance and indeed the necessity of applying the method of science to the solution of the great social and political problems of the day is recognized by the public mind. It is not surprising, therefore, in a country where the government is "of the people, by the people, and for the people," to note that the education of the people in religious matters has already passed out of the control of the state, while in social and political concerns voluntary associations are rapidly taking the place of the state in the instruction of the people, and even in the enforcement of the law and the administration of justice. The Citizens' Association, the Society for the Prevention of Crime, the Societies for the Prevention of Cruelty to Children and to Animals, labor organizations and arbitration committees, the Prison Reform Association, and the Social Science Association are factors in the training of our people for good citizenship, and in the administration of affairs which are not second in importance to the authorized and legalized agencies of the state.

Among the voluntary associations which are doing effective work in the moral education of the people, and in the wise direction of public sentiment toward the practical solution of our social and political problems, the Ethical Society holds a unique and important place. For a goodly number of intelligent minds—agnostics and independents in their theological views—it has already to a large extent supplanted the Church as an agency for moral, and in a qualified and unconventional sense, of religious education. Its aim is broader than that of any of the organizations devoted to specific social or political reforms; it strives not only to afford the means for wise altruistic efforts in applying ethical data to the practical problems of social life, but also, and in a special sense, to discover the true scientific and philosophical principles which underlie applied ethics and sociology.

The work of Prof. Felix Adler and his able coadjutors, Dr. Stanton Coit, Mr. Salter, Mr. Sheldon, Mr. Weston, and Mr. Mangasarian, as teachers of a noble type of ethical theory, and earnest workers among the poor and ignorant of our great cities, is worthy of all praise, and has received the cordial recognition of many who are not in full sympathy with the philosophical foundation on which the able and scholarly teaching of Prof. Adler and his disciples appears to be based.

The Brooklyn Ethical Association, which is the subject of this sketch, has no connection, however, except through its general sympathetic attitude toward noble workers for common ends, with the societies over which Prof. Adler and his devoted associates preside. This association, which has become known to the public through its efforts to bring the problems of ethics, sociology, and religion to the test of scientific and evolutionary principles, is itself a product and illustration of natural development. It did not spring, full grown, from the brain of any individual, and its ultimate success has doubtless far exceeded the expectations of any who were promoters of the earliest stages of its growth. Its original nucleus was an adult class in ethics connected with the Sunday school of the Second Unitarian Church of Brooklyn, N. Y., of which the Rev. John W. Chadwick has been for twenty-seven years the honored minister. For several years this class had been conducted by Dr. Lewis G. Janes, using as text-books such suggestive works as Spencer's Data of Ethics, Mill on Liberty, Graham's Creed of Science, Sidgwick's History of Ethics, and others of a similar character.

In the season of 1881–'82 this class was temporarily in charge of Prof. Franklin W. Hooper, now the able manager of the Brooklyn Institute of Arts and Sciences, and to him more than any other individual the organization and initiatory success of the association are due. He was made its first president, and presided over its deliberations for two years, being succeeded for a like term by Mr. Z. Sidney Sampson. At the close of Mr. Sampson's second term, in the fall of 1885, Dr. Lewis G. Janes was chosen as his successor, and has been re-elected in each succeeding year.

The association, which at first assumed the rather formidable title of "The Association for the Promotion of Moral and Spiritual Education," continuing for a time its Sunday morning meetings at the Second Unitarian Church, met also in private parlors on Friday evenings, and during its first season devoted its sessions to the discussion of certain fundamental philosophical problems and to the study of Herbert Spencer's work on The Study of Sociology. The doctrine of evolution, which, indeed, had entered largely into the discussion of ethical topics in the previous studies of the Sunday-school class, thus inspired and directed the work of the association from its inception. Its members, often differing in theology, in politics, and in speculative views, were agreed in finding in the scientific method, especially as inspired and illumined by the evolution idea, a common *pou sto*, on which they could unite in fruitful study and discussion.

From 1883 to 1885 the association continued its meetings in private parlors, studying the natural evolution and ethical foundations of the Oriental religions, with preliminary lectures on the Origin of the Religious Idea, and Fetichism; Confucianism, Brahmanism, Buddhism, Zoroastrianism, the Religions of Ancient Egypt, and the Hebrew Religion were thus reviewed during the first season, several evenings being devoted to each topic. At one meeting Prof. Charles D. B. Mills, of Syracuse, gave an interesting lecture on Our Aryan Home, and at another Baboo Amrita Lal Roy, now the editor of the Hindoo Magazine in Calcutta, described the social and religious status of his people in India at the present day. The work of the next season involved a similar treatment of the Greek and Roman Religions, Primitive Christianity, Gnosticism, and Neo-Platonism. The lectures on Primitive Christianity, which were delivered by Dr. Janes, were subsequently compiled in book form and have had a considerable sale. Other occasional lectures of this period were printed in the Westminster Review, the Index, Boston Commonwealth, Unitarian Review, and elsewhere, thus reaching and creating a larger public interest in the association and its work. As one of the results of its Oriental studies, the association obtained honorable recognition abroad, and became the authorized recipient of the first complete English translation of that monumental work, the great epic poem of India, the Mahabharâta, published, mainly for gratuitous distribution, by the Datavya Bharâta Karyalaya, at the head of which is its devoted translator, Baboo Pratapa Chandra Roy, of Calcutta. This work has now reached upward of four thousand pages, and is hardly more than two thirds completed.

In subsequent seasons the association studied the historical development of the Rational Movement in Religion, Social Problems, viewed in the Light of History, and the works of Ralph Waldo Emerson, Thomas Carlyle, and "George Eliot." Its membership had expanded so far beyond the original thirty or forty who comprised the Sunday-school class that private parlors were too contracted for its meetings, and by the courtesy of the trustees of the Second Unitarian Church they were transferred, first to the vestry, and subsequently to the main auditorium of the church. Here were inaugurated, in the fall of 1888, on Sunday evenings, the noteworthy lectures and discussions on Evolution which attracted the favorable attention of many of the leading minds in Europe and America to the association and its work.

Mr. Herbert Spencer, to whom the programme of that year was submitted, gave it his cordial indorsement, saying in his very appreciative letter: "The spread of the doctrine of evolution is both surprising and encouraging. The mode of presentation seems to me admirably adapted for popularizing evolution views, and it will, I think, be a great pity if the effect of such presentation should be limited to a few listeners in Brooklyn." Acting upon this suggestion, the association, which had now formally adopted the less formidable title of "The Brooklyn Ethical Association," commenced the regular publication of its lectures, each one being first issued in cheap pamphlet form, and the lectures of each season subsequently compiled in handsome cloth bindings. Four noble volumes now constitute the lasting memorial of the work of the association for the past four years in popularizing evolution views. Under the titles, respectively, of Evolution, Sociology, Evolution in Science, Philosophy, and Art, and Man and the State, the leading problems of physics, biology, philosophy, sociology, religion, ethics, and practical politics have been ably treated from the standpoint of the philosophical evolutionist.

Much of the work, and admittedly some of the best work of the association, has been done by its active members, among whom distinctions would be invidious. This work, which has involved much time and study, has been rendered gratuitously by the lecturers. Others, not active members of the association, whose names stand in the first rank of the disciples of science and advocates of evolution, have cordially co-operated, among whom we may mention Prof. John Fiske,* Prof. Joseph Le Conte,* Prof. E. D. Cope,* Mr. Daniel Greenleaf Thompson, Mr. Garret P. Serviss,

* Corresponding members.

Dr. Rossiter W. Raymond, Mr. C. Staniland Wake,* Prof. George Gunton, Rev. John C. Kimball,* Prof. Thomas Davidson; Dr. E. Benjamin Andrews, President of Brown University; Dr. Charles De Garmo, President of Swarthmore College; Dr. L. A. W. Alleman, Dr. Francis Ellingwood Abbott, Prof. Joseph Henry Allen, Mr. Edwin D. Mead, Mr. Arthur E. Kennelly, Mr. Thaddeus B. Wakeman, Rev. Samuel J. Barrows, Mr. Daniel S. Remsen, Hon. Roswell G. Horr, Hon. Edward M. Shepard, Hon. William J. Coombs, Prof. Amos G. Warner,* Dr. T. D. Crothers, Rev. Nicholas P. Gilman, Rev. E. P. Powell,* Mr. J. W. Sullivan, Miss Eliza A. Youmans,* and Mrs. Mary Treat.

The association has been fortunate, not only in the character and ability of its lecturers, but also in its publishers. The two volumes on Evolution and Sociology, as well as The Evolutionist, which for the past year has constituted a modest bimonthly organ of the association, were published by James H. West, of Boston, whose single-hearted devotion to the work has not been excelled by that of the active members of the association. Since 1890 the lectures have been published by Messrs. D. Appleton & Company, of New York—the publishers of the works of Spencer, Huxley, Darwin, and other eminent scientific teachers of our time. They have met with cordial recognition from leading reviewers and scientific teachers, and are having a steady and constantly increasing sale. The aim of the association has been to combine a popular mode of presentation with scientific accuracy of treatment; and this end has been fairly achieved. Each lecture is submitted to criticism by competent invited speakers when delivered, so that inaccuracies, if they exist, are discovered and corrected, and both sides of all disputed topics are fairly presented. A full abstract of the discussion is published with the lectures, which greatly adds to their value in many instances for all who desire scientific accuracy and have faith that the truth is best discovered by the free use of the enlightened reason.

The membership of the Brooklyn Ethical Association, which has gradually grown from year to year with no backward steps, now includes between two and three hundred ladies and gentlemen, of whom more than two thirds are active members, resident in Brooklyn and New York. The remainder includes a number of non-resident associate members, whose homes are in different portions of the United States and England, and fifty-five corresponding members, comprising some of the best-known names of those eminent in science and literature the world over. Among those who have accepted membership in the association and expressed their cordial sympathy with its work are Mr. Herbert

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* Corresponding members.

Spencer and Prof. Thomas H. Huxley, of London, England; Alfred Russel Wallace, D. C. L., LL. D., of Parkstone, Dorset, England, the co-discoverer with Darwin of the law of natural selection; Prof. William Graham, M. A., of Queens College, Belfast, Ireland, author of The Creed of Science, Social Problems, etc.; M. Th. Ribot, of Paris, France, editor of the Revue Philosophique, perhaps the most eminent advocate of the doctrine of evolution in that country; Count Goblet d'Alviella, of Brussels, Belgium, author of Evolution of Contemporary Religious Thought; Prof. Ernst Haeckel, of the University of Jena, Saxe-Weimar, Germany, author of The History of Creation, Evolution of Man, etc.; Prof. A. Hjalmar Edgren, Chancellor of the University of Gothenburg, Sweden; Baboo Pratapa Chandra Roy, translator of the Mahabhárata; and Baboo Amrita Lal Roy, editor of The Hindoo Magazine, Calcutta, India; and in our own country, Prof. Joseph Le Conte, LL. D., of the University of California, author of Evolution as related to Religious Thought, etc.; Prof. William Emmette Coleman, of San Francisco, member of the American Oriental Society; Prof. Edward D. Cope, Ph. D., of the University of Pennsylvania, author of Origin of the Fittest, etc.; Prof. Edward S. Morse, of the Peabody Institute, Salem, Mass.; Prof. John Fiske, of Cambridge, Mass., author of Cosmic Philosophy, etc.; Prof. Otis T. Mason, of the National Museum, Washington, D. C., President of the American Folk Lore Society; Prof. Amos G. Warner, Superintendent of Public Charities, Washington, D. C., recently elected to the chair of Economics in the Leland Stanford University, California; Rev. William J. Potter, of New Bedford, Mass., President of the Free Religious Association; Rev. Minot J. Savage, of Boston, author of the Evolution of Morality, etc.; Rev. E. P. Powell, of Clinton, N. Y., author of Our Heredity from God, etc.; Andrew Dickson White, LL. D., late President of Cornell University and United States Minister to Russia; Mr. Frederick May Holland, of Concord, Mass.; Mr. J. W. Alfred Cluett, of Troy, N. Y.; Rev. John C. Kimball, of Hartford, Conn., and others.

Though the association is perhaps best known for its advocacy of evolution views, its terms of membership are entirely undogmatic and unsectarian, being conditioned only by good moral character and a tacit pledge to the use of the scientific method in its investigations. Its constitution expressly declares that "membership in this association shall not be regarded as committing one to any particular form of religious belief, nor as interfering with other religious or secular connections. No doctrinal test shall ever be required as a condition of membership. Any person of good moral character, over eighteen years of age, approving the objects of the association, may become a member on recommendation of the Committee on Membership, duly reported to and approved by the association." In order to popularize the conditions of membership the annual dues have been kept very low, being at present only two dollars per annum. The conditions for non-resident membership are similar to those for active membership, the dues being the same, and non-resident members being entitled to receive without further expense "publications of the association of a value not exceeding the annual membership fee." Corresponding membership, which does not involve any pecuniary obligation to the association, is bestowed on such persons in sympathy with its aims as the Board of Trustees may nominate and the association elect.

On the 5th day of February, 1891, the Brooklyn Ethical Association was duly incorporated under the laws of the State of New York, its objects being stated as follows:

"*a*. The scientific study of ethics, politics, economics, sociology, religion, and philosophy, and also of physics and biology as related thereto.

"*b*. The application of the results of such studies to the problems of practical philanthropy and statesmanship.

"*c*. The procurement, preparation, and delivery of popular lectures, expositions, and discussions, and the circulation of the same, together with other printed matter related to such subjects.

"*d*. The promotion of unity and harmony among the friends of progress by correspondence, friendly intercourse, and the application of the scientific method to social, religious, and political reforms.

"*e*. The maintenance of a library for the purpose of more effectually carrying out the objects of the association."

The association long since outgrew whatever theological limitation may have been presumably implied by its connection with a Unitarian society. Its membership now includes a minority of avowed Unitarians, together with orthodox Congregationalists, Episcopalians, Catholics, Friends, and people of other diverse religious connections, as well as agnostics and liberals of various stripes and degrees of belief or unbelief.

The success of the association in recent years and the extension of its work into new fields of practical investigation have been due in no small degree to the faith, wisdom, energy, and enthusiasm of Mr. James Avery Skilton, for three years its corresponding secretary and an untiring worker in its behalf. Mr. Skilton is a member of Plymouth Church, a graduate of the Rensselaer Polytechnic Institute of Troy, N. Y., and the Wesleyan University of Middletown, Conn., and with a thorough scientific education combines a large experience in practical affairs and long acquaintance and thorough sympathy with the doctrine of evolution as expounded by Mr. Spencer, Mr. Fiske, and its ablest advocates in

Europe and America. With a clear insight into the causes of social phenomena, he possesses great independence of mind and judgment. Though temporarily withdrawn from official connection with the association, he continues his membership, and is in thorough sympathy with its work and aims.

Mr. Herbert Spencer has manifested his sustained interest in the objects and work of the association by frequent correspondence and generous commendation of its efforts and accomplishments. After declining membership in the French Academy and the leading scientific bodies of Europe, he paid the Brooklyn Ethical Association the high compliment of accepting its corresponding membership. The cordial feeling on his part is heartily reciprocated by every member of the association, and it has fallen to the lot of some of its representatives to be honored by the privilege of defending Mr. Spencer against the unjust assaults of his critics on this side of the Atlantic. Happily, he has lived to see his great work almost accomplished, and its purport much better understood than it was two decades ago. Nowhere has it found firmer or more appreciative friends than in America. That the Ethical Association has been able in a modest way to take up and carry on the work of popularizing evolution views so ably begun by the founder of The Popular Science Monthly is not the least among the sources of congratulation in the judgment of its members.

To continue this work, and by means thereof to aid in the scientific solution of those vast and impending problems of our social and political life in the discussion of which, under the prevailing *a priori* and empirical methods, wisdom has often been obscured by a multitude of unscientific and conflicting counsels, is their continued ambition, and to this end they solicit the sympathy and co-operation of all consenting minds.

Several travelers in Africa remark upon the better condition of the negroes in proportion as they are remote from the white men. Mr. Alfred Coode Hore, in his book, Tanganyika, which records his eleven years' experiences in central Africa, says that along almost any section of the continent, from coast to center, "the farther the traveler advances into the interior, the better is the condition of the natives found to be; less drunkenness, less immorality, more industry and independence." Mr. Wilmot Brooke, says the London Spectator, writing of the west coast, tells us the same story, with a more severe reference to the exterior influences inimical to the African peoples. Describing the degradation of the coast tribes and its causes, he adds, "Last of all, they are dragged lower still by their contact with the white man." As he ascended the Niger, the squalid villages were seen no more; they were replaced by fine, clean, open towns, with thousands of inhabitants, and he entered a new world, physical, political, social, and religious.

NOTES ON PALÆOPATHOLOGY.

By R. W. SHUFELDT, M. D.

ANIMALS that lived during the past ages of the world, and now long since extinct, must have suffered, it would seem, from many injuries quite similar to those now sustained by their descendants of the present epoch. So far as the writer is aware, the discovery of the evidences of such conditions is of extremely rare occurrence, and the literature pertaining thereto practically a blank page.* Among fossil invertebrate remains I do not recall ever having either observed or heard of a single instance, although during geologic times many forms of the invertebrata must have perished when such parts of their economies as usually fossilize exhibited evidences of disease, and would thus be observed by the paleontologist when those specimens came to be discovered and examined.

With respect to the vertebrata, however, I have been somewhat more fortunate in this matter, as I can show in the course of the present article. Still, even among them one may examine many hundreds of specimens before he will meet with one of their fossilized bones which shows that it was diseased at the time of the death of its owner. It is one of the very rarest of things. In two or three different articles, several years ago and later, I published a number of instances where, in the preparation of the skeletons of existing birds, I had discovered a variety of pathological conditions of the bones.† Many, if not the majority of those cases, however, were the results of gunshot wounds, and, of course, it goes without saying that that class of injuries would not occur among fossils; and their very absence is one good reason for the greater rarity of examples of disease in the skeletons in these extinct forms, as one may easily imagine.

Several months ago Prof. E. D. Cope, of Philadelphia, placed in my hands for description some fifteen hundred specimens of fossil birds from the Pliocene of southwestern Oregon. Here then, indeed, was an excellent opportunity to investigate such a matter, for surely among several hundreds of bones we would be

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* Palæopathology (Greek *παλαιός*, ancient, and *πάθος*, a suffering), the word used in the title of this paper, is a term here proposed under which may be described all diseased or pathological conditions found fossilized in the remains of extinct or fossil animals.

† The following are the principal articles of mine on this subject: (1) Notes on a Few of the Diseases and Injuries in Birds, The American Naturalist, vol. xv, April, 1881, pp. 285–286; (2) Notes on the Diseases of Birds' Beaks, The Journal of Comparative Medicine and Surgery, vol. viii, No. 2, April, 1887, pp. 181, 182 (illustrated); (3) Examples of Fractures and their Union in the Bones of Birds, The New York Medical Journal, vol. xlviii, No. 26, New York, December 29, 1888, pp. 714, 715 (illustrated).

most likely to meet with at least a few specimens of a character to which reference has just been made.

These fossils were principally of water birds, having been discovered in the former bottoms of dried-up Tertiary alkali lakes, or upon the margins of those undergoing a similar process. With them were found immense numbers of arrow points of human manufacture, and the question had arisen as to whether it were not possible that they had been shot at the game during former times. To shed further light upon such an interesting subject, I most carefully examined each and all the specimens to discover if possible any healed wounds (fossilized) that may have been produced by such means. My interest in this matter was much stimulated by what Prof. Cope had formerly written in the American Naturalist for November, 1889. After describing the discovery of the bird-fossils referred to above, that eminent paleontologist there says that "scattered everywhere in the deposit were the obsidian implements of human manufacture. Some of these were of inferior, others of superior workmanship, and many of them were covered with a patine of no great thickness, which completely replaced the natural luster of the surface. Other specimens were as bright as when first made. The abundance of these flints was remarkable, and suggested that they had been shot at the game, both winged and otherwise, that had in former times frequented the lake. Their general absence from the soil of the surrounding region added strength to this supposition. Of course, it was impossible to prove the contemporaneity of the flints with animals with whose bones they were mingled, under the circumstances of the mobility of the stratum in which they all occurred. But had they been other than human flints, no question as to their contemporaneity would have arisen" (page 979).

Now, I found no fossilized injuries of the bones in question that could be attributed to wounds of them that arose from arrow-shot; but, on the other hand, one or two pathological conditions of interest were discovered, and one of these a fracture in the course of healing.

In order to make clear the stage at which this healing fracture existed at the time of the death of the individual that sustained it, I will first offer a few remarks upon the course of such injuries in existing animals.

Fractured extremities of bones in both mammals (not including man) and birds are rarely kept quiet and properly approximated during the healing process, which takes place at the fractured extremities. This results in the formation of a "provisional callus" which soon surrounds the broken ends of the bones, and acts as an osseous splint, that strengthens with time.

For the first week or more this exudation of reparative material takes place at the point of fracture—occurring externally between the periosteum and the bone, and internally between the medullary membrane and the bone. At the end of about three weeks this provisional callus acquires a firmness about equal to that of cartilage; which, at the end of three months, both internally and externally, ossifies—the ossification being more or less of a spongy nature. Shrinkage now takes place, and this spongy ossification becomes modeled down, forming compact bone. Still, at this stage the fractured ends are only united by fibrous tissue, though the surrounding ossified callus holds them firmly together.

Finally, this provisional callus undergoes more or less complete absorption, and the *permanent* callus forms directly between the fractured ends of the bone. This results in the nearly complete disappearance of the periosteal enlargement, and, internally, in the re-establishment of the medullary canal. Normally, this is the course of the union of fractures in long bones, of the character referred to above, but there are a number of exceptions to it, and irregular unions occur which do not require comment from me in the present connection.

Several years ago I obtained a turkey vulture (*Cathartes aura*) that had survived a glance shot from a carbine ball which fractured both bones of the left forearm of the upper extremity. It had also sustained other fractures, all of which I fully described in the New York Medical Journal (see No. 3 of foot-notes given *antea*). This bird I subsequently killed with chloroform and prepared its skeleton. Upon examination it was discovered that the left ulna and radius were each fractured at the points shown in the accompanying cut (Fig. 1),* and were at the time of its death at that stage of union where the provisional callus is well under way toward absorption.

From my various observations in such cases I have arrived at the conclusion that at this stage the *weakest* point in the provisional callus lies in the plane of the meeting of that material, as it is furnished by the two broken ends of the bone—in other words, it is at its *thickest* part and *in the plane of the fracture*. I mention this fact, as reference will soon be made to it again, further on.

Owing to the support afforded by the quill-butts of the secondary feathers of the wing in a bird, acting as a compound splint of Nature's furnishing, the radius and ulna in that class of verte-

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* I am under obligations to the New York Medical Journal for the loan of the electro … I hereby tender my grateful acknowledgments for the same. The origi- … from my specimen, a number of years ago, and I still possess … ret.

Fig. 1.—Left Ulna and Radius of a Specimen of the Turkey Vulture (*Cathartes aura*). Outer aspect, showing union three weeks after fracture from a glance shot from a ·45 Government carbine ball. From the author's figure. (The larger bone is the ulna.)

brates usually unite with scarcely any deformity. This is by no means the case in mammals below man, for in them, where the long bones of the limbs are fractured near their middle, or even in the upper and lower thirds, very considerable angularity results upon union—an angularity that in some cases may even equal a right angle, as I once saw in the case of a fracture of the femur in a muskrat (*Fiber zibethicus*).

The specimen exhibiting the fracture in Prof. Cope's collection of fossil birds consists of a portion of some such bone as the humerus from a bird apparently about the size of a medium-sized goose. It is about 4·5 centimetres long, and has been broken longitudinally both through the callus and the shaft, the corresponding piece having been lost. If the piece be from the humerus of such a bird as I have mentioned, it must be from the very *middle* of the shaft, for it presents no part of the sigmoid curve as seen at either extremity. The walls are comparatively thin, and the medullary canal large. The fracture occurred square across, or at right angles to the axis of the shaft. There is no provisional callus within the medullary canal, but the bone in the neighborhood of the fracture within that tube is roughened, showing the effects of the attempt at repair. Probably the internal provisional callus may have been broken out of the specimen before it was discovered. Externally the fossilized, spongy, bony callus is quite abundant, and has all the appearance of the distal moiety of the callus upon the ulna of the turkey vulture shown in Fig. 1, and was at about that stage when the individual perished. Among existing birds of the group to which I suspect this specimen belonged, as the swans, geese, and ducks, I have known very excellent results follow in the case of the direct simple fracture of the shaft of the humerus. If they be not pursued to the death by the hunter, they usually swim about on the water during the day, and feed along the shore or in the marshes at night, always holding the wing well up until the fracture unites. The case is different with land birds, where, in getting about, the seat of the break is often violently disturbed.

This interesting fossil specimen, then, goes to prove that the union of fractures of the shafts of the long bones in the vertebrata during the later Tertiary times was identical with what now occurs in the case of existing forms. Such a thing would be most naturally suspected, but, as with some of the simpler, self-evident theorems in geometry, it is invariably required that the *proof* be forthcoming. It is quite another thing to conjecture *how* this fracture came about. If I be right in my guess that the specimen was a bird, and that bird was a goose, why, it may have been done in battle with one of its own kind; it may have been done by a blow from a bird of prey, which afterward failed to secure the quarry.*

Such evidence as I possess upon the first-mentioned supposition is by no means to be implicitly relied upon; and in the case of the second supposition such a circumstance as is pointed at would certainly be one of the rarest occurrence.

The bone could much more easily have been broken by having been struck by an arrow by its flint-pointed head, provided it were shot with sufficient strength from a bow. Of the probability of that I leave the reader to judge for himself; there is some evidence to sustain such a conjecture, no inconsiderable part of which has been presented above, and more can easily be found between the lines.

I pass now to the consideration of one other pathological condition pre-

FIG. 2.—LEFT CARPO-METACARPUS FROM THE HAND OF AN EXTINCT SWAN (*Olor paloregonus*) FROM OREGON. Outer aspect and natural size from the specimen by the author. *a*, the seat of the disease on the summit of the first metacarpal.

* In the collection I discovered the remains of two new species of extinct eagles.

sented on the part of the bones of the fossil birds in Prof. Cope's collection. It occurred only in specimens of swans, geese, and ducks, and consisted in a more or less abundant exudation of spongy, osseous material that appeared upon the proximal part of the first or pollex metacarpal of the carpo-metacarpus (Fig. 2, *a*). It was present in a good many specimens of all the families enumerated above; it was entirely absent in a lesser number of specimens of two or three of the same groups. It would seem to me that such a condition could only be brought about by some blow or other given at the point in question, which point is one in the wing of those birds that is quite superficial, in so far as the bone is concerned, and might, upon receiving a square rap of sufficient force, injure its periosteum to such an extent as to have a subsequent osseous exudation result there. The vast majority of those fossil anserine birds of that region were identical with those species now in existence in our avifauna, and, it is but fair to presume, possessed habits similar to them. Yet in *Pliocene* time they may all have had some different habits: it occurred to me that they may have fought each other with their *wings*—or, may be, fought some common enemy as yet unknown to us. The fossil bones exhibiting this disease may have belonged only to the males, and they may have fought during the breeding season; or it may have occurred only in the females, who for some reason may have been called upon to fight with their wings in defense of their young. Some *existing* birds have large *spurs* upon certain bones of their hands, and they are known to fight with their wings at the present time; but in some future epoch, if the descendants of those forms persist, the necessity for such an armature may pass away, and with it the spurs themselves. Modern swans are known to strike a blow with their wings in defending themselves or their young. With these thoughts in my mind I asked Prof. Cope for his opinion in the premises, and, without hesitation or hint from me as to my own musings, he answered, "Why, possibly, they fought each other with their wings." I have never observed any similar pathological condition in our modern *Anseres*, and I have both made and examined skeletons of a great many of them.

A Danish archæologist, G. V. Smith, has been experimenting upon the practicability of using the simpler forms of flint implements for working in wood. He fitted handles of various forms to the flints and worked with them on pine with complete success. He was in some cases convinced that the same flint hatchet would serve equally well for working harder wood than pine. With these primitive tools it would be possible to bring down large trees and execute all kinds of simple carpentry work.

THE SCHEELE MONUMENT AT STOCKHOLM.

By FRED. HOFFMANN.

ON the first day of August, 1874, the chemists of Great Britain dedicated a monument to the British discoverer of oxygen. On the same day a large number of American chemists assembled at the beautifully located village of Northumberland at the junction of the two branches of the Susquehanna River, in order also to pay homage to the memory of that remarkable theologian, philosopher, and naturalist, Joseph Priestley, who lived and died in that quiet Pennsylvanian village. In the orations delivered at this occasion of the centennial of the discovery of oxygen, the element which for the following half century became the cornerstone for the structure of a new chemical philosophy, equal justice was done, especially by the late Prof. Sterry Hunt and Prof. Lawrence Smith, to both discoverers of oxygen, Priestley and Scheele. Both men, though of different caliber and station in life and searching in different directions, recognized almost at the same time and independently of each other the nature of oxygen, and to a large extent also the important part which this element plays in the commonest chemical processes and changes of matter. Yet both, skilled and ingenious experimentalists though they were, and Scheele keen and discerning in deduction and application, prepossessed by the doctrine of Stahl, then prevalent and apparently settled, missed the real bearing and ultimate consequence of their discovery, and died defenders of the theory of phlogiston—the very men who furnished the facts and the weapons with which that hypothesis was shattered a few years afterward by Lavoisier, and a new system of chemical philosphy was established.

The memory of these three contemporary representative investigators of the three foremost nations of their time—England, Germany (Scheele was a German by nationality, born in Pomerania, then under Swedish rule), and France—has ever since been honored. Monuments have been erected to Lavoisier in Paris, to Priestley in Birmingham (1874), and to Scheele in Köping (1827). Scheele especially has repeatedly been remembered by his grateful adoptive country, Sweden. In 1790, four years after his death, the Academy of Sciences in Stockholm, of which he had been a member, had a medal struck to his memory. It contained on one side his portrait in relief, and on the other a symbolic representation of the discovery of oxygen, and the inscription, "*Ingenio stat sine morte decus*" (the beauty of his genius stands immortal). In 1827 the Academy had a second medal ...eele's portrait, and on the other side the veiled figure of Isis with Hermes lifting the veil, and the inscription, "*Naturæ sacra orgia movit*" (he stirred the holy mysteries of Nature). In the same year the Apothecaries' Society of Sweden erected a monument with a relief portrait of Scheele in the Lutheran church in Köping, of which Scheele had been a member.

At the occasion of the centennial of Scheele's death, May 21, 1886, a memorial service was held at Köping, where Prof. Bergstrand, of Stockholm, delivered an oration on the life and life-work of the eminent apothecary and chemist. On this occasion the project was advanced to erect to Scheele a monument at Stockholm similar to the one that had been placed there to Berze-

lius in 1855. The Apothecaries' Society of Stockholm fostered this project in close accord with the learned societies of the country, and with so much success that the requisite funds were soon raised. A committee, with Prof. von Nordenskjöld at its head, took charge of the matter. Prof. I. Börgeson, the eminent Swedish sculptor, undertook the modeling of the statue, and has executed a fine work of art. The statue, which represents the chemist resting on a chair and watching a process of ignition in a crucible, was unveiled on the 9th of December, 1892, the one hundred and fiftieth anniversary of Scheele's birth. It stands in the "Humble Garden," one of the city parks, upon a beautiful floral parterre near the monument of Linné, erected in 1885. The unveiling took place in the presence of King Oscar of Sweden, all the royal princes, the ministers of state, the invited descendants of the Scheele family, and of numerous representatives of the state and city governments, of the universities and the learned societies of the country. Prof. von Nordenskjöld delivered a brief dedication oration, and numerous wreaths of flowers were deposited at the base of the monument as offerings from the institutions and societies represented by delegates. This ceremony being over, a state banquet took place, at which Prof. P. T. Cleve, of Upsala, the biographer of Scheele, delivered a brief oration; and Prof. Retzius, of Stockholm, Prof. Waage, of Christiania, Prof. Curman, of Stockholm, and apothecary William Sebald addressed the assemblage. A large number of congratulatory telegrams and messages from learned societies and eminent scholars from Sweden, and from Berlin, Vienna, St. Petersburg, Copenhagen, Paris, and other cities were received and read.

In the evening the Apothecaries' Society of Stockholm gave a banquet to about two hundred and fifty invited guests. Apothecary I. Nordin delivered the oration on Scheele as an apothecary and chemist. Prof. Stahre, of the Pharmaceutical Institute of Stockholm, communicated the thanks of the society to the chairman of the Scheele committee, Prof. von Nordenskjöld, as well as to the sculptor, Prof. Börgeson, and presented them with the first copies of a Scheele medal, struck for this occasion in silver and in aluminum. This medal bears a relief portrait of Scheele with this inscription: "Carolo Guilmo Scheele, *pharmaceutæ chemico grati cultores Ordo Pharmaceut. Suecia*" (the Swedish order of pharmacists, grateful cultivators of their art, to Charles William Scheele, the chemist). On the other side is a representation of Scheele's house and pharmacy in Köping, with the inscription, "*Domestici parietes ipsum, non famam continuerunt*" (the walls of his house could not contain his fame).

Besides notices in larger chemical and historical works, brief biographies of Scheele have been published at different times, mostly in Germany, and especially at the occasion of the celebration in 1886, but only a few in England and America. Of the more recent ones are those by Prof. P. T. Cleve in Upsala, and by Prof. F. A. Flückiger in Strasburg,* and a brief sketch in Vol. XXXI, pages 839–844, of The Popular Science Monthly.

Scheele's writings, all in German,† of which the treatise on

* Reprinted in vol. iv, pp. 188 and 208, of Pharmaceut. Rundschau, New York.

† [illegible] living more than half his life in Sweden, Scheele remained so much a Ger- [illegible] of the Swedish language was imperfect; his essays addressed to [illegible]ala, as well as his correspondence, were all written in

Air and Fire, written in 1775, is the most remarkable one, were collected and published in 1793. His contributions to the Academy of Sciences in Stockholm have been issued in an English translation by Thomas Beddoes. Prof. von Nordenskjöld prepared for the recent celebration a complete collection of Scheele's scientific notes and of his letters to eminent contemporaries, which has just been issued in a Swedish and a German edition.* This voluminous and splendidly prepared work is an important supplement to all former publications of Scheele's writings and the several historical sketches of his life and labors, and is of paramount value to every student of the history of chemistry. From among the many interesting new facts brought to light in it are: Scheele obtained and recognized oxygen (fire-air) as early as in 1765 in connection with his researches of nitrous acid. Before the year 1771 he obtained oxygen in various ways by heating silver and mercury carbonates, silver and gold oxides, alkaline nitrates, arsenic acid, and black oxide of manganese. He therefore *obtained and recognized oxygen several years before Priestley's independent discovery of it.* At about the same time he obtained and recognized nitrogen, hydrogen sulphide, hydrogen chloride, ammonia, and nitrogen dioxide gases. He knew before 1773 the color reaction of the blowpipe flame with potassium and sodium compounds, and made use of them, as also the methods of separating iron from manganese by means of acetic acid. He was also familiar with the transformation of insoluble silicates into soluble ones by fusing them with alkalies.

Scheele's letters and laboratory notes just published by Prof. von Nordenskjöld bear evidence of his advanced knowledge in most departments of chemistry, and of the unusually large number of his researches, observations, and exact discernment in his numberless experiments and deductions. The book abounds in novel views and facts relative to the interesting period of the transformation from the phlogiston epoch to the modern doctrines of chemical philosophy and application. It furthermore bears ample evidence of the fundamental influence and part which Scheele's labors and ingenuity have had in preparing and clearing the domain of chemistry for Lavoisier's subsequent theoretical consummation.

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* Carl Wilhelm Scheele. Nachgelassene Briefe und Aufzeichnungen. Herausgegeben von A. E. Nordenskjöld. One large octavo volume, pp. 506, with illustrations and *fac simile* letters. Stockholm, 1892. This work is published by subscription only, and according to order the German or Swedish edition will be sent postpaid by mail on receipt of five dollars paid by international money order addressed to Dr. E. Svedmark, Geological Survey, Stockholm, Sweden.

EAST CENTRAL AFRICAN CUSTOMS.

By JAMES MACDONALD.

PART I.

THE following account of a few of the customs common among the tribes of east central Africa, in the region of Lake Nyassa, has been gathered from many sources; most of the statements have been revised and corrected by missionaries and others who have, during the past twelve years, been resident in the lake region.

As early as 1586, Don Santos, writing of the natives of eastern Africa, inclines to the belief that they once were acquainted with true religion, and that they had degenerated to such a degree that it, and all idea of a former civilization, had been entirely lost. This opinion he based upon the existence among them of trial by ordeal, which he regarded as having its origin in Scripture, and that from this source they must have first obtained it. The worthy Portuguese, had he lived in our day, would hardly have attributed customs, dating perhaps thousands of years before the Exodus, to the Mosaic legislation. One fact he does record which is of deep interest, if his account can be fully relied upon, and that is, that near Teté, on the Zambezi, men and women were confined in regular pens like cattle, and slaughtered for food as required. These were prisoners taken in war, and who could not, there being a large number, be "used up at once."

Of all central African customs trial by ordeal, which is universal, is that which is most revolting to a European brought for the first time into contact with savage life. When a man is accused of any crime, as theft, arson, murder, witchcraft, or the like, evidence is brought against him in the way common throughout the whole continent. This, however, is never final. The accuser's witnesses swear to anything required of them without the slightest compunction of conscience, and as the prosecutor must produce his evidence first, the defendant's witnesses are ready to swear, and do swear, the opposite of all that has been said. Trial is invariably in open court, and nothing said by the witnesses for the prosecution can be concealed from those that are to follow. There are no affidavits, thus making contradiction at once simple and safe. If rebutting evidence were allowed, the most paltry trial would be interminable. For a witness to be called a liar is, in such a case, a compliment. It proves that his evidence told, and that he, by inference, is a very clever fellow. If the same man were accused of bewitching he would regard it as a foul libel and demand the poison bowl without an hour's delay.

To remedy the defects of trial in court, that by ordeal is adopted in all kinds of causes, both civil and criminal. As the case proceeds before the council, the accused at intervals demands the *mwai*, and this demand his friends, if they believe him innocent, persistently press. The accuser resists the demand as unnecessary, knowing that should the culprit, even if caught red-handed, recover, he will be placed in a difficult position. He will in that case have no claim to compensation for an injury, and may in turn be successfully sued for willfully seeking to destroy another man's reputation. The belief in the absolute certainty of trial by *mwai* is universal, and the beginning and end of reasoning is thus: "If he is guilty, he dies; if he does not die, should the stolen property be found on his person, he is not guilty; another put it there, or he was bewitched."

The life of an African properly begins at puberty. Then he is no longer a child, and discards both the work and amusements of boyhood. There is no great difference between the customs in central Africa and those in the south as regards infancy and childhood.* The seclusion of the mother, purification by the magician, sacrifice to ancestral spirits, wearing of charms to ward off evil and to promote growth and strength, are all customs with which we are familiar among the better known tribes bordering on the Cape Colony. In the lake region the rites of initiation into manhood do differ considerably, but as this is a subject which has not been very fully investigated, what follows is in a measure tentative. The rite of circumcision is general, and, though many observers trace this to Arab influence, there seems no sufficient warrant for the assumption. Few, if any, Arab habits have been universally adopted, and why this one rather than others? At circumcision it is customary to isolate the neophytes and treat them generally as is done by Zulus and Kaffirs, the close of the ceremonies being marked by dancing, feasting, and riot. The young men have arms put into their hands and are harangued by the elders, bards, and magicians. They are now men and men's work is to be theirs. Herding, hoeing, reaping, and all domestic duties in which they assisted their mothers, they have no longer any concern with. War, hunting, and hearing causes must now occupy their thoughts, for they are to take the place of the fathers, and on them will depend the defense of the tribe and the maintaining of its honor. They must defend their chief, avenge his wrongs, wage war at his word, and obey his commands if that should imply death; "a man can die but once," with which philosophy they are launched into the new life of full manhood.

* The Yao, Makololo, Makuas, Machingas, Anguni, and many other tribes observe substantially the same customs at birth and during childhood.

Young women are initiated into the mysteries,* as the ceremonies are called, by rites and ceremonies nearly akin to *intongane* in the south, and are then taught, in actual fact and by experience, much that would be regarded as immoral and not to be named among Western nations. The details of these ceremonies I have not been able to obtain and verify with that degree of accuracy that would justify publication, as it might tend to mislead and confuse. One thing is certain, that in the case of both young men and women separating into pairs with persons of the opposite sex is deemed essential. If this were neglected in the case of girls after the establishment of the menstrual function, they would die. There is a second ceremony when a woman is for the first time *enceinte*. Her friends gather and make preparations as for a marriage feast; her head is shaved; the matrons in attendance sing songs and give the neophyte much advice, finishing with a glorious revel at night.

Taking the people as the traveler meets with them, the first thing to be studied is village life and personal rights and liberties. From that we may conveniently advance to the study of tribal life and national institutions. When a Yao or Wanyasa leaves his home to form a new village, he wishes to strengthen his position by every means at his command. This he can do in several different ways. Free men may be induced to join him and form the nucleus of the proposed settlement; he may purchase slaves and many slave wives, or, if able, make a raid and capture slaves to do the work necessary during the initial stages. When the village is recognized by the chief, it becomes subject to the general laws of the territory. There is the same council, presided over by the new headman; the same intercourse between the headman and chief by special "messengers"—that is to say, confidential advisers; the same system of land distribution and tenure, with the yearly tribute, as in older settlements. Petty cases are tried by the headman, graver cases are reserved for the hearing of the council. The head of a village may, under African law, kill his slave,† but only a fool would do so, as he would simply impoverish himself by the value of his chattel in the open market. Besides, should a man kill a slave unjustly, he himself would "wither away and lose his eyesight." Domestic slaves have a *quasi* right to any property they may accumulate while they remain with the master under whom they gather it, but if sold the property remains the master's. Most Africans like to see their slaves become rich. "Are they not," say they, "our own

* Wanyasa—south end Lake Nyassa ceremonies. Boys do not pass through them, but Yao, Makua, and Angoni boys do.

children?" When the Fingoes left the Gcalekas, whose slaves they were, to come under British rule, they brought with them numerous droves of cattle which they were allowed to possess in the land of their captivity. A slave's wives and children belong to his master and may be sold at any time. A headman who is in debt * sells first his slaves, then his sisters, next his mother, and finally his free wives, after which he resembles the proverbial Highlander; there is nothing more of which he can be stripped.

Closely connected with personal rights and liberty is the law of inheritance.† A man's heir is his brother, the son of his mother, failing that, his sister's son; his own children are excluded. This, as will be easily understood, is to make perfectly sure, in a land where every married woman has a lover, that the heir has the family blood in his veins. The succession to the chieftainship is based on the same principle, which is curious, considering the terrible severity with which known cases of adultery, in the case of chiefs' wives, are punished. A man succeeds to his deceased relative's wives as well as to his property and rights; they are a part of the estate. And here it may be mentioned that wives are obtained by inheritance, by purchase as slaves, by presentation, or by raiding and theft. Generally one wife only is free. An infant a few days old may be bought and betrothed, or even an unborn child, conditionally of course. In the case of infant betrothal the suitor provides her with clothes, which is the token of his pledge.

At an African village the work is done chiefly by the women;‡ they hoe the fields, sow the seed, and reap the harvest. To them, too, falls all the labor of house-building, grinding corn, brewing beer, cooking, washing, and caring for almost all the material interests of the community. The men tend the cattle, hunt, go to war, and, curiously enough, do all the sewing required on their own and the women's garments. Neater tailors than Africans it would be impossible to find anywhere. By means of an awl and tendons from animals of the chase they can sew small squares of skin together so as almost to defy an expert to find a seam without looking at the reverse side, nor are they mean artists as regards cut and fit according to African notions. Whether they would satisfy those who wear only "tailor-made gowns," is a question which the ethnologist is not called upon to solve.

The African can not always remain at his own village; he may be called upon to undertake a journey on his own account, or at the behest of his chief, and in either case it is necessary to take

* Notably among the Yao.

† Yao, Malemya's people at Zomba, Machinga, and many others.

‡ This is universal.

precautions to insure success. There are places in Africa where three men can not be sent on a journey together for fear two of them may combine and sell the third. But that by the way. When a man has determined on a journey he must consult the oracle by means of divination. The methods most commonly employed are as follows: The magician takes a quantity of flour and lets it fall in a steady stream on a flat stone placed at the head of the traveler's bed. If it forms a perfect cone as it falls, the omen is good; if not, there is an end of the matter at that time and by means of the flour cone. Sacrifice must now be offered to propitiate the offended spirits. When the cone is perfect it is covered by an inverted pot and left for the night. In the morning the pot is removed and the cone examined; if it is still whole and in the exact state in which it was left when covered, there is nothing further to be done beyond presenting a thank-offering of rice, flour, or fowl to the ancestral spirits and set out on the journey. Should there be a falling of the cone, even a small slip down its side, it is a sign not to be disregarded, and the oracle, after propitiatory sacrifice, must once more be consulted. The flour cone is now abandoned. The magician takes a pot of beer which he pours out upon the ground. If it sinks in one spot the gods are propitious, but should it run along the ground their faces are averted in anger or grief.

Another common method of divination is by means of small stones, claws, teeth, bits of snake-skin, and other odds and ends which the magician keeps in a calabash or gourd, and which are shaken to be thrown as is done with dice. He examines the position in which the contents fall, and as claws, teeth, or stones are to right or left he gives his responses, always with Delphic ambiguity. It is not necessary to have a magician present in order to consult the oracle, though this is desirable. The recognized diviners sell bits of prepared root which travelers carry. These, three in number, are in cases of difficulty placed upon the ground, two side by side, and the third across those lying parallel. The owner, after placing them in position, retires, and after an interval of some hours returns to examine them and learn the response. If they are in the position in which he left them, the oracle is favorable; if not, the reverse.

But even after the responses have been favorable and the sacrifices and offerings made, the departure of the travelers may be delayed. Should the leader, during the first day's march, hurt his toe against root or stump, they must return and begin the process of divination *de novo*. A rabbit crossing the road they are following denotes the death of the leader should they persist in the enterprise. A certain species of snake found on the path bodes evil to the whole party. When fairly on the road they must observe certain time-honored customs. They must not use salt; if they did, and their wives were not behaving in their absence, the salt would act as a corrosive poison of the most virulent kind. Few Africans would take this risk.

The magician is in requisition in connection with every detail of life. In a case of illness an offering of flour is made to the ancestors. This is placed by the patient's pillow,* where the spirits come to regale themselves with its essence. If there is no improvement the magician is called, who may simply direct the patient to change his residence for a time and then take his departure. At other times he practices the art of cupping by means of an inverted horn, in which case he professes to "extract" the disease, as is done in the south, in form of bug or beetle. Counter-irritation, by means of incisions, into which ashes and pounded roots are well rubbed, is termed "killing" the disease. A charm may be given which the patient must wear as a means of cure and as a talisman against evil.

By far the most common method of cure is "smelling out" the person bewitching the patient by means of sorcery, and this is done both in cases of protracted illness and when a person dies suddenly.† The magician may simply "mark" the person who is causing the disease, who at once goes with a present to the sick man and a fee to the magician. It is, however, much more common to find the wizard put to death as a *sacrifice*,‡ and in this the custom differs from that observed in the south. There the culprit is always put to death as a *criminal*, and only after a tribal council has met and heard him "named" in the most formal manner. In central Africa the magician has the power of summary condemnation, when execution may follow immediately. The custom of human sacrifice accounts for the difference where, on the whole, the customs are the same, and regulated by the same usages. Any one may be accused of bewitching, and in the case of sudden death a traveler as readily as a resident. Dr. Elmslie, while traveling among the Angoni a year or two ago, came to a village where he halted for the night. He had three days of forest travel before he could reach the next settlement. The morning of his intended departure threatened rain, and his men, as always happens in such circumstances, were determined not to move. Again and again he tried to get them together, but without success. When he was about to give the case up as hopeless, a wailing and howling was set up in one of the houses and taken up by the villagers in chorus. His men came flying to their loads, which they picked up and struck into the path, adjuring him by

* Yao, as observed by Rev. Duff Macdonald. † Angoni, Notes by Dr. Elmslie.
‡ Rev. Duff Macdonald, Nyassa Region.

all the gods they knew to follow instanter, as some one had died and they might be accused of bewitching. The doctor followed, nothing loath to get on the road so easily.

The magician, when answering questions, shakes his gourd and examines the claws, teeth, and pebbles it contains.* From these he receives his oracles, and according to their position his answers are satisfactory or the reverse, but generally shrewd advice if somewhat ambiguous. It is they who prepare war medicine and doctor soldiers for the field; they, too, prepare the poison bowl and administer it to those who are to be tried by that means. At births, deaths, and marriages they are in constant attendance, and, while the chief derives his revenue largely from voluntary gifts, the magicians receive fees which are rigidly exacted.—*Journal of the Anthropological Institute.*

SKETCH OF ROBERT HARE.

THE name of Robert Hare, said the American Journal of Science at the time of his death, "has for more than half a century been familiar to men of science as a chemical philosopher, and to the cultivators of the useful arts throughout the civilized world." Dr. Hare was born in Philadelphia, January 17, 1781, and died in the same place, May 15, 1858. His father, the proprietor of a large brewery in Philadelphia, was an Englishman of strong mind, occupying a prominent position in society, and enjoying the confidence of his fellow-citizens. The management of this concern shortly fell into the hands of the son. He was soon drawn away from it, however, by the strength of his predilection for scientific pursuits; and before he was twenty years old he was enrolled as an attendant of the course of lectures on chemistry and physics in Philadelphia, and became a member of the Chemical Society of that city. There he found Priestley, Sybert, and Woodhouse among his associates. To this society he communicated in 1801 a description of the oxyhydrogen blowpipe, which was then called the hydrostatic blowpipe, and which Prof. Silliman, who had been engaged with him in 1802 and 1803 in a series of experiments with the instrument, afterward called the compound blowpipe. On his return from Philadelphia, in 1803, Prof. Silliman constructed for Yale College the first pneumatic trough combining Dr. Hare's invention; an apparatus which was afterward figured and described by Dr. Hare in his memoir on the Fusion of Strontia and the Volatilization of Platinum—a paper which was republished in London and in the

* Anyasa, Yao, Manganga, Wanasomba, etc.

Annales de Chimie. This apparatus, according to Prof. Silliman, was the earliest and most remarkable of Dr. Hare's original contributions to science. It revealed to the chemical student a source of artificial power far transcending anything he had ever known before; and this, though the facts on which it was based were not unknown.

Lavoisier had directed a jet of oxygen on charcoal and had burned the elements of water together; but even he, and in the face of these experiments, had failed to comprehend the power of this heating apparatus, and it was left for the acumen of Hare to demonstrate it and make it practically applicable. The author of the biography in the American Journal of Science says of it, "In our view, Dr. Hare's merit as a scientific philosopher is more clearly established upon this discovery than upon any other of the numerous contributions he has made to science." Dr. Hare's original experiments were repeated in 1802 and 1803 in the presence of Dr. Priestley and Messrs. Silliman, Woodhouse, and others. In recognition of the discovery, Dr. Hare received the Rumford medal from the American Academy of Science at Boston. An attempt was afterward made, in 1819, by Dr. Clarke, of Edinburgh, to rob him of the credit of this discovery; and though he showed that the oxyhydrogen apparatus had been before the public several years, no attention was paid to his protests. The calcium and Drummond lights also furnish instances of most important applications of Dr. Hare's invention, in which no reference is made to him. He himself led the way to these devices by constructing an apparatus on a gigantic scale, with large vessels of wrought iron, capable of sustaining the pressure of the Fairmount Water Works, with which he was able to fuse at one operation nearly two pounds of platinum, with a resultant production of metal greatly purified.

He devoted much labor and skill to the construction of new and improved forms of the voltaic pile; "and it is easy to show," Prof. Silliman says, "that owing to his zeal and skill in this department of physics American chemists were enabled to employ with distinguished success, the intense powers of extended series of voltaic couples long in advance of the general use of similar contrivances in Europe."

In 1816 Dr. Hare constructed an instrument called the calorimeter, in which great extent of surface was obtained by combining many large plates of zinc and copper into one series, and plunging the whole at once into a tank of dilute acid. Great magnetic and heating effects were obtained with this instrument, and it was many years before any other voltaic apparatus was constructed in which the movement of so great a volume of heat was attained with so low a projectile or intensive force. By it large rods of iron or platinum were ignited and fused with splendid exhibitions, while the intensity of the current was so low that hardly a visible spark could be made to pass by it through poles of carbon. The magnetic effects were afterward shown by Prof. Henry to be attainable from a single cell, if combined with suitable conductors. Instead of Cruikshank's cumbrous battery of alternating zinc and copper plates, which Davy used in the experiments that resulted in the discovery of the metallic bases of the alkalies, Hare found a way of obtaining a corresponding amount of surface and its resultant power with a single roll of metal, and in 1820 introduced the deflagrator, in which any series, however extended, could be instantaneously brought into action or rendered passive, at pleasure. This apparatus consists of a large sheet of copper having several hundred square feet of surface and a similar one of zinc, separated by a piece of felt or cloth saturated with acidulated water, and then rolled up in the form of a cylinder. Faraday bore testimony, in his Experimental Researches, to the merit of this invention when, in 1835, he acknowledged that, having worked exhaustively to perfect the voltaic battery, finding that Hare had anticipated him many years before, and had accomplished all that he had attempted, he at once adopted his instruments, as embodying the best results then possible.

With one of Hare's deflagrators, Prof. Silliman, in 1823, first demonstrated the volatilization and fusion of carbon, a result then considered so extraordinary that it was a considerable time before it was fully credited. It was with these batteries that the first application of voltaic electricity to blasting under water was made in 1831 in experiments conducted under Dr. Hare's direction.

Dr. Hare was also distinguished in chemistry as the author of a process for denarcotizing laudanum, and of a method for detecting minute quantities of opium in solution. He was interested, too, in the discussions of philosophical chemistry, as was most notably shown in the earnestness with which he contested what he conceived were the errors of the salt radical theory.

He made studies in meteorology, and had a theory of whirlwinds and storms founded on an electrical hypothesis, which he opposed to the rotary theory of W. C. Redfield. At the second meeting of the American Association for the Advancement of Science he explained his own views on this subject, while he controverted those of Mr. Redfield. This gentleman was present and heard his remarks, but made no reply then. He was not a speaker, and did not address the public except in writing.

In 1818 Dr. Hare was chosen Professor of Chemistry and Natural Philosophy in William and Mary College, and in [illegible] year was made Professor of Chemistry in the medical [illegible] of the University of Pennsylvania. He held the [illegible] till 1847. His teachings were marked by the [illegible] experiments and the extent and variety of the apparatus he employed. He spared no labor or expense in his operations, and, being a handy mechanician, he was able to bestow much ingenuity in the construction of novel devices for experiment and illustration. He accumulated instruments and material with astonishing profusion. To these he added graphic illustrations and lucid descriptions to make his lectures intelligible and interesting. When he resigned his professorship, he gave all the apparatus he had accumulated to the Smithsonian Institution.

He was a man of literary tastes, fond of poetry, and himself wrote verses occasionally. He also sometimes wrote articles on the political and financial questions of the day, and contributed moral essays to the Portfolio, under the signature of "Eldred Grayson."

In person he had a robust frame, a large head, and an imposing figure and presence.

In his family and among his friends, according to Prof. Silliman, he was very kind, and his feelings were generous, amiable, and genial; yet, in the absence of mind occasioned by his habitual abstraction, and when absorbed in thought, his manner was occasionally abrupt. With his keen and active mind, conversation would sometimes seem to awaken him from an intellectual reverie. He had great colloquial powers, but to give them full effect it was necessary that they should be aroused by a great and interesting subject, and the effect was heightened by the injection of antagonism. He would then discourse with commanding ability, and his hearers were generally as ready to listen as he to speak. He was a man of unbounded rectitude, a faithful friend, and a lover of his country and its best interests, without thought of personal emolument or political advancement. He was a voluminous scientific writer. For many years his contributions to the American Journal of Science were more numerous than those of any other correspondent. The full list of them includes about one hundred and fifty articles, in forty-eight volumes of that journal, the record of the titles of which occupies five columns in the General Index of the first fifty volumes. Besides notices of the various substances he discovered or experimented with, and descriptions of apparatus, we find among these articles some that touch the principles of chemical and physical philosophy—as on the nature of acids and salts; concerning Faraday's views on atoms; on chemical nomenclature, a subject which is also discussed in a letter to Berzelius; on some inferences from the phenomena of the spark in Thompson's work on heat and electricity; on the error that electric machines must communicate with the earth; on a new theory of galvanism; on the cause of heat; a reply to Prof. D. Olmsted's views on the materiality of [illegible]

Reply to Matter is Heavy, as demonstrated by W. Whewell; on meteorological topics—storms of the Atlantic coast; reviews of Redfield's theory of storms and of Dove's essay on storms; an account of a storm or tornado in Rhode Island, August, 1838, "and others"; on Causes of Storm, Tornado, and Water-spout; among accounts of experiments and new methods—blasting rocks by galvanic ignition; apparatus for producing ebullition by cold; process for fulminating powder, consisting of cyanogen and calcium; mode of obtaining the specific gravity of gases; analysis of gaseous mixtures; method of dividing glass by friction; and apparatus for decomposition and recomposition of water. He was also author of a Brief View of the Policy and Resources of the United States (1810); Chemical Apparatus and Manipulations (1836); Compendium of the Course of Chemical Instruction in the Medical Department of the University of Pennsylvania (1840); Memoir on the Explosiveness of Niter (1850); and Spiritualism Scientifically Demonstrated (1855).

He was a member of the American Academy of Arts and Sciences and of the American Philosophical Society, and was one of the few life-members of the Smithsonian Institution.

In his geological explorations of the basin of the Red River of the North through six seasons, Mr. Warren Upham has paid careful attention to the geographic limits and relative abundance of both native and introduced plants. "It has been interesting," he says, "to find there the intermingling and the boundaries of species whose principal homes, or geographic range, lie respectively in the direction of the four cardinal points, east and west, and south and north." After describing this diversified vegetation in detail, the author concludes that besides the greater part of our flora which is of northern origin, coming to us from an ancestral flora that probably in the beginning of the Quaternary period occupied continuous land around the globe in high northern latitudes, the plants of the Red River basin include many species derived, as Gray and Watson have shown for a large portion of the flora of California, the Great Basin, and the southern Rocky Mountain region, from the plateau vegetation of Mexico. By the return of a warmer and drier climate in the southwestern United States, following the Ice age of the North, our cactus species, petalostemons, and onagraceæ, many of our compositæ, the milkweeds, and many more, have been enabled to spread from their original Southwestern and Mexican home-land, becoming a most important element of the flora of all the plains and prairie region to the Saskatchewan and Red Rivers, and gaining a less numerous representation in the wooded country east to the Atlantic coast. How these Northern and Southwestern floras have become intermingled, the geographic limits of separate species, and the gradual changes observable in the specific characters of some of our plants in passing between distant parts of their range, are themes of sufficient interest to repay the careful observations of amateur botanists in all parts of our country. In these directions important additions to botanic science may be made by many who have neither leisure nor ability for valuable biologic study of plants, but who love the search for wild flowers.

CORRESPONDENCE.

RECENT GLACIAL RESEARCHES IN ENGLAND.

THOSE readers of the Monthly who may be interested in the subject of glacial geology will recall a brief sketch of recent glacial discovery in England published in the December number. The article included a map of the glaciated areas of Great Britain and Ireland, prepared for Prof. G. F. Wright's new book, Man and the Ice Age, by Prof. Percy F. Kendall, of Leeds, England. We have, since the article was published, received a letter from Mrs. H. Carvill Lewis, calling attention to "a few slight inaccuracies contained in it." We regret that the whole letter is longer than we can make room for, but we give the most important points of it. "In the first place," Mrs. Lewis writes, "reference is made to the completion of my husband's 'field notes under the joint editorship of the Rev. Dr. Crosskey and Prof. Kendall'—now of Leeds. The truth of the matter is, that Prof. Kendall's only contribution to the volume is a short introduction containing a *résumé* of his own observations during the last three years—many of which seemed to throw light on the vexed questions of British glacial geology which my husband had attempted to solve. To the best of my knowledge, Prof. Kendall never saw my husband's manuscripts, and the onerous task of arranging the large collection of unfinished papers and diagrams was a labor of love on the part of the Rev. Dr. Crosskey, of Birmingham, who undertook it in compliance with my husband's parting request. The volume in question consists of a full introduction—written partly by Dr. Crosskey and partly by myself—which is followed by notes and observations made by my husband in this country [England, where Mrs. Lewis is at present residing], and then by two appendixes. The first appendix is by Prof. Kendall, as I have said; and the second, which was compiled by myself at Dr. Crosskey's request, consists of such abstracts from my husband's continental work as promised to throw light upon the problem of glacial action in Great Britain. In connection with my husband's explorations in Pennsylvania, I may state, in passing, that it was only over the *last third* of the work that my husband had the pleasure and benefit of Prof. Wright's companionship; all the foregoing portion of the terminal moraine was traced by himself alone. Further on in your article I find the remark that, 'upon completing this work [the tracing of the moraine in Pennsylvania], the two professors, *by previous arrangement*, divided the work of exploration—Prof. Wright carefully surveying the line westward, etc., while Prof. Lewis went to England to do the work of which we have spoken there.' Now as I had the privilege of sharing all Prof. Lewis's thoughts and plans since before he had the honor of making Prof. Wright's acquaintance, I can confidently state that when the work in Pennsylvania was brought to a close in 1881, my husband had no idea whatever of going to England, and that it was not till the summer of 1884 that he gave the matter serious thought."

With regard to Prof. Wright's participation in the Pennsylvania survey, Prof. Warren Upham is quoted in the sketch of Prof. Henry Carvill Lewis, published in The Popular Science Monthly for July, 1889, as saying—a statement to which no exception has ever been taken: "Prof. Lewis first became specially interested in the glacial drift and its terminal moraine during the latter part of the year 1880, when, in company with Prof. G. F. Wright, he studied the remarkable osars of Andover, Mass.; the gravel of Trenton, N. J., containing palæolithic implements; the drift deposits of the vicinity of New Haven, Conn., under the guidance of Prof. Dana; and, finally, the terminal moraine in eastern Pennsylvania between the Delaware and Lehigh Rivers. The following year Profs. Lewis and Wright traversed together the southern border of the drift through Pennsylvania from Belvidere on the Delaware, west-northwesterly more than two hundred miles, across the ridges of the Alleghanies to Little Valley, near Salamanca, N. Y., and then southwesterly one hundred and thirty miles to the line dividing Pennsylvania and Ohio, which it crosses about fifteen miles north of the Ohio River." This fully substantiates Prof. Wright's claim that he accompanied Prof. Lewis in Pennsylvania everywhere except through small portions of Northampton and Luzerne Counties and through the region extending from Pine Creek in Lycoming County to Olean in New York—or was with him through more than three fourths of the distance.

It is probably too much to say that Prof. Lewis definitely laid his plans, while engaged with Prof. Wright in the Pennsylvania survey, to make a glacial survey in England like what they were then doing in the United States; but we understand that the matter was frequently talked over by them, and was more than once introduced by Prof. Lewis. His subsequent work was mostly in the line of what he had often said remained to be done in Great Britain and ought to be done.

Mrs. Lewis makes some [illegible] of the map published with Prof. [illegible] and protests that it "[illegible] be taken to represent my husband's personal observations as to the extent and limits of the several glaciated areas, as it bears little or no resemblance to the records which he has left of them"; and she proceeds to point out some of the points of difference, particularly in Ireland.

The map does not profess to be that of Prof. Lewis, but represents the work as completed in England by Prof. Kendall. Very likely it is imperfect in Ireland, but it gives the general facts as well as could be done before Prof. Lewis's notes are published.

We are pleased to learn from Mrs. Lewis's letter that the manuscript of her husband's book has gone to press.—Editor.

HABITS OF POGONIA OPHIOGLOSSOIDES.

Editor Popular Science Monthly:

Sir: In reading the very interesting article in your November number, Color in Flowering Plants, I am at a loss to understand the author's description of the orchid *Pogonia ophioglossoides.*

She says, "There is no other pogonia . . . which has its leaves *whorled* on the stem," and speaks of its "greatly elongated sepals and three-parted corolla—all *green*," etc. She also describes it as growing in the same places as the "much more abundant Indian cucumber," and as resembling it much more closely than allied orchids. It grows quite abundantly in Nantucket, but I have never found it there with whorled leaves, green flower, or growing with the medeola.

On the contrary, its single leaf, growing midway on the slender stem, first attracted my attention as distinguishing it from the *Calopogon*, of which, at first glance, I took it to be a faded specimen. I have frequently found them growing together, and have mistaken one for the other.

Gray's Manual describes exactly the species I have found as *Pogonia ophioglossoides*, so I can not think it a "form" peculiar to Nantucket. I am, therefore, considerably puzzled to account for the discrepancies, and should be glad to be enlightened.

Mabel P. Robinson.

El Mora, N. J., *October 28*, 1892.

EDITOR'S TABLE.

THE EVERLASTING GHOST.

THE believers in ghosts are just now jubilant over some anticipated revelations to be made through the medium of photography. In a recent number of the Fortnightly Review the Rev. H. A. Haweis has a long article under the title of Ghosts and their Photos. He introduces the subject by a historical survey, intended to show the inextinguishable character of the ghost. Ancient history certainly does furnish a vast amount of grist for the spiritualist mill, and the Rev. Mr. Haweis lays hold of it all. The angels that appeared to Jacob were real ghosts; the prophets were mediums; Elijah was in very truth "levitated"; so also was Philip the evangelist; so also was Francis of Assisi; the "tongues" at Corinth and the tongues among the Irvingites bespoke real possession, not mere disorder of the brain; the saints did actually come out of their graves at Jerusalem and still more or less keep up the practice. All these things, and a thousand more, added to "the raps, the lights, and the materializations" of the modern *séance*, compose, in the opinion of the reverend gentleman, such a mass of evidence in favor of ghost activity in connection with human affairs that to doubt any longer becomes a little ridiculous. We fear the stigma is one which must continue to attach to ourselves for a little while longer, at any rate. Our obstinate incredulity is not shaken even by the statement, given on the authority of the Psychological Society, that out of seven thousand sane persons one woman in twelve and one man in ten had had "experiences of an occult character." We are simply moved to congratulate the gentler sex on their appreciably more restricted converance with the works of darkness—for we suppose the term can not be altogether inapplicable to "experiences of an occult character." It may curdle the blood of some to read that "you can visit no part of

England, Scotland, or Ireland without finding, on inquiry, that within a radius of ten miles there is some house or place said to be haunted; some house that either can not get, or can not keep, tenants on account of ghosts," but to us—we can not help it—the statement simply seems a lamentably silly one for a man of so much general intelligence as the Rev. Mr. Haweis to have made.

However, the great evidence is yet to come: the ghosts are going to sit for their photographs. Whether the photographer will have to be a medium or not does not distinctly appear, but the ghosts will, in a short time, distinctly appear. Mr. Stead is working up this part of the case with unbounded zeal and faith, and the Rev. Mr. Haweis is quite confident the ghosts are going to come out all right. "Many photographers," we read, "are in the habit of casting aside plates after partial development, because they have what they call a fault—that is, a blur or marks obscuring or occupying portions of the plate. Photographers will, in future, perhaps be more wary. I heard the other day of a young lady who was photographed at Brighton, I believe, and twice the plate came out blurred. The second time she persuaded the photographer, who was about to lay it aside as useless, to develop it. The blurs, on being examined with a magnifier, proved to be faces—all the same face. She at once recognized it as the face of a rejected lover who had died." Why this young man took up the plate with so many different specimens of his face, and how he managed to prevent the rest of his spectral body from being taken, and why he stood so far away from the beloved one as to come out so small that he had to be explored with a magnifier, are questions on which, we fear, it would be vain to expect any light. Was he all "face" in his lifetime? Did the minuteness of his spirit image signify the smallness of the place he had held in the young lady's affection; or did the stand he took far in the background signify the distance at which the young lady had kept him? It is said the young lady recognized the likeness; but was this young lady wholly veracious, or was she indulging a fond fancy that the swain was still hovering round her with his face? We read sometimes of faces in the fire; and Hamlet, if we remember rightly, succeeded in getting the wise Polonius to see in a cloud the image, first, of a camel, then of a weasel, and, lastly, of a whale. As the old man gazed, conviction grew, so that in the end he was able to say with emphasis, "*Very* like a whale." Who knows but that, as the young lady gazed, conviction may have grown in like manner, and the blur have passed through various phases before it finally came out a rejected lover? One asks where this wonderful thing happened, and all Mr. Haweis can tell us is that he "believes" it was at Brighton. Perhaps so; but until the place can be given with a little more certainty, and until a good deal of corroborative evidence is forthcoming, we prefer to assign the chief share in the whole business to the young lady's imagination and the remainder to somebody else's credulity.

We are asked to believe in ghosts because in every age there have been ghost stories. But would it not be more natural to suppose that in every age the human mind has been subject to aberrations, and that some specific weakness or irregularity of the mental constitution, or of the physical organ, the brain, on which all thinking, so far as we are aware, depends, has probably given rise to this particular class of hallucinations? We can not pretend as yet to know the mind thoroughly in health and disease; but this we do know, that there are thousands and millions of persons whose lives are never intruded on by ghosts, and who know absolutely nothing of "occult" phenomena. According to the reverend gentleman's own figures, only one woman in twelve and one man in ten has had any "occult" experiences. Now, what we should like very much to have would be a further analysis of these figures, showing the percentage of flighty or otherwise ill-balanced minds among the "occult" and the "non-occult" (if we may so apply the words) classes respectively. Our own experience would lead us to believe that the proportion would be vastly larger in the former class than in the latter. Who has not known many examples of the tremulous, nervous, hypersensitive, wonder-loving, hysterical, or semi-hysterical type of constitution among the devotees of ghost lore? And if such examples occur, as we believe they must, to the mind of every one, is it not at least a probable inference that "occultism" in its various phases has something to do with that kind of mind? The ghost may be very ancient, but we do not believe in him the more. The trouble about him is that he has made no progress since the earliest times; in fact, on the whole, he has fallen back. We should not be disposed to talk of the "levitation" of Elijah ourselves had not the reverend Mr. Haweis used the term before us; but if, following the reverend gentleman's lead, we consider the prophet's alleged translation in that light, surely it was a most successful feat in "levitation," and a little ahead of anything the modern world can show. And, speaking generally, the apparitions and visions and other spiritual or occult phenomena of ancient times had more "body" to them than those of our own day. If, therefore, the ghost has made no progress in the course of three or four thousand years, if he is just as uninstructive and inconsequent a phenomenon now as he was when we first encountered him, if not a little more so, we may perhaps be pardoned for thinking that he may be safely and fairly ignored by people who have an average amount of business to attend to. The world is still waiting for the very first message of any practical importance coming from a well-authenticated ghost, and, considering that ghosts, such as they are, have been coming and going for some thousands of years, it is high time, if they have anything to say, that they said it. We are sadly in want of light on many matters, and a well-informed ghost might conceivably be of very great assistance in human affairs. Up to the present, however, all our light and knowledge have come from patient study of the laws of Nature; and, such being the case, we prefer to stand in the paths that Science has worn and work at the tasks she assigns. Even if the ghosts succeed in getting themselves photographed, we shall not trouble ourselves much about them, till we see what the practical bearing of the whole business is. If we might venture a prediction, it would be that ghost photographs will turn out to be an utter fraud, and that, when the matter has been thoroughly explored, one more lesson will have been given to the world as to the delusive character of "occultism" in all its shapes and forms.

A SHATTERED ARGUMENT.

Many of our readers will remember the very truculent attack made by the Duke of Argyll upon Prof. Huxley in connection with the latter's demonstration of the impossibility of the Noachian Deluge. Among the proofs of that catastrophe adduced by his Grace was the existence high up on the Welsh hills of large beds of comparatively recent marine shells. The sea had been there on the mountain tops, exclaimed the Duke in triumph, and that quite recently. One of two things, therefore, had happened: either the sea had been raised over a thousand feet above its present level, or the land had been suddenly depressed to that extent, either of which occurrences would produce a first-class flood. But what do the most recent investigators, the late Prof. Carvill Lewis and Prof. G. F. Wright, tell us on this point? The answer is furnished in our issue for December, a paragraph of which we may here quote:

"This evidence" (viz., for a recent submergence, as supposed by the Duke of Argyll and others) "consisted of shell-beds inclosed in true glacial deposits eleven hundred feet above the sea at Macclesfield near Manchester, and fourteen hundred feet above the sea at Moel Tryfaen, on the northern flanks of Snowdon in Wales. Prof. Lewis and those who have followed out the clews which he started, have proved that these shell-beds were not direct deposits during a submergence of the country, but rather beds washed out of true glacial deposits which had been shoved along by the ice in its passage over the bottom of the Irish Sea. The shells were pushed up with the mud from the sea bottom, as pebbles are known to have been in so many instances. The melting of the ice furnished the water necessary for partially working over the original deposit and sorting out and stratifying the inclosed gravel and shells."

A proof that this is the true explanation is that "the shells are not such as would haunt the same place under water. In these beds rock-haunting and mud-loving species and shallow-water and deep-water species are indiscriminately mingled together."

We see here once more the value of close and thorough observation. No point in scientific theory should be considered settled till all the facts are in. If the Duke of Argyll wants to prove that the whole of England got a dip in the days of the patriarch Noah, say about five thousand years ago, he will have to look about for other arguments. As the case now stands, the shells to which he pointed so triumphantly tell an altogether different story.

STOVES WITHOUT FLUES.

There has recently appeared a fresh illustration of "what knowledge is of most worth" in the dangers that come from the pitiful ignorance of the simplest facts of science still prevailing among presumably well-informed persons. Certain "patent fuels" have been put on sale, to be used in stoves without chimney connection, and are advertised as being entirely harmless. The natural result has followed. Gullible merchants, ministers, and even doctors have been buying them and nearly smothering themselves or their friends with the gases which must result from the combustion of any form of carbon. The makers of these fuels state that ventilation is required with their apparatus, but their customers reason, Why let in the cold air if the fuel is harmless, as stated? or they imagine that one opening from a room into a hallway secures "ventilation." Probably most of the victims of the patent fuels have read about the process of combustion, but they have not learned its nature from experiments that would make this knowledge real to them. Their education has been of the antiquated but not yet abandoned kind which substitutes the study of books for the study of things. As an explorer who tries to cross a deep river is drowned if he can not swim, so any one who lives in the present age, when natural forces are being put to service as never before, is badly off if he does not understand how to use these forces without letting them overwhelm him. Science is doing many wonderful things in these times, but its achievements always consist in employing the laws of Nature, never in circumventing them.

LITERARY NOTICES.

The Lost Atlantis, and other Ethnographic Studies. By Sir Daniel Wilson. New York: Macmillan & Co. Pp. 402. Price $4.

This is a posthumous work, completed in accordance with the author's desire by his daughter. It is described in his note-book as "a few carefully studied monographs linked together by a slender thread of ethnographic relationship." The thread scarcely as it seems susceptible of description, assumes the form of an inquiry into the probability of there having been any relationship between the developments of primitive Old World and of aboriginal New World civilization. The first essay, which gives its title to the book, embraces a critical inquiry into the origin of Plato's story of Atlantis—which is left in the great philosopher's imagination—a discussion of the legends that have been current on the subject, a presentation of scientific evidence as being decisive against such a land having ever existed; and the conclusion—while the admission is made and even the belief is avowed that the Phœnicians may have visited America, and evidences of their presence here may yet be found—that ancient American civilization was native. In the next essay, the discovery of America by the Northmen and their attempts at colonization are accepted and discussed as established facts. The essay on Trade and Commerce in the Stone Age concerns the whole world, while the evidences of trade relations between different parts of America are considered in it in full. The conclusion is expressed that the exceptional aptitude of skilled workmen was recognized and brought into use for the general benefit, and co-operation and the division of labor were known at a very early stage in the development of primitive mechanical art; that materials for manufacture were transported from remote localities, and the exchange of products was facilitated by professional traders. The native origin of American civilization is again taken up in the essay on Pre-Aryan American Man. The succeeding essay is concerning the Æsthetic Faculty in Aboriginal Races; and in the following one the Huron Iroquois are presented as a typical American race. In the paper on Hybridity and Heredity the idea, fostered by Morton, of an approximation of the Anglo-American to the red Indian type is rejected; and an interesting speculation is suggested of the future of the colored race in this country, which, left free, as it now is, to enjoy the healthful social relations of a civilized community, and protected by prejudice from any large intermixture with the white race, will survive distinct. In the last paper, on Relative Racial Brain-weight and Size, the conclusion is reached that in the remarkably exceptional characteristics established by the study of certain Peruvian crania, "we have as marked an indication of a distinctive race-character as anything hitherto noticed in anthropology."

Creation of the Bible. By Rev. Myron Adams. Boston: Houghton, Mifflin & Co. Price, $1.50.

The author of this book is a Congregational clergyman, and he has given an excellent summary of the results of the "higher criticism." He follows Kuenen and Wellhausen, chiefly, in his views of Israelite history, beginning with the prophecies of the eighth century B. C. as a basis, and working back to the origin of the nation and forward to the introduction of Christianity. He thinks that Genesis is largely mythical, and was not composed till the Babylonish exile. He rejects the Mosaic authorship of the Pentateuch, and ascribes its composition to several authors between the sixth and eighth centuries B. C. The creation of the Bible, in fact, began with Ezra, the scribe, after the Babylonish exile. Prior to that time the sacred books of the Jews were lightly esteemed, and were tossed from pillar to post, but Ezra and his associates gathered them into a canon. The prophecies are the earliest and most reliable books of the Bible. The older parts of Genesis are products of oral tradition. The Levitical law and priesthood were not established in Israel until after the exile. Amos was the first prophet, Hosea came next, Joel and Malachi about two and a half centuries later. Isaiah wrote the first part of the book bearing his name, but the latter part was written by an unknown prophet of the exile. One of the most interesting chapters of the book is that entitled "From Gods to Gods," in which Mr. Adams shows that Israelite monotheism was developed from fetichism and idolatry. The prophets were the originators of monotheism in Israel, not Abraham, as is popularly supposed. The prophets also attacked the bloody sacrifices of the people. Human sacrifice was often practiced, even as late as Micah's time, for he protested against it. Jephthah offered his daughter in sacrifice to Jehovah; Samuel hewed Agag into pieces "before Jehovah"; and Abraham was tempted to sacrifice Isaac.

The books of Job and Daniel are "fictitious." They are not false, but they are true only in the sense that novels, poems, allegories, and parables are true. Job is a magnificent poem and a profound piece of philosophy, written by some unknown sage at an unknown date. Daniel is one of the several apocalypses which appeared about B. C. 150, called forth by the sufferings of the Jews under their Greek oppressors. The author thinks that David did not write many if any of the Psalms, and they were attributed to him simply because he was Israel's greatest king, a lover of music, and the patron of poets and prophets. "The real power of the Old Testament is in its poetry," but we must "resolutely reject" many of the sentiments of the Psalms, such as their imprecation of divine wrath upon the enemies of Israel. Mr. Adams gives a fine sketch of the Persian, Greek, and Roman influence upon the Jewish nation and religion. It is commonly believed that Judaism degenerated between the exile and the birth of Jesus, but our author rightly says, during that period "the principal preparation was made for the introduction of Christianity." The Holy Scriptures were translated into Greek; synagogues were built in Alexandria and wherever the Jews were dispersed and settled. Their ideas of the world were broadened and their religious views were liberalized. Devout and learned scribes traveled from place, to place teaching the people. The Pharisees, Sadducees, and Essenes propagated various phases of religious belief and practice. The book of Ecclesiastes, written about 200 B. C., and therefore not by Solomon, shows us the effect Greek philosophy had on Jewish thought. It produced pessimism. "When the fullness of the times was come," God sent forth the great teacher of Nazareth to fulfill the law and the prophets. Mr. Adams accepts the critical and rational view of the Gospels, concluding that they were compilations by unknown authors from oral tradition and perhaps written sources, between A. D. 70 and 150.

All "miracles" are rejected, except those that may be explained as extraordinary natural events. The bodily resurrection of Jesus and his birth of a virgin, in particular, are denied, and Mr. Adams thinks that a better statement of the Incarnation is a necessity. Commenting upon the doctrine of the Logos in the Johannine Gospel, he says: "The Word which has always been with God and is God becomes the rocks of the world, the water of the oceans, the stars of the sky, and in due process becomes flesh and dwells among us, full of grace and truth. Nothing is made without the Word. Jesus," he adds, "certainly did not build the worlds, but that manifesting Spirit, which became flesh in him, has always been uttering God."

On the whole, this book accomplishes its purpose very satisfactorily. The writer covers a large field, and it is remarkable that he has made no more mistakes than he has. His thought is clear and suggestive; his style easy and flowing; his spirit earnest and reverent; his conclusions judicious and undogmatic. Those who are not familiar with the subject treated will find the book very instructive; and those who are well versed in such matters will find it a good summary of scholarly opinions on the most important religious problems of the day. If Mr. Adams had appended a list of such authorities as those mentioned in the preface, he would have added to the value of his book, for one of the chief functions of such books is to make their readers read further and more thoroughly.

The Chemical Basis of the Animal Body. An Appendix to Foster's Text-book of Physiology (sixth edition). By A. Sheridan Lea, D. Sc., F. R. S., University Lecturer in Physiology in the University of Cambridge, etc. New York and London: Macmillan & Co., 1892. Pp. 268. Price, $1.75.

Heretofore the chemical basis of the animal body has been presented in a brief appendix incorporated with the final book of Prof. Foster's Text-book of Physiology. But the advances of science, as well as the demands for more thorough knowledge, have expanded the fifty pages that sufficed, in the former editions of that text-book, to describe this subject, into the present volume. Dr. A. Sheridan Lea was the author of that appendix, as he is of this volume that constitutes a treatise on the chemical substances occurring in the animal organism.

In the first portion of the volume we find the section on proteids enlarged by the addition of the discoveries that have been made regarding these substances; methods of preparation are clearly and concisely described, and the various reactions are explained. The section describing peptones now includes albumoses, that are classed with the former, both on account of their close relationship and for convenience. The author calls attention to the fact that various substances that have been described as peptones have consisted, to an extent at least, of a mixture of true peptones with variable quantities of albumoses, and that our knowledge of true peptones is at present in a state of transition. In fact, as he truly states, until some new property of proteids is discovered by which their absolute purity may be determined, the question of the constitution of proteids will probably remain unsolved.

A new section is added on the enzymes, in which we find descriptions of trypsinogen, pialyn, rennin, muscle-enzyme, and urea-enzyme.

In the section on the nitrogenous non-crystalline bodies allied to proteids, descriptions of the mucin of bile, of that of the submaxillary gland, and of that of the umbilical cord, of gelatin-peptones, of neurokeratin, of chitin, and of nucleo-albumins have been added. In the section on carbohydrates the dextrins are now well described; while the sugars are satisfactorily explained by Emil Fischer's able researches regarding the several members of this class of carbohydrates.

In the sections on the fatty acids and fats, on the amides and amido-acids, on urea and the uric-acid group, on the bile acids, and on the coloring matters and pigments of the animal body, much recent material has been incorporated, while a brief section is devoted to ptomaines and leucomaines.

The volume is a most useful addition to the literature of the subject; the numerous references it contains will permit the student to consult original authorities should he so desire; while in general an immense amount of time will be saved for those studying this subject by this collocation of results that are scattered throughout medical literature.

English Classics for Schools. New York: American Book Company, 1893.

An admirable idea is embodied in the series of English Classics for Schools of the American Book Company—a series in which the masterpieces of English literature are presented in attractive form for reading in class or for supplementary reading. Of this series there are now sent to us Ten Selections from the Sketch Book of Washington Irving, Shakespeare's Tragedy of Julius Cæsar, and his Comedy of Twelfth Night, at the price of twenty cents each, and Sir Walter Scott's Ivanhoe at fifty cents. With the text are given brief notices of the author, with analyses of the particular works.

Finger Prints. By Francis Galton. New York: Macmillan & Co. Pp. 216. Price, $2.

Mr. Galton's attention having been directed to the individuality and significance of the marks made by the tips of the fingers, he was surprised when he came to inquire into the subject at perceiving what had been done, and what a promising field of inquiry still lay in it. He found it of real importance and investigated it, with results, truly curious and valuable, which are given in this book. The account begins with notices of the previous employment of finger prints among various nations, with objects partly superstitious and partly ceremonial; then various methods of making good prints are described at length; next, the character and purpose of the ridges, whose lineations appear in the finger prints, are discussed. These preliminary topics having been disposed of, the inquiry proper begins with a discussion of the various patterns formed by the lineations, illustrated by plates of the principal varieties. The question is raised as to the persistence of the patterns, or whether or no they are so durable as to afford a sure basis for identification, and is answered, except as to proportions, in the affirmative. An attempt is made to appraise the evidential value of finger prints by the common laws of probability. A succeeding chapter deals with the frequency with which the several kinds of patterns appear on the different digits of the same person; and in it unexpected relationships and distinctions are established between different fingers and the two hands. Methods of indexing are discussed and proposed, by which a set of finger prints may be so described that it may easily be searched for and found in any large collection. The practical results of the inquiry are discussed as to its possible use in differentiating a man from his fellows; and the finger prints are found to afford one of the most certain marks of identification. The question whether patterns are transmissible by descent is answered affirmatively; and this leads to the estimation of their use in indicating race and temperament. In the last chapter the right is discussed of the nine fundamentally differing patterns to be considered as different genera, and of their more characteristic varieties to rank as different genera or species, as the case may be, with affirmative conclusions.

Sound and Music. By the Rev. J. A. Zahm. Chicago: A. C. McClurg & Co. Pp. 452. Price, $3.50.

The author of this work is Professor of Physics in the University of Notre Dame. The main purpose of the book is to give musicians and general readers an exact knowledge, based on experiment, of the principles of acoustics, and to present at the same time a brief exposition of the physical basis of musical harmony. The author believes that, in view of the attention now given to theoretical as well as practical music in European and American conservatories, this presentment can not be considered altogether untimely. The treatise is based on the recent and most exact observations of modern physicists, most prominent among whom are Helmholtz and Koenig, as well as the works of the older acousticians, and is intended to include a summary of all that has been learned and determined down to the date of publication. To Koenig, the latest of these investigators, and the one probably who has carried our knowledge of the philosophy of music to the most successful results yet obtained, personal obligations are acknowledged. The volume has grown out of a course of lectures that were given in 1891 in the Catholic University of America, Washington, D. C. These, however, have been thoroughly revised, with the purpose of making the exposition of the subject more complete than was possible in lectures actually delivered, so that it is practically a new work. Yet the lecture form has been retained as being more animated and picturesque, and more in keeping with the character of a work that deals so largely with apparatus and experiments. Of the illustrations and experiments many were prepared expressly for this work, while others are to be found only in the more recent French and German treatises on sound and music. The first chapter, beginning with a reference to the relation of the science to the art of music, is devoted to the explanation of the Production and Transmission of Sound and the Nature of Sonorous Vibrations. In the next two chapters the laws of Loudness or Intensity of Sound and Pitch are considered, with a description of Koenig's *Grand Tonomètre Universel*, and the subjects of Velocity, Reflection, and Refraction of Sound. The topics of Musical Strings, Vibrations of Rods, Plates, and Bells, and Sonorous Tubes follow; after which come the theoretical subjects of Resonance and Interference, Beats and Beat-tones, the Quality of Sound, and Musical Intervals and Temperament.

Text-book of the Embryology of Man and Mammals. By Dr. Oscar Hertwig, Professor Extraordinarius of Anatomy and Comparative Anatomy, Director of the II Anatomical Institute of the University of Berlin. Translated from the third German edition by Edward L. Mark, Ph. D., Hersey Professor of Anatomy in Harvard University. With 339 Figures in the Text and Two Lithographic Plates. London: Swan, Sonnenschein & Co. New York: Macmillan & Co., 1892. Price, $5.25.

The fact that this work possessed sufficient merit to go through three editions in German in the four years following its first publication, implies an intrinsic merit; for there is no paucity in the literature of this subject, while the new discoveries that are constantly being reported by investigators tend to make a comparatively recent book behind the times, speaking from a scientific standpoint.

In the first chapter the sexual products are described, and following this is an explanation of the phenomena of the maturation of the egg and of the process of fertilization, the author presenting the theory that the female nuclear substance transmits the peculiarities of the mother, the male nuclear substance those of the father. This is an expansion of the theory of fertilization into one of transmission.

We do not think that the translator has been felicitous in his choice in using the term "process of cleavage" [illegible] usual term of segmentation of the ovum, even though he has the precedence afforded by Prof. Huxley's employment of a term that should have been left to its original scientific use in geology and mineralogy.

The methods of development of the two primary and of the two middle germ layers—the so-called gastræa theory and cœlom theory—are presented in separate chapters. The author maintains that at the close of segmentation there is only one germ layer present—the epithelium of the blastula. From it the remaining germ layers arise by the processes of invagination and evagination—the inner germ layer being formed by means of gastrulation, the two middle germ layers being formed by the formation of the body cavities, in that two body sacs are evaginated from the cœlenteron and grow out between and separate the two primary germ layers. After their origin the middle germ layers are differentiated into several fundaments (rudiments) by processes of folding and constricting off.

The development of the connective substance and blood is explained by means of the mesenchyme germs. This is followed by chapters on the establishment of the external form of the body and on the fœtal membranes of reptiles, birds, mammals, and man.

The consideration of the science of the embryology of organs is divided into four sections, comprising the morphological products of the inner, of the middle, of the outer, and of the intermediate germ layers. This is, of course, an arbitrary division, for the teeth arise from the intermediate and the outer germ layers, while the alimentary canal and its glands contain elements from the inner, middle, and intermediate layers.

Space forbids any extended consideration of the features pertaining to these latter topics. The work is certainly a comprehensive presentation of the subject, and the translator has performed his arduous task in a satisfactory manner.

Commercial Organic Analysis. By Alfred H. Allen. Volume III, Part II. Philadelphia: P. Blakiston, Son & Co. Pp. 584. Price, $5.

Each successive portion of this valuable work testifies to the masterly ability with which its author has handled a large and difficult undertaking. The present part deals with Amines and Ammonium Bases, Hydrazines, Bases from Tar, and Vegetable Alkaloids. The substances of chief commercial importance that are treated are, therefore, drugs, such as aconitine, atropine, cocaine, morphine, quinine, and their allies; the alkaloids of coffee, tea, and cocoa, and the aniline colors. Substances of special interest at the present time which fall within the scope of this part are antipyrine and certain other antipyretics. A third part of Volume III is to be issued to complete the treatise, and it is gratifying to note that the success of the work in its enlarged form warrants the author in announcing a new edition of the earlier volumes.

Railway Injuries, with Special Reference to those of the Back and Nervous System, in their Medico-legal and Clinical Aspects. By Herbert W. Page. New York: William Wood & Co. Pp. 157.

The aim of this book is to give an account of the injuries received in railway and similar accidents that become the subject of medico-legal inquiry. The author has long been a student of this branch, having published in 1883 a work on Injuries of the Spine and Spinal Cord and Nervous Shock, to which he had given several years of preparation, and having continued his observations since. While injuries of all kinds and degrees are caused by railway accidents, they do not differ for the most part from those which are seen after other forms of violence. Even the injuries in the back received in railway accidents do not differ from similar injuries received in other ways; but their frequency, and the character they impress on the features of many other forms of injury, demand for them a place by themselves. It is, in fact, a peculiarity of railway accidents that these injuries of the back are nearly always produced, whatever other injuries may occur, and even though there may not be other injury; that the patient is often not aware of them till some time afterward, and that their direct and indirect effects are often widespread and long continued. Vastly more numerous and even more important than these are the cases of "general nervous shock"—an unprecise term applicable rather to the whole of the clinical circumstances of the case than to any one symptom which may be presented by the injured person. The characteristics of the cases described by it indicate some functional or dynamic disturbance of the nervous equilibrium or tone, rather than structural damage to any organ. Another class of effects is included under the designation of fright neurosis or traumatic hysteria. The diagnoses of these phenomena are complemented by the citation of considerable numbers of cases which illustrate the almost capricious variety of the forms under which they are manifested. In treatment a pre-eminently important factor is rest; but, besides this general remedy, there are special forms of affection that require special applications. The mental condition is all-important; and in this connection special stress is laid upon the effect of the expectation of compensation, and upon malingering, into which the patient is to a greater or less extent seduced unintentionally and unconsciously by the trend of his thoughts and fancies; so that complete recovery is not assured till the mind is cleared, to which payment of damages contributes greatly; yet this is predicated without reflection on the character, motives, or entire honesty of the patient. The closing chapters are devoted to the discussion of this branch of the subject in its medico-legal aspects.

A Text-book of Physiology. By M. Foster, M. A., M. D., LL. D., F. R. S., Professor of Physiology in the University of Cambridge, etc. Sixth edition, revised. Part IV. London and New York: Macmillan & Co., 1891.

This part of this excellent text-book treats of the physiology of the various senses, of that of certain special muscular mechanisms, as of the voice, of speech, and of locomotion; of the tissues and mechanisms of reproduction, including impregnation, menstruation, pregnancy, parturition, the phases of life, and death. Preceding the physiology of each organ there are descriptions of its anatomy and histology, as in the other parts of this work.

The great caution that Prof. Foster displays throughout the work in judicially presenting both sides of a moot point is well shown in the section on color sensations. Both the Young-Helmholtz and the Hering theory of color perception are explained, but the author is inclined to accept the latter, both because there is a recorded case in which only white and black could be seen, and because the phenomena of peripheral color vision better accord with Hering's theory.

In the chapter on hearing the author states that the exact nature of the process by which the vibrations of the perilymph, produced by waves of sound, give rise to auditory impulses is uncertain. Even accepting the theory that the basilar membrane may be considered as consisting of a number of parallel radial strings, each capable of independent vibrations, the other structures in the auditory epithelium present problems that are as yet unsolved; for the true function of the rods of Corti and of the reticulate membrane of which these form a part, of the cells of Deiters, and of the inner as distinguished from the outer hair-cells, are yet unknown.

The author considers, in the section on taste and smell, that certain recorded cases lead to the provisional conclusion that the gustatory fibers are fibers belonging to the fifth nerve, though they may reach the tongue partly by way of the glosso-pharyngeal, partly by way of the chorda tympani nerves.

While we agree with the author that cutaneous pain is a separate sensation, developed in a different way in the skin than is pressure or temperature sensation, we think that he should have laid stress on the latter as being developed in a different way than is pain or pressure sensation. In fact, recorded cases of nervous diseases suggest that, though correlated, the pressure, pain, and temperature senses are distinct entities.

He does not regard "muscular sense" as an appropriate term for the recognition of impulses that are derived not only from the muscular fibers, but also, and possibly to a large extent, from the tendons and other passive instruments of the muscles. Therefore this so-called muscular sense is the outcome of afferent impulses proceeding from the periphery and started in the parts concerned in the movement, and it should not be described by a term that implies a single source of the phenomenon.

The entire volume exhibits the same cauful presentation of the subjects under consideration that has characterized Prof. Foster's former work, and has made this in the past one of the best works on physiology that we have; and the incorporation of the more recent discoveries in that science in this volume sustains its high standard. The only thing that detracts from this volume is the omission of an index.

The Great World's Farm. By Selina Gaye. New York: Macmillan & Co. Pp. 365.

This book is described in the subtitle as "Some Account of Nature's Crops, and how they are grown." It maintains the proposition that "the whole earth is one great farm or garden, almost everywhere covered with vegetation, and bringing forth crops of the most luxuriant and varied kind"; and that Nature farms in ways of her own, on a large scale and without fuss, with a tillage of the most thorough kind, though it may be carried on without steel plows, and so quietly as to escape our notice. "There are vast pasture-lands here, there are extensive forests there; there are woods, jungles, heaths, moors, downs, but they have all been planted; and the soil was prepared in the first instance, and has been renewed since, by laborers who are not less truly deserving of the name of laborer than the plowman, though they do not work with his implements." Of these laborers we are introduced first to the "pioneer laborers"—the gases of air and water—"which wear away the very hardest rocks by degrees"; then to the "soil-makers"—the lichens which sprout in the *débris* of the weathered rocks, and the roots of which, with those of the plants that follow them, continue the work done by air and water; to the "soil-carriers"—the rivers; the "soil-binders"—grass and plant roots; and the "field laborers"—worms and burrowing insects and animals, which loosen the soil; the work of which in the field particularly under view is graphically described. The work of water and roots, and the reason for deserts, are more fully considered. The office of plants in drawing food from the soil and leaving it there when they die in a more assimilable condition, and leaves and their work, are described—the influence of climate, "blossom and seed," the meaning of fertilization and the work of insects in assisting the process, and the methods of diffusion, are explained; and chapters follow on the Chances of Life, Friends and Foes to Plant Life, Nature's Militia, and Man's Work on the Farm. The whole is a successful attempt to present knowledge of the phenomena and processes of growth in an attractive form, to which a few excellent illustrations lend additional grace.

Manual of Qualitative Blowpipe Analysis and Determinative Mineralogy. By F. M. Endlich. New York: The Scientific Publishing Co. Pp. 456. Price, $4.

In this treatise the use of the blowpipe in analytical and determinative work is treated with great fullness. The chapter on appliances and flames is fully illustrated. This is followed by descriptions of the several modes of examining minerals, including some operations with wet reagents. A dozen pages of tables giving reactions for the oxides of earths and metals constitute Chapter III. Some seventy pages are devoted to prominent blowpipe reactions for the elements and their principal mineral compounds, arranged alphabetically under the names of the elements. Special suggestions as to the treatment of alloys, metallurgical products, and pigments are given; and these are followed by a systematic method of qualitative analysis before the blowpipe. Over a hundred pages of determinative tables are given, in which more than four hundred species of minerals are described. In these tables seven chief divisions are made—namely, metallic malleable minerals, flexible minerals, sectile malleable minerals, minerals with and those without metallic luster, earthy minerals, and hydrocarbon compounds. The methods of Prof. Richter, of Freiberg, have been largely followed in this manual, the author having been one of Richter's pupils.

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POPULAR MISCELLANY.

Extent of the Great World's Fairs.—In his paper before the British Society of Arts, on the coming Chicago Exhibition, Mr. James Dredge, of the Royal British Commission, presented a summary of previous World's Fairs and their results. The first great World's Fair was held in Hyde Park, London, in 1851, in a single building, 1,851 feet long and 450 feet wide. It accommodated not quite 14,000 exhibitors, half of whom came from the colonies, and closed with a net profit of $750,000. The first World's Fair in the United States was held in New York in 1853, accommodated 4,100 exhibitors within an area of 263,000 square feet, and lost $300,000. The first Paris Exhibition, in 1855, covered 1,886,000 square feet, had nearly 24,000 exhibitors, 144 of whom were from the United States, and was visited by 5,162,000 persons

Smaller exhibitions were held in Melbourne in 1854, Turin in 1856, Brussels in 1857, Lausanne in 1858, and Hanover in 1859. The second International Exhibition in London was held in 1862, covered 17 acres, was visited by 6,210,000 persons, and lost $2,001,500. The second Great Exhibition in Paris, in 1868, covered 11 acres besides many annexes, and had 52,200 exhibitors and 10,200,000 visitors. The Great Exhibition at Vienna in 1873 failed on account of the cholera. The Centennial Exhibition in Philadelphia in 1876 occupied 285 acres; was participated in by 32 foreign nations, while the United States furnished 30,864 exhibitors, Great Britain and its colonies 3,584, and Spain 3,822; and was visited by 9,911,000 persons. The Paris Exhibition of 1878 covered 54 acres, with annexes and special buildings; had 52,835 exhibitors, of whom 1,203 were American; was attended by more than 16,000,000 visitors; and lost $8,580,000. The Paris Exhibition of 1889 exceeded all these, and had 30,000,000 visitors. The Chicago Exhibition will occupy 666 acres, of which more than 200 acres will be crowded with buildings. The total expense of it will be between $8,000,000 and $10,000,000.

New Studies for Grammar Schools.—The Association of Officers of Colleges in New England, at its meeting held at Williams College in November, 1892, recommended for gradual adoption in the programme of New England grammar schools the introduction of elementary natural history in the earlier years as a substantial subject, to be taught by demonstrations and practical exercises rather than from books the introduction of elementary physics into the later years, to be taught by the experimental or laboratory method, and to include exact weighing and measuring by the pupils themselves; the introduction of elementary algebra at an age not later than twelve years; the introduction of elementary plane geometry at an age not later than thirteen years; the offering of opportunity to study French, or German, or Latin, or any two of these languages, from and after the age of ten years; the increase of attention in all class-room exercises in every study to the correct and facile use of the English language. In order to make room in the programme for these new subjects, the association recommends that the time allotted to arithmetic, geography, and English grammar be reduced to whatever extent may be necessary.

Rocks and Waters of Arkansas.—Arkansas, says Prof. Branner, in his report on the mineral waters of that Commonwealth, is a well-watered State. Besides the springs of which analyses are given in the report, hundreds of beautiful, free-flowing springs of excellent water gush from hillsides and valleys in all parts of the State. In the limestone region north of the Boston Mountains such springs are especially abundant, large, and beautiful. They are not mineral waters, properly speaking, but they are more valuable than if they were. Some of these springs are so big that they are utilized for driving mills, cotton gins, and other machinery, and, as their discharges are subject to little or no fluctuations throughout the year, they are free from the dangers of freshets and the risks of droughts. Besides these truly gigantic springs, no one who travels through north Arkansas can fail to be impressed by the great number of large and beautiful springs to be found at every town and village, to say nothing of those at almost every farmhouse. Many springs are remarkable for the purity of their waters. The waters of the Hot Springs claim the place of first importance in any consideration of the medicinally valuable waters of the State. It is the custom to speak of a large number of the hot springs, variously estimated at from fifty to seventy; but, while hot water does issue from the ground at as many or more points, it is hardly worth while to dignify each of these trickling streams with the name spring. Much curiosity is naturally manifested on the part of visitors to hot springs regarding the cause of the high temperature of the waters. In the Yellowstone National Park, where hot waters abound, the activity of igneous agencies offers a ready answer to such questions; but in Arkansas, where nearly all the rocks to be seen are of sedimentary origin, there is no evidence of recent volcanic activity. Some of the theories advanced are interesting only as curiosities, and are not mentioned by the author as having any other value. For example, it has been suggested that the heat comes from coal burning beneath the surface of the ground. It is perhaps enough to say that the coal measures to which coal is confined in Arkansas lie far to the north of Hot Springs, and that the hot waters come up through Silurian rocks which contain no coal. Of the theory that heat may be produced by chemical action, it may be said that the water itself gives no evidence of its having received its heat in this way, its chief foreign constituent being carbonate of lime. So far as the geology of the region is concerned, if there were no hot water in the vicinity none would have been anticipated on geologic grounds alone. Notwithstanding a writer at the beginning of the century mentioned having seen a volcanic outburst and streams of molten rock near Hot Springs, there is no evidence of such recent eruptive action, which could not have taken place without leaving readily recognizable traces. There are, however, eruptive rocks near Hot Springs, although they certainly were not thrown up during the last hundred years; and it is probable that the heat of the water is derived from its having come in contact with hot rocks, the cool edges of which may or may not be exposed at the surface.

Ancient Outlet of the Great Lakes.—Among the latest geological observations of Prof. G. F. Wright is the discovery of a former outlet of the Great Lakes through Lake Nipissing and the Mattawa River to the Ottawa. It has long been recognized that an elevation of less than fifty feet at Niagara or a depression of an equal amount at Chicago would cause the lake waters to flow into the Mississippi instead of the St. Lawrence. Recent railroad surveys have further shown that a subsidence amounting to only a trifle more than a hundred feet would turn the current from Lake Huron through Lake Nipissing and the course already mentioned. Prof. Wright has discovered evidence that this condition at one time prevailed. Lake Nipissing is scarcely seventy feet above Lake Huron, and empties into it through French River. The western extremity of Trout Lake, the source of the Mattawa, is less than three miles from North Bay on Lake Nipissing, and is separated by a wide, swampy channel which is only about twenty-five feet above the level of either lake. It is large enough to conduct the waters of the Great Lakes over into the present water-shed of the Ottawa when called upon to do so. "On looking for more positive evidence, we find it in a clearly defined shore-line of well-rounded pebbles extending upon the north side of the channel from one lake to the other, and at a uniform height of about fifty feet above the connecting channel. This shore-line is as well defined as that on the banks of the Niagara River, just west of the present cataract. Such a deposit could not have been formed along this connecting depression except by a stream of vast size passing from Lake Nipissing into the Mattawa. It is, however, on going down to the junction of this outlet with the Ottawa that the most positive and striking evidence is seen. For ten miles above the junction signs of the old river terraces are more or less visible high above the present stream; but at the junction there is an accumulation of river deposits, unparalleled, probably, by anything else in the world. The lower angle of the junction between the two streams is filled to a height of eighty feet or more above the present water level with a bowlder-bed about half a mile in width, and extending up the Mattawa for nearly a mile, where it shades off into finer material. On the upper angle the Mattawa is bordered by a terrace equally high, but consisting for the most part of fine gravel." The accumulation is clearly a terrace and not a simple glacial moraine; and that it is a delta brought down by the Mattawa and not by the Ottawa is shown by the fact that it has dammed the latter stream, producing in it deep water above and rapids below, according to the well-known law of river bars.

Traveling and Camping in Egypt.—Dr. Frederick Peterson, of this city, recommends winter camping in Egypt as a hygienic measure. He finds it something luxurious, and says: "I have camped out on shooting expeditions in Nebraska, Dakota, and other Western places, and endured hardships that I should not care to experience again. But in Egypt, where labor and carrying cost next to nothing, where everything in the way of furniture and supplies can be stored away somewhere on a camel; where every day can be foreseen to be rainless and beautiful, life in tents becomes a pleasure. It is a ways well to have some objective point in view to reach, and among the pleasantest desert trips with tents and camels are those to the Sinaitic Peninsula, to the Natroon Lakes, to the Fayûm, and to several other oases to the west of the Nile. Probably the warmest and driest for an invalid would be that from Assiût, Girgeh, or Esneh to the Great Oasis. But one may camp on the edge of the desert, traveling southward along the Nile, in that way having the advantage of more interesting surroundings; for some people might find the desert monotonous." On a trip to Wadi Natroon, where they spent ten days, "we were a party of three, and had eight camels with their drivers, a dragoman (interpreter), desert guide, cook, hunter guide, and a boy; two tents, three folding bedsteads with mattresses, two folding tables, chairs, rugs, cook-stove, fuel, water, rifles and shot-guns, and provisions for all the party, camels included. Camel-riding becomes easy after a time. One can assume almost any position, even lying down and going to sleep, and one can read with ease. Ladies are not at all debarred from taking such trips. Everything necessary can be procured in Cairo, and the expense should not be over five or seven dollars per day for each traveler."

The River from the Lucie Glacier.—The most novel and interesting feature in the Lucie Glacier, Alaska, as described by Mr. Israel C. Russell, is a glacial river which bursts from beneath a high archway of ice and flows for about a mile and a half through a channel excavated in the ice, then to enter the mouth of another tunnel and become lost to view. The stream is swift, and its waters are brown and heavy with sediment. Its breadth is about one hundred and fifty feet. For the greater part of its way, where open to sunlight, it flows between banks of ice and over an icy floor. Fragments of its banks and portions of the sides and roof of the tunnel from which it emerges are swept away by the swift current or stranded here and there in midstream. The archway under which the stream disappears is about fifty feet high, and the tunnel retains its dimensions as far as one can see by looking in at its mouth. Where the stream emerges is unknown; but the emergence could no doubt be discovered by examining the border of the glacier some miles southward. No explorer has yet been bold enough to enter the tunnel and drift through with the stream, though possibly this could be done without great danger. The greatest risk in such an undertaking would be from falling blocks of ice. While the author was standing near the mouth of the tunnel there came a roar from the dark cavern within, reverberating like the explosion of a heavy blast in the chambers of a mine, that he did not doubt marked the fall of an ice mass from the arched roof. At the mouth of the tunnel there are always confused noises and rhythmic vibrations to be heard in the dark recesses within. The air is filled with pulsations like deep organ notes. It takes but little imagination to transform these strange sounds into the voices and songs of the mythical inhabitants of the nether regions.

Nansen's Plan for reaching the Pole.—The main principle of Dr. Fridtjof Nansen's plan for reaching the north pole, as it was described by him recently at a meeting of the Royal Geographical Society, is that of working with the forces of Nature rather than against them. In this view the shortest and most certain route to the pole is probably to be found in the ocean current running north from Siberia and south by Greenland. The existence of such a current seems to be proved by the floating of relics of the Jeannette from where she sank in the waters north of Siberia apparently across the polar sea to the vicinity of the southwest coast of Greenland, and by the frequent appearance of Siberian objects in Greenland waters. Dr. Nansen's ship has been built with especial reference to its resisting the pressure of the ice. It is as small as possible consistently with its carrying the coal and stores that will have to be taken along. It is shaped, avoiding perpendicular lines and angles, so that in case of an ice crush it can not be nipped, but, with regularly sloping sides, shall permit the ice to glide under it and lift it up. It will be one hundred and twenty-eight feet long over all, with thirty-six feet greatest beam, a draught of twelve feet with light cargo, and a bearing capacity of three hundred and eighty tons of coal and cargo. It will be built almost solid, and will be rigged as a three-masted fore-and-aft schooner. The expedition is expected to start in the spring. It will try to make the farthest possible point north in open water, and, when it can get no farther, will run into the ice at the most favorable spot, and from there trust entirely to the current running across the polar region. The possibility of the ship being, after all, crushed by the ice is provided against by having two boats aboard, with which the men will move with their provisions upon the ice and camp there. Thus the journey would be continued, with the only difference that there would be two small ships standing on the ice instead of the big one lying between the floes. When they emerged into the open sea on this side of the pole there would not be any great difficulty in the boats; such a thing had been done many times before. The chief difficulty would be to get duly into the current north of Siberia; when this was done, they must be carried some where northward. Whether he succeeded or not, the author was convinced that this was the way in which the unknown regions would some day be crossed. Possibly the current would not carry them exactly across the pole, but it could not easily be very far off; and the principal thing was to explore the unknown polar regions, not to reach exactly that mathematical point in which the axis of our globe has its northern termination.

Terra Cotta Roofing Tiles.—In his very interesting study of that subject, Prof. E. S. Morse mentions it as a noteworthy fact that the earliest type of terra cotta roofing tile ever exhumed still forms the roof covering of the greater mass of mankind to-day. The enduring nature of these objects, he adds, will ultimately enable one to trace the paths followed by tile-making races in their various migrations. The roofing tile has a considerable antiquity, for its appearance in Greece dates back to the earliest dawn of Greek art; and yet before this, in Asia Minor, there was a time when the tile was not, for, though in Schliemann's Ilios many other kinds of pottery were found in great abundance, there was no trace of tiles. It is probable that the roofing tile was introduced into Greece from the East fully developed. The sloping roof must have preceded the roofing tile by many thousands of years; at the outset, bark, straw, thatch, rough stones, and similar substances were used until better devices were made, which finally terminated in the terra cotta roofing tile. The shape of the earliest form of tile—a normal tile, as Prof. Morse calls it—suggests its derivation from the bark thatch. It consists of a wide under piece (*tegula*) slightly curved, and a narrow semi-cylindrical piece (*imbrex*), which was placed in an inverted position so as to cover the junction of two adjacent *tegulæ*. So, in roofing with bark, we would put down two pieces, concave side up, and cover the crack between them with a piece concave side down. A second type of tile is the pan tile or S-tile, which has a double flexure, forming in section a figure like that of the letter S laid upon its side (∞). This is an evident adaptation from the normal tile, in which the two elements, *imbrex* and *tegula*, are combined in one piece. A third type, the flat tile, or plain tile, has no genetic relation to the other forms, but is simply a shingle in terra cotta. With few exceptions, the normal tile is the only form used in Asia, Asia Minor, Greece, Italy, Sicily, Spain, the countries bordering the southern shores of the Mediterranean, and all the Spanish and Portuguese countries and colonies in both hemispheres. The pan tile, or Belgic tile, prevails in the countries around the North Sea and the Baltic; and the flat tile in France and central Europe, away from the Mediterranean.

The Disinclination to meditate.—A suggestive essay is published in the London Spectator on the Dread of Thought, in which, remarking upon the necessity of people having something with which to occupy their minds—a book, for instance—when left to themselves, the writer asks the questions: "Why is it natural for a man to dread being thrown back upon his own thoughts? Why should he find meditation so unnatural, and reading so natural?" The writer believes that the dread of thought (a little too strong a term, for it is really rather a neglect or ignoring of thought) "in a great measure comes from lack of habit. All children pass a good deal of time in thinking, but men, in the press of business and pleasure, forget how to think, and grow to regard reading as the only possible way of passing the time quietly. . . . We venture to think, however, that a very little patience, and a very little practice, would soon make most men give up their dread of thinking, and would make an hour spent without books or talk a pleasure instead of a pain. No doubt this is not true of all men. There are certain persons cursed with a constitutional melancholy so deep that it is impossible for them to think cheerfully. . . . These, however, are the abnormal cases. The ordinary man at ordinary times has no real reason for dreading his thoughts. It is merely want of habit that makes him dislike thinking. Let him make the plunge, and select something definite to think about, and ten to one he will find following a train of thought a very agreeable exercise. Letting the mind veer backward and forward like a weathercock, at the suggestion of this or that external circumstance, is, of course, dull and worrying; but the man who knows how to think does not do that. He thinks, as he reads, with a definite purpose." The writer concludes by observing that "the man who trains his mental powers by meditation and by following out lines of thought, obtains an intellectual instrument a hundred times more powerful than he who is content never to think seriously and consecutively. The things one merely reads about never stick. Those on which one thinks become permanent acquisitions. Hence, the man who is never afraid of thinking, and who does not dread 'that cursed hour in the dark,' is at a distinct advantage on every ground. He passes the time without being bored, and he strengthens his mind. . . . The man who can enjoy and make use of his own thoughts has a heritage which can never be alienated. Even blindness for him loses some of its terrors."

The World's Mineral Industries.—The reviews of the mineral industry, published yearly in a statistical supplement of the Engineering and Mining Journal, have been rising every year to increased value and importance. The publishers of the journal have decided to issue those for the last year in a large octavo volume, under the title of the Mineral Industry, its Statistics, Technology, and Trade, both in the United States and Foreign Countries, from the Earliest Times to the Close of 1892. It will treat the substances which are the objects of mining for profit, from scientific, technological, and economical points of view, describing the modes of occurrence of the minerals, their exploitation and preparation for the market, and the statistics of the trade in them.

The Material of Folk Lore.—Mr. George Laurence Gomme maintains, in his Ethnology in Folk Lore, that the constituent elements of folk lore—consisting as they do of beliefs, customs, and traditions that are far behind civilization in their intrinsic value to man, though they exist under cover of a civilized nationality—must in general be traceable to the survival of a condition of human thought more backward, and therefore more ancient, than that in which they are discovered, and which may, therefore, conveniently be called with reference to it a condition of uncivilization. It follows that, as an element of uncivilization, existing side by side with civilization, its development must have been arrested at the point where the civilization began. It may have experienced modification, and, indeed, in most cases has been largely modified; but that modification has tended rather to its extinction than to its development upon the lines upon which it was proceeding at the time the arrestment took place. Ascertain the point of arrestment, which may in general be expected to coincide with the appearance on the scene of a race of people to whom the belief or custom or tradition is strange or unknown, and you may reasonably attribute it to the pre-existing people whom they displaced or subdued. When, therefore, savage or rude customs are stated to have existed in Rome or Greece, or the German or Celtic countries of modern Europe, it is not to be assumed, as it has hitherto been, that they are of Roman, Greek, German, or Celtic origin; but it is to be ascertained whether they embody an idea the development of which was arrested by those civilizations, and if so, they must be referred to an antecedent race of relative uncivilization. Mr. Gomme adduces in support of this conclusion the annual ceremonies connected with the worship of the village goddess in southern India. On this sole occasion in the year it is the outcast pariah, the descendant of the aboriginal race, who is the officiating priest. The goddess is generally adored in the form of an unshapen stone. Bloody animal sacrifices are offered, and the heads of the slaughtered creatures are eagerly scrambled for. Women walk naked to the temple in fulfillment of vows, under the shelter of leaves and boughs of trees. If, Mr. Gomme argues, there is a strong line of parallel between these Indian ceremonies, which are demonstrably non-Aryan, and ceremonies formerly and even still observed in Europe, must not such ceremonies have been in their origin non-Aryan in Europe?

Buddhistic Carved Figures.—At a recent meeting of the English Anthropological Institute, Major R. C. Temple illustrated a paper on the Developments of Buddhist Symbolism and Architecture as revealed in Cave Explorations, by exhibiting photographs of life-size figures in wood carved by an artist of Maulmain, of the "four sights" shown to Buddha as Prince Siddhartha on his first visits to the outer world—viz., the old man, the sick man, the dead man, and the priest; and some wooden representations from Rangoon, of Buddha in his standing and recumbent postures, with his begging bowl, and seated as King Jambopati, surrounded by priests and other worshipers. He next showed a set of gilt wooden images from the platform of the great Shnedagon pagoda at Rangoon, of various spirits believed in by the Burmese, seated on the steps of a lofty post, on the top of which is always perched the figure of the sacred goose, which apparently protects pagodas in some way. Some large glazed bricks or tiles from Pegu, at least five hundred years old, which formed the ornamentation of the procession paths round a ruined pagoda, represent the march, battle, and flight of a foreign army, depicted with elephants', monkeys', and other animal faces, with some of the figures clad in the Siamese or Cambodian fashion. A huge figure of a recumbent Buddha, of the fifteenth century, is a hundred and eighty-one feet long and forty-six feet high at the shoulder. Its history is lost, and so was the image itself, till it was accidentally discovered in the jungle by a railway contractor in 1881. Views of the Kawgun Cave were shown, exhibiting the wonderful extent of its decoration by a vast number of terra cotta tablets and images in wood, alabaster, and stone, and the extraordinary variety and multitude of objects of Buddhistic worship found in it. This cave is the richest of those which Major Temple visited; but he had examined half a dozen others in the district, and had gathered information of the existence of about forty. Many of these are hardly inferior to Kawgun in richness of Buddhistic remains, and several are said to contain besides ancient manuscripts which must now be of inestimable value. A few such manuscripts have been found.

NOTES.

White bread and fine flour are named by Sir James Crichton Browne as one of the causes of the increase of dental caries. Failing to eat as large proportions of bran as our ancestors did, we are deprived to a large degree of the fluorine which they contain. The enamel of the teeth has more fluorine, in the form of fluoride of calcium, than any other part of the body. Fluorine might, indeed, be regarded as the characteristic chemical constituent of this structure, the hardest of all animal tissue; hence a supply of fluorine, while the development of the teeth is proceeding, is essential to the proper formation of the enamel, and any deficiency in this respect must result in thin and inferior enamel.

On the reopening of an old mine at Bangor, Cal., a few months ago, flies were found in a dry slope connecting two shafts, all white except the eyes, which were red, and a white rattlesnake was killed. The animals had lived in the dry passages, where they had been supplied with air but not with light. A few of the flies, exposed to light in a glass case, recovered their proper color within a week.

A large dirigible balloon, intended to make headway against air currents of twenty-eight miles an hour, is being made in France. It will be similar in form to the La France of 1884–'85, but larger—two hundred and thirty feet in length and forty-three feet in its greatest diameter. It will weigh sixty-six pounds per horse power, and will be propelled by a screw in front with a rudder behind.

From various experiments respecting a connection between thunderstorms and the souring of milk, Prof. H. W. Conn draws the conclusion that electricity is not of itself capable of souring milk or even of materially hastening the process; nor can the ozone developed during the thunderstorm be looked upon as of any great importance. It seems probable that the connection between the thunderstorm and the souring of milk is one of a different character. Bacteria grow most rapidly in the warm, sultry conditions which usually precede a thunderstorm, and it will frequently happen that the thunderstorm and the souring occur together, not because the thunder has hastened the souring, but rather because the climatic conditions which have brought the storm have at the same time been such as to cause unusually rapid bacteria growth.

A vivid sketch was given by Prof. Gruber, of Roumania, in the International Congress of Experimental Psychology, of remarkable associations of color and sound which he had been observing for many years. To a small number among his best-educated patients the sound of the vowel *e* was accompanied by a sensation of yellow color, of *i* by blue, of *o* by black, and so on through all the Roumanian vowels and diphthongs, and to some extent with numbers. The same color was not always induced by the same sound in different persons, but the observations had been carefully tested.

The Superintendent of the Natal Observatory, in his report for 1890–'91, acknowledged his obligations to seven ladies, without whose zealous assistance, he says, the greater part of the astronomical computations, etc., would not have been carried out.

The programme of the sanitary exhibit to be held in connection with the Chicago Exhibition defines its purpose to be to show as adequately as possible the position in which the theory and practice of hygiene stand at the present day. The programme itself is a full one, and includes classes of physical exercise, alimentation, hygiene of dwellings, hotels, lodging-houses, etc., public baths and lavatories, and numerous other features entering into the detail of hygienic management.—In connection with this subject we notice a paper on Typhoid Fever in Chicago, by William T. Sedgwick and Allen Hazen, in which the disease is shown to have increased in the city at a fearful rate within recent years. The cause of the increase is attributed to polluted water supply, which efforts are now being made to remedy.

A new coating for the protection of metalwork and woodwork from the effects of the weather or of water is based on the adaptability of cotton-seed oil to unite with lead. Melted lead is poured into cotton-seed oil under continual stirring, and the mixture is allowed to cool. When the oil is poured off the lead will be found at the bottom, but reduced in weight by the absorption of a part of it in the oil. The operation is repeated, with the lead left at the end of each trial, five times. When cold, the oil has the appearance of thick varnish, and is ready to be applied with a brush or a sponge. This coating unites quickly and firmly with any material.

The price of platinum recently rose, under a speculative combination, nearly to that of gold. This stimulated the discovery of new sources of supply, and the price of the metal went down again. There are now forty mines along the course of a single river in the Ural. The grains of ore are obtained from the sand by washing. The metal as found is usually associated with gold, iron, osmium, iridium, and other rare metals, and has to be purified from them.

It is related by the British consul at Cadiz, Spain, in illustration of the perfection with which natural wine can be imitated by modern chemical methods, that he and a friend, visiting one of the native sherry cellars there, were given two samples of wine to drink which seemed to be almost identical; and were told that one was a natural product and very costly ($250 a bottle), while the other was a manufactured product, the market price of which was only a few cents a bottle. In making the imitation, the natural product is first analyzed, and the chemist, ascertaining the exact nature of its constituent parts, is able to combine them and thus nearly reproduce the original compound.

The longest balloon ride on record is described by M. Maurice Mallet, in L'Aéronaute. It was from La Villette, Paris, to Wahlen, in central Germany, and occupied thirty-six hours and ten minutes, from October 23 to the morning of October 25, 1892. The flight was disturbed by snow in the upper regions of the atmosphere, which melted in the lower. During one of its descents the balloon, as is characteristic of the border land, was stopped and examined by a Prussian guard, who had galloped after it for a considerable distance.

The celebration of the three hundredth anniversary of the beginning of Galileo's labors as professor in the University of Padua, December 6, 1892, was attended by the Americans, Prof. William James, of Harvard, and Prof. Allan Marquand, of Princeton. The commemorative oration was by Prof. Antonio Favaro, who has been for fifteen years a student of Galileo, and is editor of the national edition of his works. He spoke chiefly of Galileo at Padua. He was followed by about a dozen of the foreign delegates and some of the Italian delegates. University honors were conferred upon seven foreign scientific men, representative of their several nations, including Prof. Newcomb. Besides some memorial works published by the ancient Academy of Padua, and by the university, the students of the university are about to issue a collection of documents relating to the sojourn of the philosopher at Padua.

Herr Nagel has succeeded in localizing the sense of taste of sea anemones in their tentacles. A piece of sardine brought carefully to the tentacles of one of these animals was seized at once by the one touched, then by the others, and was swallowed. A piece of blotting paper saturated with sea-water and applied in the same way was not seized; when soaked in the juice of fish, it was seized with the same energy as the piece of fish, but was often given up ultimately without being swallowed; soaked with sugar, it was accepted more daintily; but if saturated with quinine it was refused, the tentacles drawing back. On the outer surface of the body, and on the part between the tentacles and the mouth, quinine had no effect; nor did several other drugs of similar properties. Meat placed within or near the mouth of a widely open animal was not noticed; it was seized only when the tentacles were touched.

Among some recently observed interesting results of application of cold, M. Raoul Pictet has found that at $-150°$ all chemical reaction is suppressed. Thus, if sulphuric acid and potash are brought together at this temperature, they do not combine. Litmus paper, introduced, keeps its color. It is possible to restore energy to these substances by passing the electric current, and the current passes readily, whatever the substances; at $-150°$ all bodies are good conductors. The disappearance of affinity at a low temperature can be utilized to get absolutely pure substances; and M. Pictet has thus obtained alcohol, chloroform, ether, and glycerin.

A law has been enacted in Ontario forbidding the spraying or sprinkling of fruit trees while they are in bloom with any mixture containing Paris green or other substances poisonous or injurious to bees. The object of the legislation is to protect the bees from harm, the honey from possible taint of poisoning, and to avoid possible obstacles to the complete fertilization of the fruit.

The Prussian Government has decided to introduce the use of the centigrade thermometer instead of that of Réaumur, which was still in use in some parts of the kingdom.

From a careful review of the characteristics as to inheritability of certain diseased conditions of the human system, Henry J. Tilden has drawn the conclusion that pathology, so far from offering any support to the hypothesis of the transmission of acquired characters, pronounces against it.

Among the congresses to be held at Chicago by the World's Congress Auxiliary of the Columbian Exposition will be an international conference on aërial navigation. Its objects will be to bring about the discussion of some of the scientific problems involved, to collate the results of the latest researches, to procure an interchange of ideas, and to promote concert of action among the students of this inchoate subject. The meetings will be held on the afternoons of August 1st, 2d, and 3d. The topics to be discussed will be arranged under the three headings of Scientific Principles, Aviation, and Ballooning.

OBITUARY NOTES.

The death is announced of John Obadiah Westwood, President of the British Entomological Society. He was born in 1805, at Sheffield, and was appointed a Professor of Zoölogy at Oxford in 1861. He received a royal medal from the Royal Society for his scientific work in 1855, and was elected a member of the Entomological Society in Paris, to succeed Humboldt, in 1860. He was author of an introduction to the Modern Classification of Insects, British Butterflies and their Transformations, and other works of a similar nature.

F. von Hellwald, a well-known Austrian writer on ethnography, died in Bavaria, November 1, 1892, in the fiftieth year of his age. He entered the army, but left it in 1864 to engage in scientific studies, then re-entered it and took part in the Austro-Prussian War. He was for several years editor of *Das Ausland*. Since 1882 he had devoted himself chiefly to the production of works relating to geography and the history of civilization.

James Plant, of Leicester, a distinguished English local geologist, died in November, 1892, in the seventy-fifth year of his age. He was chairman of the British Association's Committee on Erratic Blocks.

Prof. E. N. Horsford, of Harvard University, died in Cambridge, Mass., January 1st. After four years of service as teacher of mathematics and natural sciences in Albany Female Academy, he spent two years of study and research in the Liebig Laboratory at Giessen. Returning home, he became Rumford Professor of Science applied to the Arts. He afterward submitted plans which led to the foundation of the Lawrence Scientific School, where he spent nineteen years. He then went into business in the manufacture of chemicals, and became President of the Rumford Chemical Works. He published a paper more than thirty years ago on stilling the waves with oil. He was interested in archæology; published a lexicon of five Indian languages; and tried to determine the location of the ancient settlement of Norumbega on Charles River, Mass.

Amedée Guillemin, one of the most successful and eminent French popularizers of science, died early in January, at his native village of Pierre, France. He was born in 1826, and began the publication of his celebrated works in physics and astronomy in 1864, with *La Ciel* (the sky). This was followed by similar works on comets, etc., The Physical World, the *Petit encyclopédie populaire*, in sixteen volumes, the books on Steam and Railroads in the Library of Wonders, etc. He was a frequent contributor to La Nature.

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SCIENCE AND THE COLLEGES.*

By DAVID STARR JORDAN.

WE have come together to-day to do our part in raising one of the milestones which mark the progress of education in America. Our interest in higher education brings us here, and our interest in science; and, more than ever in the past, we find these two interests closely associated. More and more each year the higher education of America is becoming steeped in science; and in the extension of human knowledge the American university now finds its excuse for being.

I hope that in what I shall have to say I shall not be accused of undue glorification of science. I recognize in the fullest degree the value of all agencies in the development of the human mind. But the other departments of learning may each have its turn. We are here to-day to dedicate a hall of science. We are here in the interest of science teaching and scientific research. When, in a few years to come, we may dedicate a hall of letters, we shall sing the praises of poetry and literature. But to-day we speak of science, in the full certainty that the humanities will not suffer with its growth. All real knowledge is a help to all other, and all real love of beauty must rest on love of truth.

At this time, as we stand together by the side of the milestone we have set up, on the breezy upland which marks the boundary of our nineteenth century, it is worth while to glance back over the depressing lowlands from which we have risen; and, in our discussion of the relations of the American college to science,

* Read at the dedication of the Science Hall of the University of Illinois at Champaign, November 16, 1892.

we find depression and darkness enough without going back very far.

I am still numbered, I trust, with the young men. I am sure that I have never yet heard the word "old" seriously joined to my name. When they speak of "old Jordan," I know that they mean the river, and not me. Yet, in the few years during which I have taught biology, the relation of science to education has undergone most remarkable changes.

I remember very clearly that, twenty years ago, when, in such way as I could, I had prepared myself for the two professions of naturalist and college professor, I found that these professions were in no way related. I remember having in 1872 put the results of my observations into these words: "The colleges have no part or interest in the progress of science, and science has no interest in the growth of the colleges."

The college course in those days led into no free air. *A priori* and *ex cathedra*, two of its favorite phrases, described it exactly. Its essentials were the grammar of dead languages, and the memorized results of the applications of logic to number and space. Grammar and logic were taught in a perfunctory way, and the student exhausted every device known to restless boys in his desire to evade the instruction he had spent his time and money to obtain. Then, when all the drill was over, and the long struggle between perfunctory teachers and unwilling boys had dragged to an end, the students were passed on to the president to receive from him an exposition of philosophy. This was the outlook on life for which three years of drill made preparation. And this philosophy was never the outgrowth of the knowledge of to-day, but simply the *débris* of the outworn speculations of the middle ages.

We well remember the first invasion of science in the conventional programmes of study. This came in response to an outside demand for subjects interesting and practical. It was met in such a way as to silence rather than to satisfy the demand. A few trifling courses, memorized from antiquated text-books, and the work in science was finished. The teachers who were capable of higher things had no opportunity to make use of their powers. Their investigations were not part of their duties. They were carried on in time stolen from their tasks of plodding and prodding. It is to the shame of the State of Indiana that she kept one of the greatest astronomers of our time for forty years teaching boys the elements of geometry and algebra. That he should have taught astronomy and made astronomers occurred to no one in authority until Daniel Kirkwood was seventy years old, and by the laws of Nature could teach no longer. What was true in his case was true in scores of others. The investigator had no part in the college system; or, if on sufferance he found a place, his time was devoted to anything else rather than to the promotion of science. It is not many years since the faculty of one of our State universities spent a whole afternoon discussing a proposal to abolish laboratory work in science, and the substitution for it of good text-books and suitably illustrated lectures.

All this time, as Emerson has said, "the good spirit never cared for the colleges, and, while all men and boys were being drilled in Greek, Latin, and mathematics, it had left these shells high on the beach, and was making and feeding other matters in other parts of the world." These other matters were the study of men and plants and animals, the laws and forces of Nature, the laws which govern human life, and the manifold laws of divine workings—to which we give the name of science. Everywhere in Europe and America men were eagerly devoting their lives to this work, but in nineteen cases out of twenty these men were outside of the colleges.

Have I drawn the picture in colors too dark? In an address given in Detroit eighteen years ago, Andrew D. White used these words: "While the United States has pushed the roots of its public-school system down into the needs and feelings of the whole people, and thus obtained a deep, rich soil which has given sturdy growth, it has pushed the roots of advanced education down into a multitude of scattered sects, and has obtained a soil wretchedly thin and a growth miserably scant.

"Within the last twenty years I have seen much of these institutions, and I freely confess that my observations have saddened me. Go from one great State to another, in every one you will find that this unfortunate system has produced the same miserable results—in the vast majority of our States not a single college or university worthy the name; only a multitude of little sectarian schools with pompous names and poor equipments, each doing its best to prevent the establishment of any institution broader and better.

"The traveler arriving in our great cities generally lands in a railway station costing more than all the university edifices in the State. He sleeps in a hotel in which is embarked more capital than in the entire university endowment for millions of people. He visits asylums for lunatics, idiots, deaf, dumb, and blind, nay, even for the pauper and criminal, and he finds them palaces. He visits the college buildings for young men of sound mind and earnest purpose, the dearest treasures of the State, and he generally finds them vile barracks.

"Many noble men stand in the faculties of these colleges, men who would do honor to any institution of advanced learning in the world. These men of ours would, under a better system, develop admirably the intellectual treasures of our people and the material resources of our country; but, cramped by want of books, want of apparatus, want of everything needed in advanced institutions, cramped above all by the spirit of the sectarian college system, very many of them have been paralyzed. Then, too, the really strong men holding professorships are too often hampered by incompetent men, whose main function was to hear boys 'parrot' text-books by rote in the recitation-room, and to denounce 'science falsely so called' in the chapel, varying these avocations by going about the country denouncing every attempt at a better system as 'godless,' and passing around the contribution-boxes in behalf of the bad system they represented."

The American college of the middle of this century, like its English original, existed for the work of the Church. If the college dies the Church dies, was the basis of its appeal for money and influence. Its duty was to form a class of educated men in whose hands should lie the preservation of the creed. In the mouths of ignorant men the truths of the Church would be clouded. Each wise church would see that its wisdom be not marred by human folly.

The needs of one church indicated the needs of others. So it came about that each of the many organizations called churches in America established its colleges here and there about the country, all based on the same general plan.

And as the little towns on the rivers and prairies grew with the progress of the country into large cities, so it was thought, by some mysterious virtue of inward expansion, these little schools in time would grow to be great universities. And in this optimistic spirit the future was forestalled, and the schools were called universities from the beginning. As time went on, it appeared that a university could not be made without money, and the source of money must be outside the schools. And so has ensued a long struggle between the American college and the wolf at the door—a tedious, belittling conflict, which has done much to lower the name and dignity of higher education. To this educational planting without watering, repeated again and again, East and West, North and South, must be ascribed the unnaturally severe struggle for existence through which our colleges have been forced to pass, the poor work, low salaries, and humiliating economies of the American college professor, the natural end of whom, according to Dr. Holmes, "is starvation."

The intense rivalry among these schools, like rivalry among half-starving tradesmen, has done much to belittle the cause in which all are engaged. At the same time, their combined rivalry has too often prevented the growth within their neighborhood of any better school.

In this connection you may pardon me for a word of my own experience, when twenty years ago I set out in search of a place for work. A chair of Natural History was the height of my aspirations; for anything more specialized than this it seemed useless to hope. I was early called from New York to such a chair in a well-known college of Illinois. But in those days the work of a college chair was never limited by its title. As a Professor of Natural History I taught zoölogy, botany, geology, physiology—of course, a little of each, and to little purpose. Then physics, chemistry, mineralogy, natural theology, and political economy, also as a matter of course. With these went German, Spanish, and evidences of Christianity, because there was no one else to take them. There finally fell on me the literary work of the college—the orations, essays, declamations, and all that flavorless foolishness on which the college depended for a creditable display at commencement. When to this was added a class in the Sunday school, you will see why it seemed necessary that the naturalist and the professor must sooner or later part company. I tried at one time to establish a little laboratory in chemistry, but met with a sharp rebuke from the board of trustees, who directed me to keep the students out of what was called the cabinet, for they were likely to injure the apparatus and waste the chemicals. When I left this college and looked elsewhere for work, I found on all sides difficulty and disappointment; for the reputation I had, wholly undeserved, I am sorry to say, was the dreaded reputation of a specialist. The question of theological orthodoxy seemed everywhere to be made one of primary importance, and candidates for chairs who, like myself, were not heretics on the subject of the origin of species, passed the rock of evolution only to be stranded on the inner shoals of the mysteries of the Scottish philosophy.

But these were not the only sources of difficulty. In one institution toward which I had looked the chair of Natural History was found unnecessary. In the meeting of the board of trustees a member arose and said in substance: "We have just elected a Professor of History. This includes all history, and the work in natural history is a part of it. Let the Professor of History take this, too"; and for that year, at least, the Professor of History took it all, and it was not hard for him to do it, for the college course in history consisted of nothing but cut straw and its preparation—that is, the reading of a chapter in the text-book a day in advance of the class was no drain on the time or the intellect of the teacher.

Even in the excellent State university into which I ultimately drifted I was met at the beginning by the caution that the purpose of my work must be elementary teaching, the statement of the essential facts of science, and by no means the making of naturalists and specialists.

I could give more illustrations, and from better schools, showing that the demand of the colleges of twenty years ago was always a demand for docility and versatility, never for thoroughness or originality; and, as a rule, the progress of science in America came from men outside of the college, and in a great part outside of college training and college sympathies; that to promote science or to extend knowledge was not often one of the college ideals, and that the colleges' chief function was to keep old ideas unchanged. What was safe in times of old will be safe to-day, and safety, rather than inspiration or investigation, was the purpose of the college. From time immemorial until now Oxford and Cambridge, the schools of clergymen and gentlemen, have been the center of English conservatism. The American colleges—dilute copies of Oxford and Cambridge—were likest their models in their retention of old methods and old ideas. The motto, once suggested for a certain scientific museum, "We will keep what we have got," might have been taken by the American college. There was no American university then, unless a few broad-minded teachers—such men as Lowell, Gray, Silliman, Henry, Baird, and Agassiz—could, as so many individuals, be properly regarded as such.

In a high sense, as I elsewhere have said, the coming of Agassiz marked the foundation of the first American university. Agassiz was the university. The essential character of the university is *Lernfreiheit*, freedom of learning, the freedom of the student to pursue his studies to the furthest limit of the known, the freedom of encouragement to invade the infinitely greater realm of the unknown. It is from this realm that come the chief rewards of the scholar. The school from which no exploring parties set out has no right to the name of university. In the progress of science, and the application of its methods to subjects not formerly considered scientific, the German university has its growth and development. In like progress must arise the American university.

You remember the story of the discussion, some forty years ago, between Emerson and Agassiz, as to the future of Harvard. Emerson, himself one of the sanest and broadest of men, saw in the work of Agassiz elements of danger, whereby the time-honored symmetry of Harvard might be destroyed. In a lecture on universities, in Boston, Emerson made some such statement as this: That natural history was "getting too great an ascendency at Harvard"; that it "was out of proportion to other departments, 'and hinted' that a check-rein would not be amiss on the enthusiastic professor who is responsible for this."

"Do you not see," Agassiz wrote to Emerson, "that the way to bring about a well-proportioned development of all the resources of the university is not to check the natural history department, but to stimulate all the others?—not that the zoölogical school grows too fast, but that the others do not grow fast enough? This sounds invidious and perhaps somewhat boastful, but it is you," he said, "and not I, who have instituted the comparison. It strikes me that you have not hit upon the best remedy for this want of balance. If symmetry is to be obtained by cutting down the most vigorous growth, it seems to me it would be better to have a little irregularity here and there. In stimulating, by every means in my power, the growth of the Museum and the means of education connected with it, I am far from having a selfish wish to see my own department tower above the others. I wish that every one of my colleagues would make it hard for me to keep up with him, and there are some among them, I am happy to say, who are ready to run a race with me."

In these words of Agassiz may be seen the keynote of modern university progress. The university should be the great refuge hut on the ultimate boundaries of knowledge, from which daily and weekly adventurous bands set out on voyages of discovery. It should be the Upernavik from which polar travelers draw their supplies, and, as the shoreless sea of the unknown meets us on every side, the same house of refuge and supply will serve for a thousand different exploring parties, moving out in every direction into the infinite ocean. This is the university ideal of the future. Some day it will be felt as a loss and a crime if any one who could be an explorer is forced to become anything else. And even then, after countless ages of education and scientific progress, the true university will still stand on the shore, its walls still washed by the same unending sea, the boundless ocean of possible human knowledge.

The new growth of the American university which we honor to-day is simply its extension and its freedom, so that a scholar can find place within its walls. The scholar can not breathe in confined air. The walls of mediævalism have been taken down. The winds of freedom are blowing, and the summer sunshine quickens the pulse of the scholar in the deepest cloister. In the university of the future all departments of human knowledge, all laws of the omnipresent God, will be equally cherished because equally sacred. The place of science in education will then be the place it deserves—nothing more, nothing less.

Many influences have combined to bring about the emancipation of the American college. Not the least of these is the growth of the State university as an institution existing for all the people, and for no purpose but that of popular instruction. It is a part of the great training school in civics, morals, and economics which we call universal suffrage.

Most of these schools have celebrated their coming of age within the last five years, and their growth is certainly one of the most notable features in the intellectual development of America. The State university was founded as a logical result of the American system of education. It was part of the graded system through which the student was to rise step by step from the township school to the State university. It has grown because it deserved to grow. When it has deserved nothing it has received nothing. In the persistence of old methods and low ideals we find the reason for the slow growth of some of the State universities. In the early dropping of shackles and the loyalty to its own freedom we find the cause of the rapid growth of others.

In its early years the State university was in aim and method almost a duplicate of the denominational schools by which it was surrounded. Its traditions were the same, its professors drawn from the same sources, its presidents were often the defeated candidates for presidencies of the denominational schools. Men not popular enough for church preferment would do for the headship of the State universities. The salaries paid were very small, the patronage was local, and the professors were often chosen at the dictates of some local leader, or to meet some real or supposed local demand. I can remember one case when the country was searched to find for a State university a Professor of History who should be a Democrat and a Methodist. All questions of fitness were subordinated to this one of restoring the lost symmetry of a school in which Presbyterians, Baptists, and Republicans had more than their share of the spoils. This idea of division of spoils in schools as in politics is only a shade less baleful than the still older one of taking all spoils without division. And when the spoils system was finally ignored, and in the State universities men were chosen with reference to their character, scholarship, and ability to teach, regardless of "other marks or brands" upon them, the position of professor was made dignified and worthy.

The first important step in the advance of the State universities came through the growth of individualism in education—that is, through the advent of the elective system—and its first phase was the permission to substitute advanced work in science for elementary work in something else. It does not matter from what source the idea of individual choice in education has arisen. It may be a gift of far-seeing Harvard to her younger sisters; or it may be that in Harvard, as elsewhere, the elective system has arisen from a study of the actual conditions. The educational ideas which are now held by the majority of teachers in our larger schools were long ago the views of the overruled minority; and for fifty years or more individuals in the minority have looked forward to the time when inspiration and not drill would be the aim of the colleges. "Colleges can only serve us," said Emerson long ago, "when their aim is not to drill, but to create. They will gather every ray of genius to their hospitable halls, that by their combined influence they may set the heart of the youth in flame." It was in 1864 that Agassiz said, in advocating the elective system, that although it might possibly give the pretext for easy evasion of duty to some inefficient or lazy students, it gave larger opportunities to the better class, and the university should adapt itself to the latter rather than to the former. "The bright students," he said, "are now deprived of the best advantages to be had because the dull or the indifferent must be treated like children."

In the same year Emerson spoke of the old grudge he had for forty-five years owed Harvard College for the cruel waste of two years of college time on mathematics without any attempt to adapt these tasks to the capacity of learners. "I still remember," he said, "the useless pains I took, and my serious recourse to my tutor for aid he did not know how to give me. And now I see to-day the same indiscriminate imposing of mathematics on all students during two years. Ear, or no ear, you shall all learn music, to the waste of the time and health of a large part of the class."

I remember well the beginning of the modern system in the university of a neighboring State. It came as the permission, carefully guarded, to certain students who had creditably passed the examination of the freshman year in Latin, to take, instead of the sophomore Latin, some advanced work in zoölogy. To the very great surprise of the Professor of Latin, those who availed themselves of this opportunity "to take something easy" were not the worst students in Latin, but the best. Those who were attracted by investigation chose the new road; the plodders and shirks were contented with the evils they had, rather than to fly to others that they knew not of. And so, little by little in that institution, and in all the others, has come about a relaxation of the chains of the curriculum of Oxford and Cambridge, and the extension of opportunities for students to find out the facts of Nature for themselves, rather than to rest with the conserved wisdom of an incurious past.

Thus slowly and painfully came about the development of the scientific courses. We can all remember the dreary time when, in the tedious faculty meetings, we used to devise scientific courses, short in time and weak in quality, for students who could not or would not learn Latin and Greek. There was no scientific preparation or achievement required in these courses. They were scientific only in the sense that they were not anything else. Their degree of B. S., which should have meant

Bachelor of Surfaces, was regarded as far inferior to the time-honored B. A. In the inner circle of education it was regarded as no degree at all, and its existence was a concession to the utilitarian spirit of a non-scholastic age. The scientific course was, indeed, inferior, for it lacked substance. There was no lime in its vertebræ. The central axis of Greek had been taken out, and no corresponding piece of solid work put in its place. Gradually, however, even this despised degree has risen to a place with the others. Slowly and grudgingly the colleges have admitted that under some circumstances the study of science might be as worthy of recognition as the study of Greek. When science was worthily studied, this proposition became easy of acceptance. In our best colleges to-day the study of science stands side by side with the study of language, and the one counts equally with the other, even for the degree of Bachelor of Arts. For not the Greek itself, but the culture it implies, was the glory of the course of arts. When equal culture and equal work come through other channels, they are worthy of this degree. To deny this would be to make of the degree itself a mere child's toy, a play on words. As a matter of fact it can be little more, and sooner or later the college will have no need for degrees. It was the firm belief, I am told, of Chancellor Gregory, who laid broad the foundations of the University of Illinois, that the work of the future college should need no stimulus from honors or degrees, and that these playthings of our educational childhood might some day be laid aside forever. In this feeling I fully sympathize. All these things are forms, and forms only, and our higher education is fast outgrowing them. Science has shown herself a worthy suitor of the highest degree the university can give. She will show herself strong enough to care for no degrees at all. In the great schools of the future, each study shall become its own reward. Let all come who will, and let each take what he can, and let the ideals be so high that no one will imagine that he is getting when he is not. Scholars can be made neither by driving nor by coaxing. In any profession the inspiration and example of educated men are the best surety that the generation which succeeds them will be likewise men of culture.

Not the least of the aids to freedom in science was the Morrill Act, under which a certain part of the public lands was given for the foundation of schools of applied science. Unhappily, much of this fund was wasted outright by thriftless management. Much more was in some States half wasted by the formation of separate schools for applied science, where State colleges of the old type already existed. Indeed, in many States, the college and the technical school were so far separated, that the legislators of 1868 saw in them nothing in common. Nevertheless, the highest wisdom in education is to bring these various influences together as much as possible. There is no knowledge which is not science, and there can be no applied science without the basis of pure science on which to rest. Schools of applied knowledge can not be legitimately separated from schools of knowledge. But, whatever the use made of the money, the passage of the Morrill Act in the interest of applied science has given scientific work a prominence in our colleges it did not have before. It has given science definite rights in the curriculum, where before it seemed to exist by sufferance.

I congratulate the State of Illinois that its university is one university; that its pure and applied science, its literature, history, philosophy, and art are taught in one institution by a united faculty. The best results in any line of education can not be reached without the association of all others. The training of the engineer will be the more valuable from his association with the classical student. The literary man may gain much, and will lose nothing, from his acquaintance with the practical work of the engineer. The separation of the schools founded by the Morrill Act from the State university, as we have seen in nearly half the States of the Union, was a blunder which time will deepen into a crime. With the union of the two has come the rapid growth of the Universities of Wisconsin, Illinois, California, Minnesota, and Nebraska, where the higher work of the State is concentrated in one place.

The freedom of choice has not worked to the advantage of science alone. The element of consent in college study has brought about a revival in classical education as well. It is not certain, even, that more science studies are chosen on the elective system than were taken on the old plan of a required curriculum. But the work is done in a different spirit. Colleges and investigators are being drawn together. There is no line of investigation in which the college can not help, if the investigators have freedom to use it. The scientific men are being drawn into sympathy with higher education. Men are now in college who under the former system would have been self-made men, with all the disadvantages that isolation implies. Education gives the ability to enter into the labors of others, and the scientific man of to-day must use every advantage if he is to make his own work an advance in knowledge. He must know what has been done by those who have gone before him. He must stand upon their shoulders if he would look further into the mysteries of Nature than they. Science can not for a moment let go of its past; and to the self-made man of science, struggle as he may, the books of the past are at least partially closed.

The men of science twenty-five years ago the college repelled, rather than aided. I know a well-known naturalist who twenty years ago was dropped from the rolls of one of our State universities; not because he was idle or vicious or inattentive, but because he spent too much of his time studying birds, and did not keep up with his classmates in some of the conventional requirements in mathematics or Latin. The college had no use for bird knowledge, but it came out strong on irregular verbs. And so, like hundreds of others, this man went away, and carried on his own studies in his own fashion. And others similarly situated, with aspirations in science or literature, history or engineering, went away or stayed away, and grew up untouched by the higher education of their times. The elective system provides for such as these. It not only gives a new impulse to the students' work, but it brings a new body of students under collegiate influences.

Nothing in our educational history has been more remarkable than the increase in numbers of students in our principal colleges, and the corresponding increase in influence of these schools within the last ten years. Yet nothing is more evident than the fact that these students are not going to college in the old-fashioned sense. The old-fashioned college ideals are not rising in value; but new possibilities of training and the inspiration of modern thought bring to the university all sorts and conditions of men and women whose predecessors twenty years ago would not have thought of entering an American college. Where old educational ideas still reign, be the college rich or poor, there is no increase in numbers nor in influence. Unless a college education involves the emancipation of thought, unless it gives something to think about, it has no place in the educational system of the future. The future of our country will rest with college men, because the college of the future will meet the needs of all men of power, and draw them to its walls.

Scientific men have no interest in the depreciation of literary or classical training. The revolution in our higher education is not a revolt against the classics. It is an appeal from the assumption that the classics furnish the only gate to culture. It asserts the existence of a thousand gates, as many ways to culture as there are types of men. Scientific training asks only for freedom of development, and for the right to be judged by its own fruits.

With the growth of investigation has come the demand for better means of work, better apparatus, more and better books, larger collections, and especially collections for work, not for show or surprise. Better teachers are needed, and more of them. A healthy competition is set up, by which in these later days a man's pay is in some degree proportioned to his power, and the competition for places among half-starved men is changing into a competition for men among rich and ambitious institutions.

One of the great changes which have come to American education has been the extension of scientific methods to many subjects formerly deemed essentially unscientific. For this change the influences which have come to us from Germany are largely responsible. Thirty years ago the mental philosophy which formed the staple of the work of the college president was thoroughly dogmatic, like his moral science and his political economy. It was a completed subject, having its base in speculation, and its growth by logical deductions, and no thought of experimental proof or of advancement by investigation was ever brought before the student.

Now psychology is in the best schools completely detached from metaphysics, and is an experimental science as much as physiology or embryology. By its side ethics and pedagogics are ranging themselves—the scientific study of children, and the study of the laws of right, by the same methods as those we use to test the laws of chemical affinity. Metaphysics, too, has ranged itself among the historical sciences, the study no longer of intuitive and absolute truth, but the critical investigation of the outlook of man on the universe, as shown through the history of the ages. The old metaphysical idea is passing away, soon to take its place with the science of the dark ages in which it rose.

History, too, is no longer a chronicle of kings and battles. It is the story of civilization, the science of human society and human institutions. The Germans have taught us that all knowledge is science, capable of being placed in orderly sequence, and of being increased by the method of systematic investigation.

The study of language now finds its culmination in the science of philology, the science of the growth of speech. Every branch of learning is now studied, or may be studied, inductively, and studied in the light of the conception of endless and orderly change, to which we give the name of evolution. This conception has come to be recognized as one underlying all human knowledge. Seasons return because conditions return, but the conditions in the world of life never return. The present we know, but we can know it thoroughly only in the light of the past. What has been must determine what is, and the present is bound to the past by unchanging law. All advance in knowledge implies a recognition of this fact. The study of science must be grounded in the conception of orderly change, or change in accordance with the laws of evolution.

It is, after all, the presence of scholars that makes the university. It is in such men that the University of Illinois has its existence. It is located neither in Champaign nor in Urbana; it is wherever its teachers may be, wherever its workers have gone. We have met to-day to dedicate its Science Hall. To the future work in this hall we do all honor, but we do not think of it as a new hall, nor a new creation. It is simply a natural outgrowth of the work of Burrill and Forbes. Ever since, in 1878, I visited the little zoölogical workshop of Dr. Forbes in the old school building at Normal, and ever since, in 1882, I saw toadstools and bacteria in the little room across the way which Dr. Burrill called his own, I have been able to prophesy the growth of this building. We care nothing for the brick building, its desks, its shelves, and its microscopes, as things in themselves. We are thinking of Forbes and Burrill. The building is only a better tool-house in which these master workmen can shelter their tools. Their work will be what it was before; and their impulse and example are our best guarantee that so long as this building stands we shall find in it master workmen. Another Forbes, another Burrill, another Rolfe shall fill the gaps when these lay down their work; and the University of Illinois shall live through the years, because the men who compose it are truthful, devoted, and strong.

THE FESTAL DEVELOPMENT OF ART.

By Prof. DAVID J. HILL,
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GOETHE says that art is called art simply because it is not Nature. Unquestionably it has its impulse and its laws in the constitution of man. We may, therefore, accept as useful to the proper comprehension of it, in its most general sense, the definition given by Thomas Davidson: "Art is an expression of man's inner nature imprinted upon matter, so as to appeal to his senses, which deal only with matter, and through which he obtains experience." But, while every product of art is the work of human personality, neither man nor his works can be understood, or even intelligently considered, separate from Nature. He is himself a part of her, and yet he is different from any inferior part, for he alone can, in any degree, fathom the depths of natural process or formulate natural law. When, therefore, we say with the great poet-philosopher that art is called art simply because it is not Nature, we can not mean that art is in no sense a natural activity. On the contrary, while we must accept the antithesis, we must still seek the explanation of the origin and development of art in the operation of the natural forces which are present, and the natural laws which are dominant, in the nature of man; for he, although he is Nature's child, has come into possessions which are his own.

The faculty of artistic production, aided indeed by all the other powers of man's nature, under its guidance and command, is imagination. This is the combining faculty which, like an informing spirit, shapes the pre-existent elements and proximate forms of Nature for human needs and human pleasure. Its stimulus comes from the sphere of feeling, but its products are not the organic consequences of this stimulation. If they bore this relation of necessary effect to feeling as organic cause, they would be in the fullest sense the products of Nature, and the distinction between Nature and art would be effaced. But, in fact, the whole of man's being as rational intelligence intervenes between the impulse of feeling and the work of art. This is probably what Wilhelm von Humboldt intended when he said, "Art is the faculty of making imagination productive, according to law."

The primary impulse to imaginative activity is *utility*, the satisfaction of distinct vital needs. Of these the first is that of food, universal and peremptory for all living beings. Then shelter, clothing, weapons of defense and attack, implements, and utensils of various kinds, are demanded. In the lower animals, instinct directs the creature how to satisfy the simple organic needs; but in man, even with a low degree of intelligence, imagination contrives new ways and means of supplying these requirements. A sharpened flint serves as a knife; attached to a wooden handle, it becomes a spear; projected from a bow-string, it is an arrow. Thus, along lines of very gradual ascent, all the complicated equipment of home and chase and war was slowly acquired by the constant search for better means with which to accomplish necessary ends. In all invention, from the stone axe to the telephone, imagination has been the active faculty. The impulse of utility, "making imagination productive," has generated the "useful," "industrial," or "economic" arts; or, as the anthropologist Tylor calls them, the "arts of life."

A secondary impulse to imaginative activity is the *sense of freedom*, the satisfaction derived from a free exercise of power. After the strictly vital needs of the body are provided for, unless the whole store of force is exhausted in satisfying them, there remains a surplus, especially in the unused organs, which impels to activity not directed toward useful ends. The pressure of this exuberant energy for expression is probably the primitive impulse toward the decorative, representative, and imitative arts. These are called the "fine arts," the "æsthetic arts," and by Tylor the "arts of pleasure." In many languages they are designated as the "beautiful arts"—the Italian name being *belli arti;* the French, *beaux arts;* the German, *schöne Künste*. To these forms of art we shall confine the remainder of our discussion.

In his Principles of Psychology, Herbert Spencer begins his last chapter with the following allusion: "Many years ago I met with a quotation from a German author to the effect that the æsthetic sentiments originate from the play-impulse. I do not remember the name of the author; and if any reasons were given for this statement, or any inferences drawn from it, I can not recall them. But the statement itself has remained with me, as being one which, if not literally true, is yet the adumbration of a truth." The author referred to is the poet Schiller, and the writing in which the idea cited by Spencer occurs is Schiller's Letters on the Æsthetic Education of Man. What Schiller is attempting to explain is not the origin of the "æsthetic sentiments," but the nature of man as an art-producing being. This nature, he thinks, grows out of the union of two impulses: (1) The *sense-impulse* (*Stofftrieb*), which determines that there shall be constant change, that time shall have a content; and (2) the *form-impulse* (*Formtrieb*), which determines that time shall be abolished, that there shall be no change. From the union of these two impulses in man results the *play-impulse* (*Spieltrieb*), which tends to abolish time in time, and to unify becoming with absolute being, change with identity. But we must not expose ourselves too long in the rarefied air of even a poet's metaphysics. Spencer, without knowing his teacher, and kindling his torch with the stray spark of Schiller's flash upon the clouds, has shed more light upon the origin of art than the poet himself.

"The activities we call play," he says, "are united with the æsthetic activities, by the trait that neither subserve, in any direct way, the processes conducive to life. . . . Inferior kinds of animals have in common the trait, that all their forces are expended in fulfilling functions essential to the maintenance of life. They are unceasingly occupied in searching for food, in escaping from enemies, in forming places of shelter, and in making preparations for progeny. But, as we ascend to animals of high types, having faculties more efficient and more numerous, we begin to find that time and strength are not wholly absorbed in providing for immediate needs. Better nutrition, gained by superiority, occasionally yields a surplus of vigor. The appetites being satisfied, there is no craving which directs the overflowing energies to the pursuit of more prey, or to the satisfaction of some pressing want. The greater variety of faculty, commonly joined with this greater efficiency of faculty, has a kindred result. When there have been developed many powers adjusted to many requirements, they can not all act at once; now the circumstances call these into exercise and now those; and some of them occasionally remain unexercised for considerable periods. Thus it happens that, in the more evolved creatures, there often recurs an energy somewhat in excess of immediate needs, and there comes also such rest, now of this faculty and now of that, as permits the bringing of it up to a state of high efficiency by the repair which follows waste. . . . Every one of the mental powers, then, being subject to this law, that its organ when dormant for an interval longer than ordinary becomes unusually ready to act—unusually ready to have its correlative feelings aroused, giving an unusual readiness to enter upon all the correlative activities; it happens that a simulation of those activities is easily fallen into, when circumstances offer it, in place of the real activities. Hence play of all kinds—hence this tendency to superfluous and useless exercise of faculties that have been quiescent," for the mere pleasure that attends this exercise. He goes on to say: "A cat, with claws and appended muscles adjusted to daily action in catching prey, but now leading a life that is but in a small degree predatory, has a craving to exercise these parts; and may be seen to satisfy the craving by stretching out her legs, protruding her claws, and pulling at some such surface as the covering of a chair or the bark of a tree. . . . This useless activity of unused organs, which in such cases hardly rises to what we call play, passes into play ordinarily so called where there is a more manifest union of feeling with the action. Play is equally an artificial exercise of powers which, in default of their natural exercise, become so ready to discharge that they relieve themselves by simulated actions in place of real actions. For dogs and other predatory creatures show us unmistakably that their play consists of mimic chase and mimic fighting—they pursue one another, they try to overthrow one another, they bite one another as much as they dare. And so with the kitten running after a cotton ball, making it roll and again catching it, crouching as though in ambush and then leaping on it, we see that the whole sport is a dramatizing of the pursuit of prey—an ideal satisfaction for the destructive instincts in the absence of real satisfaction for them." The plays of children carry these low beginnings to a higher state. Spencer thinks that gratification from a victory at chess is a substitute for ruder victories of an earlier time. The banter of a playful conversation is also a mimic battle, in which words take the place of coarser weapons.

It would be absurd, of course, to pretend that such play is in any sense fine art, but we may see in it the impulse that sets the faculties in motion for the highest artistic productions. This we shall presently undertake to illustrate in tracing the development of the arts. As a preliminary to this, we may note the marks of differentiation which distinguish the arts of pleasure from the arts of life: 1. The practice of the useful arts is accompanied by a sense of *necessity*, growing out of the constant feeling that the process is a serious one. That of the arts of pleasure is attended with a sense of *freedom*, resulting from the surcharge of energy directed toward less indispensable issues. 2. The useful arts derive their laws and limitations predominantly from the *objective* world. The fine arts derive theirs more largely from the *subjective* world. 3. The useful arts, therefore, partake of the *uniformity* of physical law, with its consequent monotony, so much felt in work. The fine arts, on the other hand, permit of more *novelty* and *variety*, as experienced in play.

Although the play-impulse is at the foundation of the æsthetic arts, it does not follow that art is merely the product of this impulse. Play stimulates free imaginative activity, which creates a world of its own. And we must not forget that man is not simply an imaginative, but also a rational being. The reaction of reason impresses upon the spontaneous activities the characteristics of reason as a regulative faculty—unity, order, and proportion. Thus poetry, which was at first merely the spontaneous rhythmic expression of excited feeling, with little restraint of law and almost unlimited license, is modulated at last to the stringent requirements of exact meter, a prescribed sequence of feet, and the artifice of terminal rhyme. The interval between the first wild lyric of prehistoric man and the chastened symmetry of the modern sonnet is measured by the whole diameter of human culture.

In order to approach intelligently the development of the fine arts, it is important for us to form a clear idea of what should be included under this designation, and to classify this material according to some principle. We may for this purpose start with the classification of a recent and highly competent French writer upon the subject, M. Eugène Véron. He says: "By their origin and the nature of their processes, the arts naturally divide themselves into two well-defined groups. The one springs from the sensation of sight, and is more or less immediately connected with the practices of primitive scribes. The three arts of which it is composed are sculpture, painting, and architecture. Their common feature is development in space; their manifestations have to do with a single point of time; consequently they exclude movement, which is succession and duration, replacing it by simultaneity and order, whose law is proportion. The other three arts—poetry, music, and the dance—are subject to the laws of rhythm. They have sound for their vehicle of expression, they appeal to the sense of hearing, and take their immediate origin from spoken language, which seems for long to have consisted of a species of cadenced singing. Their principle of action is by succession, through which they are referred to general ideas of lapse of time and movement. They are therefore the more direct expression of the inner essence of life, while the other three deal with it rather in its exterior forms, which, being expressed at one given moment of their action, become as it were disguised by the very necessity under which they labor to limit themselves to a definite attitude, depriving them of the most salient characteristic of the other group of arts—movement and power of change." He then offers the following classification:

I. *Arts of the Eye:* Architecture, sculpture, painting.

II. *Arts of the Ear:* Dancing, music, poetry.

We may accept this as the basis of a grouping of the fine arts, but it should be revised in the light of two considerations: First, it is a mixed classification, for dancing does not appeal to us through the ear only, as Véron asserts, but partly through the eye also, in the case of a spectator, but mainly through the muscular sense; and, second, it is a grouping that entirely ignores the genetic element by which the several arts are evolved, if not out of one another, at least in a definite order of sequence. Both of these objections are fully met, and in addition each of the arts is characterized by its own distinctive peculiarity, if we adopt the following arrangement:

I. *Arts of Movement:*
1. Dancing—rhythmic motion of the *body*.
2. Music—rhythmic motion of the *voice*.
3. Poetry—rhythmic motion of *speech*.

II. *Arts of Form:*
1. Architecture—*decorative* form construction.
2. Sculpture—*representative* form construction.
3. Painting—*imitative* form construction.

A few words will assist us to see that this classification is a scientific one. In distinguishing between the arts of movement and the arts of form, we retain every advantage of Véron's scheme without a strained reference of the figures of the dance to the ear instead of the eye and the muscular sense, and at the same time do not obscure the close affiliation between dancing and music, which most obviously exists. The revised grouping also specifies the peculiar kind of movement and of form construction exemplified by each art. We further recognize in architecture its beginning as one of the useful arts, which, as mere form construction, it does not surpass. But when decoration is added, or rather when the decorative purpose pervades the entire plan and execution of architectural form, then for the first it becomes a fine art. The peculiarity of sculpture is, that it is representative form construction, endeavoring to copy literally, or to represent fully, the object of the sculptor's work. In the earliest sculpture, as we have no inconsiderable evidence to show, even color was employed, and this in a truly representative way, reproducing the colors of the parts represented. Painting is not strictly representative, but imitative, striving to present on a flat surface, with only two dimensions, objects which in reality occupy three dimensions of space. By the arts of perspective and foreshortening this aim is in a great degree accomplished, so that a result is produced which is *like* the original, but not in all respects, even from an exterior and visual point of view, the *same* as the original.

It remains now to show that the grouping offered here observes the genetic principle, and arranges the fine arts in the order of their natural sequence and evolution. Véron denies that this is possible, but this conclusion can not be maintained. It is true that we have not in our possession the earliest products of art, so as to be able to prove that any order which we may assign is the actual order of development, but we have the means of showing that the order we have indicated is highly natural and probable. As regards the two main divisions, it is clear that the arts of movement would precede the arts of form, for the arts of movement—dancing, music, and poetry—may all be practiced by man without external aids or instruments of any kind, while this is impossible for the arts of form, architecture, sculpture, and painting. We might also cite, in confirmation of this view, the facts derived from the comparative study of man, which show that the arts of movement are practiced among peoples who have no arts of form, or possess these in a less perfect state of advancement than those of the first group. As regards the particular arts embraced in the general scheme, the dance seems to be the most primitive of all, because it is a simple rhythm of the bodily movements, which requires nothing else than free limbs and a tendency to bring unused muscles into exercise. The rhythm of bodily motion is naturally accompanied by vocal rhythm, which is rudimentary music, and when to this articulate words are added, poetry has begun, although in a very elementary way. As soon as the place where the dance is held begins to be decorated, the building art blossoms into a primitive architecture. When masks are used to represent deities or absent men, or representative figures of these are set up as objects of worship or reverence in the dance, sculpture has its beginning. When such effigies are imitated on a flat surface, by applying the pigments first used upon the bodies of the dancers and then on the graven images, painting as a fine art has its humble origin. Thus, we perceive, there is a natural sequence in the advent of the several arts.

It is idle to speculate upon the question as to when the fine arts had their origin. As Véron says: "Art came before thought itself. Before he ever attempted to understand or explain the conditions of the world in which he lived, man, open to pleasure through his eyes and ears, sought in combinations of forms, sounds, movements, shadow, and light, for certain special enjoyments. Traces of these early aspirations are extant in the recently discovered works of a time when his intellectual activity must have been confined within a very narrow scope. . . . When as yet he possessed neither laws nor social institutions, even then he had art. In the dark caverns which formed his first habitations, because they alone could protect him against the attacks of beasts of prey, amid the piles of bones in which have been found the *débris* of species vanished from the earth perhaps a thousand centuries ago, we have discovered, among flint-formed arrows and knives, objects which could evidently only have been ornaments —necklets, bracelets, rings of stone and of bone—more or less roughly worked and fitted indeed, but enough to show that art is not, as has been asserted, the efflorescence of superior civilizations only. . . . Yes, those savages who lived dispersed in the holes and corners of the world . . . already felt the sentiment of art. They strove after beauty; they adorned with their best their appalling females; they decorated their weapons of stone; they devised musical instruments; by means of gravers of flint they cut upon flat bones the leading features of many animals, with enough accuracy to enable us to this day to recognize their species."

It may create some surprise that we regard the dance as the earliest form of art, or even that we allow it any place among the fine arts. To many it will seem a kind of sacrilege to combine in the same category, however broad, such extremes as a dancing savage and a painting of the last judgment; and, if the connection must be made, some would choose to make it along other lines than those of art. But, in truth, the dance supplies us with the key, so to speak, of the development of the fine arts. For light upon the problems of human culture, we naturally appeal to the anthropologist. "Dancing," says Tylor, "may seem to us moderns a frivolous amusement; but in the infancy of civilization it was full of passionate and solemn meaning. Savages and barbarians dance their joy and sorrow, their love and rage, even their magic and religion. The forest Indians of Brazil, whose sluggish temper few other excitements can stir, rouse themselves at their moonlight gatherings, when, rattle in hand, they stamp in one-two-three time round the great earthen pot of intoxicating *kawi* liquor; or men and women dance a rude courting dance, advancing in lines with a kind of primitive polka step; or the ferocious war dance is performed by armed warriors in paint, marching in ranks hither and thither with a growling chant terrific to hear." Tylor proceeds to describe the dance of the Australians, and the buffalo dance of the Mandan Indians, who, wearing masks to mark their impersonations, with rude songs and pantomimic gestures, act out the incidents of an imaginary hunt. And then he adds: "All this explains how, in ancient religion, dancing came to be one of the chief acts of worship. Religious processions went with song and dance to the Egyptian temples, and Plato said that all dancing ought to be thus an act of religion. In fact, it was so to a great extent in Greece, as where the

Cretan chorus, moving in measured pace, sang hymns to Apollo; and in Rome, where the Salian priests sang and danced, beating their shields, along the streets at the yearly festival of Mars. Modern civilization, in which sacred music flourishes more than ever, has mostly cut off the sacred dance. To see this near its old state, the traveler may visit the temples of India, or among the lamas of Thibet watch the mummers in animal masks dancing the demons out, or the new year in, to wild music of drums and shell trumpets. Remnants of such ceremonies, come down from the religion of England before Christian times, are still sometimes to be seen in the dances of boys and girls round the midsummer bonfire, or of the mummers at Yuletide; but even these are dying out."

The writers on the origin of the drama derive the tragedy of Greece, and indeed the dramatic art of the world, from simple mimetic dances, such as Tylor has described, which are found among all savage races. As Ellen Russell Emerson has said, in her curious book, Masks, Heads, and Faces: "Panoplied with the mask, representative of deity, the actor in religious rite with careful step moved in the order of the ceremonial. In the Innuit robe of evergreen boughs, or in the garment of tufted grass of the Dorian mummer, his countenance disguised with lees of wine or painted with ochre, he danced in enthusiastic mimicry of his divinity. Innuit or Greek, the same aspirations attuned the cithara or drum, the same ambition dictated the wild or solemn movement. Wheeling in weird rotation, the Selenii and satyr encircled the blazing altar on the plains of Greece. The citharist struck the measures which the mimic gestures of the chorus emphasized. Springtime, autumn, or winter, these wild ceremonies were performed in praise or appeal to the gods, in the lands of the East and of the West; with both peoples the principal object was to anthropomorphize the divinity dwelling in air or earth. Holding forth innumerable arms of appeal, barbaric Indian and barbaric Greek called on the coming of the gods."

If now we pause for a moment to consider the conditions of primitive society, we shall see that they were not such as to favor the cultivation of the independent arts, like sculpture and painting, or even architecture. The playtime of primitive man was not long enough for this. But the recurrent festival, celebrating some exploit in the chase or in war, or commemorating some departed chief, would furnish an occasion toward which men would look, for which they would prepare, and in which they would experience that pleasure which the excitement of a crowd affords, especially to the dependent mind, without resources of its own. Accordingly, it is in the festival that we must seek for those conditions in which early art was developed, and we shall find that this is true to a surprising extent of later art also. Among primitive peoples, with very little leisure and with almost no wealth, art can develop, beyond the mere decoration of the person and the ornamentation of personal weapons, only in a social and festal way. But, as leisure and wealth increase, art rises to bolder heights, especially if the faculty for art production be native among the people.

We have seen that even the domestic animals, like cats and dogs, "dramatize" in their play. So do children in their sports. The mimetic dance carries this on another step, involving the representation of characters, absent or superhuman, and the reproduction of ideal scenes. As intelligence and skill increase, this becomes more and more removed from the simple beginnings. The Attic ceremonials in their origin were merely crude efforts at dramatization, but with advancing culture the spectacles became more elaborate. There is an interval between the dance of the Brazilian Indians around their earthen pot of smoking *kawi* liquor and the Attic festival of Bacchus, performed in a great marble theatre, or temple of Bacchus, with a sculptured statue of the god in the center, the full chorus chanting to the accompaniment of many instruments, the walls of the temple adorned with heroic-size paintings of the exploits of the divinity; but it is only the interval between the first and the middle chapter of the same history. If, in a great modern city like Paris, we were to select the places where *all* the fine arts are most fully represented at once, we should not choose the palaces and the museums—for here the arts of movement are not represented—but the great churches and play-houses, especially Notre-Dame and the Grand Opera House. In Notre-Dame we should find music, poetry, architecture, sculpture, and painting, all combined. Only dancing is eliminated as an outgrown element of ceremonial. In the Grand Opera House we should find *all* the arts, and the one omitted at Notre-Dame would be most conspicuous there. The festal dramas of early times have been specialized, the religious ceremonial being separated from the secular, which finds its modern equivalent in the opera, where all the arts remain united. It is not meant that the *best* art in Paris is to be found at the opera house, but it is the kind which at the present time best represents the art appreciation of that city. Its attractions are offered every night, those of the *salon* once a year.

However paradoxical it may seem at first, reflection confirms the statement that the drama is the synthesis of all the fine arts, and the festival the common air from which all have drawn their first breath of life. If we start with the opera, for example, as a present fact, and inquire when and how it combined in itself the separate arts which it certainly unites, we shall find no point where these arts, independently developed, were first brought together for this purpose. We shall find, on the contrary, that every form of the drama was derived from some simpler form in which all the arts were constituents, until we arrive at the mimetic dance as the prototype of the whole series of dramatic phases. We are by no means justified in supposing that, at some time in the past, near or remote, a sculptor, without predecessors or examples, inspired by the impulse of a divine genius, modeled for himself a perfect human form in clay, and then with chisel and hammer proceeded to disengage a copy of this form from the solid marble. As little can we suppose that a great painter, without antecedents or training, arose in the midst of an inartistic generation, stretched his canvas, mixed for the first time his pigments, and executed a landscape or an ideal head. This is not in analogy with other lines of human development. As every great orator was once a speechless infant, finding language ready for his tongue and comprehension in his hearers, so every great artist has found a language of artistic expression waiting for his genius to improve and lovers of art ready to enjoy his creations. And thus we see that as the mechanic arts do not blush to confess that every wheel in every watch and every factory owes its parentage to the discovery that a fallen tree-trunk will roll under pressure, which probably first revealed the principle of the wheel, so the fine arts need not be ashamed of their descent from the mimetic dance. Let no idealistic devotee of art, therefore, be shocked or offended if we say that all the fine arts were at first incidental contributions to the dramatic festival, and afterward were analyzed out of this common medium of their development as independent forms of culture.

In all dramatization music has had a large place, either as the recurrent drum-tap, the percussion of cymbals, the twanging of stringed instruments like the tetrachord of the Greeks, or the blowing of pipes and horns. Between the intervals of dancing it is common in primitive ceremonies for some person to sing a few words alternated with a uniform chorus—and such, it has been suggested, might be the origin of the Greek strophe and antistrophe, "which are thought to represent the two movements of the universe from east to west, and west to east, the choir performing their dances around the altar of their gods from right to left and left to right." Thus was developed a lyric which gradually expanded into a poetic story. This, in time, developed into the recital of the rhapsodists who sang at the public festivals, which were largely dramatic in their character, and these fragments of heroic verse united and amplified become at last great epics like the Iliad and the Odyssey.

The relation of architecture to the festival is very easy to trace. The most ancient architectural remains are huge monoliths, undoubtedly intended as monuments of the dead. Perhaps hardly less old are the dolmens, or flat stones laid horizontally upon several tall upright pillars; and the cromlechs, or circles of rude stones, indicating a place of assembly or the marking off of a sacred inclosure. All these are probably early tombs. The tomb is, among primitive people, a place of religious festival. It becomes a shrine of the deified hero. Around it the living gather to celebrate the deeds of the dead and to invoke his blessing. The tomb-shrine gradually becomes a temple. The whole history of the development of architecture shows the shrine as the constant center about which are arranged the pillared halls, the colonnades, the ornate portals, the ornamental courts, and the sculpture-lined avenues of the most elaborate temples. Prof. G. Baldwin Brown says, in his recent manual on the fine arts: "Through a fortunate circumstance we are able to get behind these elaborate constructions, and learn the arrangements which preceded them in respect to the shrine and its furnishing forth. The pictures in the Egyptian hieroglyphic writing supply us with minute but extremely spirited delineations of structures and objects which may have been familiar to the inhabitants countless generations earlier than the erection of the tombs and temples that remain to us. Among these pictures are one or two representing small huts or arbors of rustic work. These, we learn, are shrines of the gods, and they represent the original shape of the sacred chamber, which remained to all time as the heart and kernel of the vast temples of a Seti or a Rameses. . . . Religious worship, it need not be said, is infinitely older than the permanent temple, and for its performance all that was needed was a gathering of the pious at a sacred spot about a rustic altar, to which might be added a movable ark, or a fixed hut or canopy for the safe keeping of any totem or apparatus of secret mummery belonging to the local divinity. Given such a permanent structure, the approach to it would be specially hallowed ground and fenced off from profane tread. Any simple device, such as a lofty flagstaff, would be adopted to give it importance from afar, and on the occasion of the festival every kind of decoration in the form of fluttering streamers, branches of green trees, and garlands of flowers, would be lavished on the building and its approaches. Here, in the little Egyptian shrine, we see at the entrance two lofty flagstaffs, and in front the indication of a palisade, evidently marking off the sacred precinct, or *temenos*. . . . Now it will be recognized that we have here, reduced to their simplest terms, just the same elements that went to make up the vast complexus of the monumental temples of Thebes or Abydos. The shrine remained as it had been, though now wrought in stone. The chambers round about it in the hinder portions of the temple were lodgings of the priests and storerooms for the offerings of the faithful; the courts and columned halls were merely developments of the palisaded inclosure. The flagstaffs actually remained till the latest times erect on each side of the single entrance to the temple, though the idea of them was still further carried out in monumental fashion by the rearing of two vast, almost completely solid masses of masonry of tower-like form, called *pylons*, that flanked the gateway and gave the desired imposing aspect to the approach toward the shrine." The writer goes on to show that a similar account might be given of "the most important monument in the whole history of architecture—the temple of the Greeks."

The manner in which sculpture contributed to the festival is also obvious. In the mimetic representations which formed a part of all the primeval religious ceremonies (and all early festivals were in some sense religious) the mask was an important factor. Much curious and suggestive lore regarding masks in all ages is to be found in a work previously referred to on Masks, Heads, and Faces. The earliest disguise was effected by the use of lees of wine mixed with black earth. This, applied directly to the face, served as a mask. Then vegetable shells and wood, later baked earth and stone, and finally metals, served a better purpose. The object was to impersonate the absent, usually a hero or a god, or the animal in which the deity was fond of appearing. "Certain lines were traced upon the masks used in ceremonial dances, and in the protection of the face of the dead, whose meaning can be understood only by a knowledge of the customs, traditions, and superstitions of the people among whom they were used. These lines are not only found on the wooden masks, but on the terra cotta and plaster, and also upon cocoanut and gourd masks. There is reason to believe that, in the case of the terra cotta, the devices were fac-simile to the tattoo-marks on the face of the deceased, the mask in this case being intended to insure preservation of the cherished lineaments, and also affording means of identification. . . . The custom of the use of portrait-masks survived in Roman burial service, when the lineaments were made in wax, and worn by his representative with a costume of the dead dignitary. From this ceremonial arose a more extensive fashion of carving the features in marble." But the same tendency had earlier shown itself in Egypt and Assyria, and preeminently in Greece. Not only real but also mythic beings, first impersonated in the festival, were carved in marble for its future ornament. "The solemn representations of the gods in the circling dance about the archaic altar admitted of no irreverent hilarity. Thus were presented the movements of the sun and moon, accompanied each by a retinue of lesser gods; for to the solar god were ascribed the Selenii, deities of the woodlands, and to the moon-goddess the Naïads of the flowing streams. And there appear also satyrs, those happy genii whom the sculptor had delighted to picture as the souls of the forest, unwitting of sorrow; of these human-eyed creatures the artist often chose representation in mask, with open look and parted lips, common feature of Hellenic sculpture—an expression of unchecked animal sweetness, no muscle drawn or compressed, and with all the unalarming hint of furry ears and budding horns!"

Painting, except as pigments were applied to faces, masks, and architectural adornments, had a relatively small place in the primitive festivals, as indeed it had in all ancient as compared with modern art. The whole theory of perspective was unknown, without which painting limps and halts. Still, we may see how it could contribute to the festival at a very early stage by the practice of the Sioux in their mimetic elk dance. When the sacred animal appears to a brave in a dream, a tent is placed with an opening to the east, and decorated at the top with four bands of blue, while across the entrance the figure of an elk is delineated with red paint, so arranged that the visitors shall pass through its body. Here is a crude contribution of painting to a very primitive festival. Of course, the evidence concerning the extent to which painting entered into the early festal performances can be only indirect. But it is important to note that the art of writing is derived from that of drawing, and that all the earliest forms of written language are pictographic. And they were also the special possession of the priests who had charge of the religious festival. It is more than probable that writing originated from the attempt to produce a series of pictures of early festivals, either religious or triumphal, or both—for victory was always celebrated with religious rites. Beginning thus as a series of rude imitative drawings, writing passed into more and more symbolic stages, among the Egyptians traversing the clearly marked phases of hieroglyphic, hieratic, and demotic writing, supplying the Phœnicians with the alphabet, whose crude characters were transported to Greece, and these—considerably modified—to Rome, whence we derive those letters with which we print our books and newspapers. Very early, then, was drawing known as a fine art, although imperfectly developed. Color was used on the earliest statuary. The independent statue, fashioned either in stone or wood, appears in the oldest Egypt, and has about it a good deal of that crude realism which marks the infancy of representative art. The flesh is colored up to correspond with Nature, the flesh of women being tinted a lighter hue than that of men; the eyes are represented often by some special material; the drapery is painted. The earliest statues of the gods of Greece were of a similar kind, only ruder and more childish in their realism than those of Egypt. The wooden doll was made as lifelike as possible by being dressed up in real clothes with a wig of hair, and with accessories or arms in actual metalwork and jewelry. These realistic images were highly honored from a religious point of view, like the *bambino* of the church of Ara Cœli, in Rome, at the present day, and were undoubtedly copied from a living effigy in the festival, as this *bambino* is now carried in the ceremonial processions at its annual *fête*. Still further light is thrown upon the subject by the religious symbolism of colors among widely separated peoples. Among the Chaldeans, the planetary gods were all symbolized by colors, yellow standing for the sun; black, for the moon; red, for the planet Mars; pale yellow, for Venus; and blue, for Mercury. So, among the Indians, green is ascribed to Venus, purple to Jupiter, and black to Saturn. All this finds its easy explanation in the color given to the representative of the god in the festal dance.

If, now, we have established our thesis, it appears that the fine arts are only the various modes of expressing the strong feelings awakened by religion and other potent stimuli of the imagination finding utterance under the social conditions of the time, and giving form in material sign and symbol to otherwise incommunicable sentiments. An analytical and philosophizing age is not particularly favorable to the production of the fine arts. They thrive best among an impressible, imaginative, spectacle-loving people. All history is a witness of this. The art of Egypt is the record of its religious rites and ceremonies, its military triumphs, and its royal processions. The same is true to a great extent of the art of Greece. The most of its sculpture is copied from figures seen in the dance, represented in the great festal games, or in the religious celebrations of the people. The marbles once in the frieze of the Parthenon, many of which were taken to England by Lord Elgin and placed in the British Museum—known as the "Elgin Marbles"—are copies from the Panathenaic festival as a spectator might have beheld it when all Athens contributed to its magnificence. The Italian *rappresentazioni*, most splendid at Florence, gave inspiration to the great painters of the fourteenth and fifteenth centuries. As these spectacles increased in beauty and artistic excellence, so did the paintings copied from them, for here the painter found his living models, already works of art in personal beauty and costume. The artists actually took both their themes and characters from these pageants. The "miracle-plays" and "mysteries," their equivalents north of the Alps, were less impressive, but these also kindled the flame of art and almost created the northern painter. There was also in Italy the *trionfo*, or procession of masked and costumed mummers, representing sacred, mythical, and allegorical personages, in a blazonry of symbolic adornment. A fine description of these and how the artist worked from them may be found in Brown's manual on the fine arts to which reference has been made.

Artistic inspiration arises from the stimulation of the imagination, the faculty of movement and form, by some strong feeling seeking expression. Among the feelings which have been most productive of such stimulation we may mention the religious sentiments, which open a limitless field for imaginative activity; the emotions of love, which stir imagination to the delineation of human beauty; the moral sentiments, which excite it to portray the heroic and sublime qualities of character; and the passion for natural scenery, which attracts it to the representation of the beautiful in Nature. All these feelings awaken a faith in some higher possibility, opening the quest for the ideal, or beauty stripped of its imperfections. Art thus becomes the appeal of personality to personality, of intelligence to intelligence. Its highest office, toward which it has been slowly striving, is to serve as a language for the embodiment and communication of ideas and sentiments which have a value for human sensibility. As Emerson has tersely said, "Art is the path of the creator to his work."

THE CORRELATION OF STRUCTURE, ACTION, AND THOUGHT.*

By T. LAUDER BRUNTON, M. D., F. R. S.

MR. PRESIDENT AND GENTLEMEN: Allow me to return you my most grateful thanks for the honor which you have done me in asking me to address you to-night. I believe that there are none here excepting myself who can understand how grateful I feel, because no one else can know how much I owe to this society. I have been compelled during my life to do a good deal of speaking and of writing, and yet these are the two things which above all others I dislike and for which I am naturally entirely unfit. Had it not been for the training which I received in this society I do not think that I should ever have been able to speak in public at all. In relation to speaking and writing, I often recall an anecdote told me by my poor friend the late Dr. Milner Fothergill, regarding a beaver which an American said he had chased so hard that it had been forced to climb up a tree to escape him. "But," said his hearer, "beavers

* Inaugural address delivered at the Royal Medical Society of Edinburgh on October 21, 1892. Abridged from the London Lancet.

can not climb trees." "Well," replied the American, "I guess this one had *just got to.*" Now this society played to me the part that the American did to the beaver and forced me both to speak and write, and I am therefore very grateful to it. My first attempt at writing was the dissertation which the rules of the society demanded, and my first attempt at speaking was made in this room when I stammered out half a dozen words, each one broken into bits by the palpitations of my heart, and then thankfully sat down.

But it is not only in speaking and writing that I owe my training to the Royal Medical Society of Edinburgh, I owe to it also my first initiation into scientific methods—my first instruction in scientific skepticism. I well remember that on one occasion a member made a certain statement; he had no sooner sat down than he was challenged by my friend Dr. John Wyllie. The first member again rose to his feet and maintained that his statement was true, and that his facts were correct because Professor So-and-so had said so. Again Dr. Wyllie rose, and with the simple question, "But is Professor So-and-so right?" swept away the ground from under his opponent's feet and gave me a new insight into scientific evidence. Previously I had been inclined to accept all the dicta of the professors as gospel truth, but from that time onward I accepted them only with the proviso that Professor So-and-so might possibly be wrong. Training like this, gained by a student in the discussions at the meetings here, is of the utmost possible importance as supplying a valuable part of medical education and complementing the instruction which he gains in the lecture rooms; it enables him to sift the statements which he there hears and to assimilate them in his own mind, so that they become as it were part of himself, and afford him a basis of knowledge upon which he not only can act in daily life, but from which he may advance onward and benefit both his profession and the world at large by new discoveries. This training is so invaluable that I should look upon anything which would interfere with it as detrimental to the student; for a little knowledge, like a little food, if well assimilated, is more useful than an undigested mass, which may be not only useless but positively injurious.

The numerous discoveries which have been made during the twenty-nine years which have elapsed since I first took my seat in this hall as a member of the society have tended to increase the mass of facts which the student has to learn; and the numerous examinations have tended to foster a system of cramming which is totally distinct from that of true education. For the purpose of examination the student is tempted to load his memory with many details and to learn by heart statements which may or may not be true, simply for the purpose of committing them to paper and thus gaining good marks in competitive examinations without considering in the least whether these statements are true, or whether the facts, so called, are likely to help him at all in his future life. The period during which I regularly attended the meetings of this society was a transitional one, because the number of examinations, competitive and professional, was then beginning to increase. I trust it is not true, but I have heard that since my time the examination incubus has been weighing even more heavily upon men than it did then, and has been interfering to some extent with the activity of the discussions in this society. Yet even if it were true it can hardly be wondered at, for it seems to me that we are living at a period which is not only one of the utmost activity, one of the most startling progress, and one of the keenest excitement for all engaged in research, but at the same time it is one of the utmost difficulty for all those who are engaged in the study of medicine, surgery, and the allied sciences. For the number of facts is not only enormously great, but is daily increasing at a rate which threatens to make it almost impossible for any ordinary memory to retain them all. Yet the darkest hour is that before the dawn, and I believe that shortly medical study will become very much easier. The great difficulty that the student has in remembering facts is that they are isolated and not co-ordinated together. In a book on memory which I once read the writer summed up his whole science in one sentence: "Observe, reflect, link thought with thought, and think of the impressions." This is easy to say but not so easy to do, and it is the difficulty of linking thought with thought that makes the tax upon the memory of the medical student so exceedingly great.

Now it seems to me that one of the objects which this society should set before itself should be not only that of training its members in the art of speaking and writing, of sifting facts and criticising statements, but of linking together and co-ordinating the data which they are called upon to recollect. When the science of astronomy was younger and the earth was supposed to be the center of the universe, the motions of the planets were known with sufficient certainty to calculate eclipses, but they could only be brought into conformity with their supposed relationship to the earth as the center by the most cumbrous system of hypotheses, and by ideas of cycles and epicycles which must have burdened the astronomer's memory to the last degree. So soon, however, as the sun and not the earth was recognized to be the center of our system the whole of the observed facts were seen to be in complete harmony, and the relationship, comparatively speaking, as simple as A B C. In our own time we have seen somewhat similar occurrences in regard to the relationship of animals and plants, or I might shortly say, of all living creatures to one another. It used to be assumed that the highest plants and highest animals were to be compared together, but all attempts to make this comparison rationally were unsuccessful; and it was only when an old member of this society, Mr. Charles Darwin, pointed out that animals and plants had sprung from one common ancestor and had diverged in different directions that the various relationships became intelligible. I well remember that when learning botany it puzzled me greatly to understand why the shape of the ovary, the nature of the ovule, and the position of the embryo should be such important characters in determining the genus of plants, and I devoutly wished that plants had been made in such a way that one could settle their nature by characters visible to the naked eye and not requiring a pocket micro-

FIG. 1.—CHICK. FIG. 2.—TORTOISE. FIG. 3.—HOG. FIG. 4.—MAN.
(After Haeckel.)

scope. But the reason for all this at once became evident when the Darwinian doctrine showed that it is in these embryonic characters that relationships are to be discovered and that it is in later development that differences occur. As Haeckel has shown, the embryos of the fowl, the tortoise, the hog, and the man, are all nearly alike in the early stages of fœtal life (Figs. 1, 2, 3, and 4), utterly different as these creatures may be when they have attained their full development—the Darwinian doctrine has thrown a flood of light on the relationship of plants and animals, and shows us that when animals have got as it were on the wrong track, however far they may go in it, they never come to anything very good.

Nobody expects much of a jellyfish. Its soft, pulpy substance is incapable of anything but the simplest movement, and no animal that has not something hard to steady it can greatly excel the jellyfish. The soft mollusks which use their hard casing only for protective purposes, like the oyster and the snail, are bound to stay low in the scale of existence, and the highest mollusk (the octopus) appears to be striving after something better, but only by the aid of an attempt at a skeleton—the so-called cuttlefish bone. But this has no joint in it, and even the octopus does not amount to much. Articulata with their jointed skeletons have reached such a pitch of social organization as to be held up for examples to mankind, and ants and bees are regarded by some as almost the mental equals, if not the superiors, of some of the savage tribes of mankind. But the outside skeleton is a sore disadvantage, for the animal must either remain without growing in

Fig. 5.—Section of Head of Femur, to show the arrangement of the fibers of bone so as to give strength to it. (From Donald Macalister.)

size, or else it must be periodically cramped for room, and periodically burst its shell, leaving itself naked, weak, and defenseless. The right thing to do is evidently to do like the vertebrata, and have the hard parts inside, and the soft parts outside; but the relationship of these parts is a sore task upon the student's memory, and to many a one anatomy is a burden too heavy to be borne, and the unfortunate youth is forced by it to leave the study of medicine and turn his attention to some easier pursuit.

Now, I think that with a little trouble one may find a way of linking anatomical relationships together in a more rational way than that of "Bodfi," a word which in my student days was used as a mnemonic to describe the form of the hippocampal convolution of the brain—backward, outward, downward, forward, and inward. The word also served to describe the course of the ribs, but Dr. Anderson Stewart has shown us how naturally the peculiar twist the ribs take in a man arises from his upright position. Taking a circular steel hoop, and simply hanging it up by one side, he shows that it assumes an oval shape, like that of the thorax of animals going upon four legs and whose ribs hang vertically from the spine. On raising this up by one point it becomes twisted upon itself and takes precisely the peculiar bend which the ribs possess in man. The advantage of a naturally jointed skeleton is so obvious that I need not further discuss it here, nor need I discuss the texture of bone which has been so admirably treated of by my friend Dr. Donald Macalister, of Cambridge (Fig. 5).

Fig. 6.—Diagram of Shoulder Joint, to show the capsule.

The ligaments and the joints were to me most puzzling until Dr. Joseph Bell pointed out to me how very simple they were. What is wanted in a joint is a capsule to go round it so as to hold the ends of the bones together and prevent the synovial fluid from oozing out. If the bones have to move freely in all directions they must have a ball-and-socket joint, as at the shoulder (Fig. 6) and at the hip, and there you will have a simple capsule because it can not be particularly strengthened at one point or another without interfering with freedom of movement. In the case of a hinge-joint, such as those of the fingers or toes, elbows or knees, you will have the capsule remaining thin at the front and back so as to leave the movement free, but you will have it strengthened at the sides so as to tie (Fig. 7) the bones more firmly together, and the stronger parts are called lateral ligaments. If several bones have to be connected, each one must be tied first of all to the one nearest it, and then two or three must be tied together at a time, and in this way we get the network of ligaments which we find at the wrist and tarsus (Fig. 8). The same thing is true

Fig. 7.—Diagram of Ligaments of Phalanges—a capsule and lateral ligaments.

of muscles, and, as Prof. Goodsir used to point out, the muscles of the back, so perplexing at first, are really quite simple in their arrangement. For each of the spinal vertebræ has to be bent and straightened and has also to rotate more or less upon its neighbors, so as to allow the upper part of the body to swing round upon the lower. We have, therefore, muscles going from the spine of one vertebra to the spine of the next, and then muscular strips stretching over a few and then over many vertebræ, so as to straighten the spine either in part or whole, as the movements may require. A similar arrangement holds good for the muscles passing from the spines to the lateral processes and which rotate the vertebræ on one another.

FIG. 8.—DIAGRAM OF THE LIGAMENTS OF CARPUS, as seen from behind. Besides these there are ligaments passing in various directions, so as to bind the bones more firmly to each other.

But if we are to group the muscles and nerves of the body into one easily remembered whole, we must see what is the chief function to be subserved by them, what is the center of the little universe which they compose. The function of most imperious necessity is respiration. A man may starve himself to death, but he can not kill himself by holding his breath. He may refuse food, but can not refuse air. In the child the function of respiration is the first which evidences itself after birth, and the muscles which subserve it are more fully developed and more perfectly innervated than others. The nerve channels which supply them are, as it might be termed, more deeply grooved than others, and it is along these channels that superabundant energy overflows in the movements of laughter which evidence joy. This has been very fully and wisely explained by Herbert Spencer in his essay on Laughter. But the great poet, whose recent death the whole civilized world is now deploring, has classed together in a few pregnant words the channels through which the overflow of energy may run in their proper order. In describing the joy evinced by a baby on seeing its mother, Tennyson says it

> "began
> A blind and babbling laughter, and to dance
> Its body, and reach its fatling innocent arms
> And lazy lingering fingers."

The very parts which attain to the highest development in adult age, and are capable of the finest and most dexterous movements, are the last to develop, and in infancy they are well described as "lazy lingering fingers." They take no part in the function of respiration, but they are of the utmost utility in the function which comes next to respiration in importance—namely, that of nutrition. The animal has to be fed, and all the arrangements of the limbs are more or less subservient to this primary object. In a fish the muscular masses at both sides of the spine bend the posterior part of the body and the tail alternately to one side or another, and so the animal is propelled through the water in search of food. No doubt these same muscles help it to escape danger, but their primary object is to obtain food; and if there be great hunger all animals will strive to feed, whatever be the risk they run in doing so. The movements of fish are simple com-

FIG. 9.—DIAGRAM OF THE MOTOR CENTERS IN THE BRAIN. (Modified from those of Ferrier and Horsley.) The motor centers have been numbered so as to represent the successive actions in seeing, taking, and eating the apple, etc.: 1. Eve sees the fruit (eyes turn to opposite side). 2. Looks more eagerly at it (head and eyes turn). 3. Turns toward it (head to opposite side). 4. Puts forth her hand to take it (*a*, movements of shoulder; *b*, of elbow; *c*, of wrist; *d*, of fingers). 5. Luxuriously shuts her eyes, so as to enjoy the sweet morsel more thoroughly. 6. Eats the apple. 7. Picks out and throws away the refuse (*d*, movements of fingers; *e*, of index; *f*, of thumb; *a*, *b*, *c*, as in 5). 8, 9, 10, 11. Went and got another for Adam (8, movements of hallux; 9, of small toes; 10, of knee and ankle; 11, of hip).

pared with those of animals with limbs, and especially with those of man. Yet the arrangements of man's body are equally adapted with those of the fish for obtaining food.

There are two prevalent ideas regarding the origin of man. One is that he started full grown and perfectly developed from the dust of the ground, and lived in a garden which he "dressed and kept." The other is the Darwinian one, that man is developed from an arboreal animal like the monkey, though lower than the monkey. It matters not which of these ideas we take, because they perfectly agree that primitive man lived at first in a kind of paradise where he was not exposed to the attacks of wild beasts, and where he fed on the fruit which he plucked from the trees around him. The story of Adam and Eve has got the advantage of not only being more poetical, but it is very much more easy to discuss the actors in the scene by the names of Adam and Eve, than by the terms "male" and "female frugivorous animal."

Let us take then the story from Genesis. One day Eve went into the garden of Eden—saw an apple upon a tree—plucked it, ate it, and then went to get another for Adam. In trying to analyze the muscles concerned in these acts, the easiest way is to go to your bedroom, strip off your clothes, imitate Eve's action, and as you do so, feel out the individual muscles as they contract under the skin. This plan of learning the muscles is one which I used to follow as a student of anatomy, and I found it a very useful one indeed. If you do this you will find the muscles of the neck, shoulder, arm, forearm, and hand contracting successively or together in co-ordinated movements, which are beautifully adapted to the purposes just mentioned. We might take the muscles which produce these movements one by one, but I think it is easier for the purpose of grouping them, though not so good for the purpose of study in your own room, to consider first of all the motor centers in the brain from which the stimuli proceed. Before proceeding to consider these I wish to draw your attention to the errors into which one may fall regarding the action of muscles as well as of the motions of the planets by regarding them from a wrong point of view. Thus, the action of the tensor vaginæ femoris is usually said to be that of rotating the thigh inward upon the body and thus turning the foot and toes inward also, an action which is denounced in all calisthenic exercises. But this muscle was not introduced into the body for the sole purpose of plaguing drill sergeants and dancing masters. As the late Prof. Sharpey used to point out, we ought to look at its action from the leg as a fixed point,

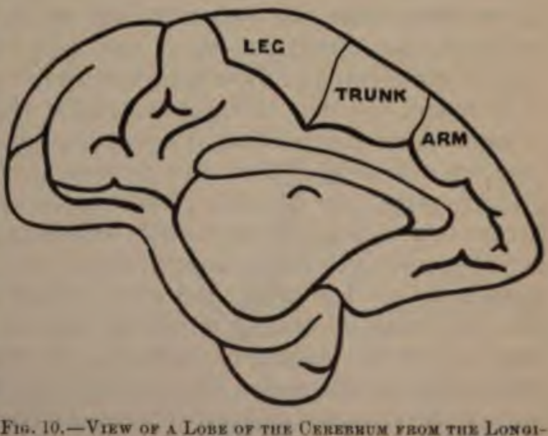

FIG. 10.—VIEW OF A LOBE OF THE CEREBRUM FROM THE LONGITUDINAL FISSURE. (After Horsley and Schäfer.)

and then we discover its true uses at once. Place your hand at the side of the hip over the muscle and march forward. You will that when one foot is planted firmly on the ground the muscle becomes tense whenever you lift the other ance it. Whenever the other foot is raised the muscle rotates the body outward on the fixed thigh and thus brings the center of gravity of the person over the resting foot. If it were not for these muscles we should run a risk of falling down as we lifted one leg instead of balancing ourselves with comfort upon that one which is resting upon the ground.

But we may now pass away from the muscles and nerves to the nervous centers from which they receive their stimulus to action, and whatever doubt may exist in regard to the adaptation of the muscles to the peripheral nerves and the action of plucking and eating the apple, I think there can be no doubt at all that such an arrangement exists in the motor centers of the brain. These centers were localized in the monkey by Ferrier, and it is the difficulty I have had in remembering their position that has led me to arrange them in accordance with some definite movements in a series of actions to which I have found they corresponded.

Fig. 11.—Diagram of Brain of Dog. (After Ferrier.) C. S., Crucial sulcus. 1. Movements of eyes, as if to see freely. 2 and 3. Movements of fore leg, and 4, of hind leg, as in running. 5. Movements of tail requisite in turning quickly, as when a greyhound is following a hare when it doubles. × × × Movements of mouth and jaws.

If we start from the posterior part of the second frontal convolution, pass upward along it and then across to the ascending frontal convolution, follow this downward parallel to the fissure of Rolando, and then turning the end of this fissure ascend again upward along the parietal convolution which lies behind the fissure, we find (Fig. 9) that the centers are arranged in the very order required for looking at the apple, stretching out the hand to take it, bringing it to the mouth, separating the seeds and throwing them away. The aim and object of the whole series of actions is to eat the apple, and we find that the centers for doing this are situated exactly where we should expect them—at the very end of the fissure of Rolando. In Ferrier's description we know that the movement which brings the hand to the mouth appears to be repeated on both sides of the fissure of Rolando, but it appears that the part anterior to the former would bring the hand to the mouth with the apple, while the part situated behind the fissure of Rolando would throw the remnants of it away. And here comes in a very interesting point: In order to complete the series of actions necessary for Eve to go and get another apple for Adam, you require movements of the leg (Fig. 10), and these are not fully represented on the surface of the brain. But they have been found by Horsley and Schäfer exactly in the place where, according to our idea, they ought to be, at the marginal convolution connecting the first and last centers of which we have just spoken and thus completing the circle of action.

Here I would like to draw your attention to the fact that great painters like great poets often appear to see more than ordinary mortals, and in his lovely picture, The Fall of Man, which is painted on the walls of the Loggia of the Vatican in Rome, Raphael seems to have almost forestalled the results of physiological experiment. In the mental picture of the scene which most of us must have formed for ourselves it is probable that it did not occur to many of us to pay any attention whatever to the movements of the great toe, and yet in Horsley's diagram of the cortical centers that for the hallux comes forward most prominently, and, as you will see from Raphael's picture (Fig. 15), Eve's foot is raised, and the great toe both in her foot and that of Adam is brought into what one would think rather too violent action. In the action of plucking and eating the fruit there is no break between the eyes, head, and arm, and that of the mouth and tongue, and in the usual process of eating the actions go on which are necessary simply to repeat the process of plucking and eating. Again, too, in the dog the arrangement is quite different (Fig. 11), and yet it is exactly what one would expect from the different necessities of the animal. In the frugivorous animal the motions are pluck and eat, pluck and eat; but in the carnivorous animal a long chase after the prey is necessary before the animal can bring the jaws into action, and in the dog accordingly we find that the movements of mastication, instead of being arranged in linear series with those of the limbs, are represented at a spot which is somewhat removed from them. In the cortex the centers are so far apart as to be distinguishable from one another; but as the nerve fibers which pass downward from them to the base of the brain become closely crowded together in the internal capsule, localization is more (Fig. 12), although Horsley and Beevor have found gen- e arrangement of the fibers from before backward rrangement of the centers just described. But

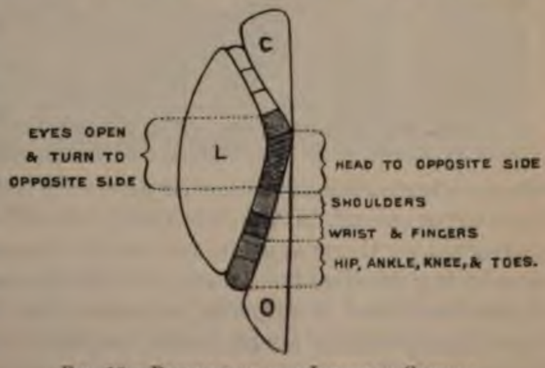

Fig. 12.—Diagram of the Internal Capsule.

as the nerves pass out from the spinal cord to reach the muscles they again become separated and, as Ferrier and Yeo have discovered, the motor roots which enter into the brachial plexus are arranged with a view to definite co-ordinated movements. Now, this plexus has been to me, and I think to many others, a perfect perplexity, both in its anatomy and physiology. Yet, if we take it from the same point of view as we have taken the motor centers, it becomes comparatively simple. We must not forget that, although the monkey is so much like man that we can draw most useful deductions regarding human physiology from experiments on these animals, we must not transfer without more ado the results of these experiments to man in their entirety. We must remember that man, although formerly a frugivorous and probably

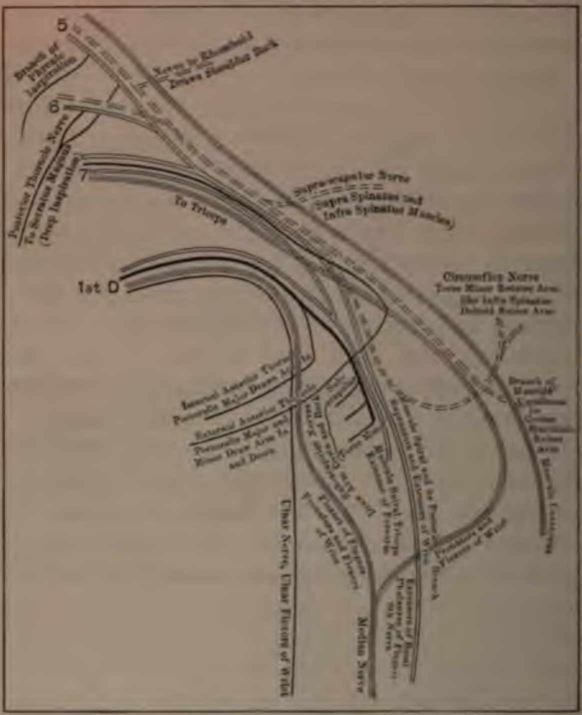

Fig. 18.—Diagram of the Brachial Plexus.

more or less arboreal animal, is now very different from a monkey, and experiments in the laboratory must be compared with and corrected by those experiments which disease makes upon man in producing localized palsies. I think it very probable that many here would find it difficult to answer the question, What are the movements which result in the monkey from stimulation of the fifth cervical nerve?—nor might he be able to remember them six months hence even if he learned to-night that they consist in the shoulder and arm being raised upward and backward, the humerus rotated outward, the forearm flexed and supinated, the wrist extended, and the tips of the fingers flexed. But he would find it easy enough to remember them, not for six months only, but for the rest of his life, if he were told that they were simply those required to raise the hand in such a way as to grasp an apple hanging straight above him. If you go through these movements you will find that your first impulse is to take a slight breath, which is chiefly effected by the diaphragm, and on looking at the brachial plexus you find that the first branch which is given off from the fifth nerve is a filament to the phrenic (Fig. 13). Then, just as you proceed to raise your shoulder, you take a still deeper breath, and this, too, is represented in the plexus by the posterior thoracic nerve, starting from the fifth and sixth nerves and going to the serratus magnus, which has little power to raise the ribs and act as an inspiratory muscle while the shoulder is depressed, but will

Fig. 14.—Expulsion from Paradise. (After Raphael.) The position of Eve's right hand shows the action of the seventh cervical nerve.

do so when the arm is raised. If your hand is hanging by your side, you will find the shoulder slightly drawn backward by the rhomboid and the arm rotated a little outward by the infraspinatus, which is supplied by the suprascapular nerve. Next, you raise your arm, and as you do so you will find that unconsciously you bend it and turn it out, you extend the wrist and flex the fingers. The raising of the arm and turning it out is effected by the deltoid and teres minor, which are innervated by the circumflex nerve, while the shoulder is still further raised by the trapezius, which gets its nervous supply from a higher source—the spinal accessory. The biceps and other flexors of the arm receive their supply through the musculo-cutaneous nerve from the outer cord. In the movements of the wrist and fingers the fifth and sixth nerves appear to co-operate, and those of the fingers are chiefly due to the sixth. The supinators and extensors of the wrist, fingers, and thumb get their nerves from the musculo-spiral or its interosseous branch. To resume, the fifth and sixth cervical nerves raise the shoulder, flex the forearm, and extend the wrist. The nervous energy passes from them along the upper trunk and outer cord of the brachial plexus to the flexors of the forearm, while the impulses to raise the shoulder, rotate the humerus, and extend the wrist and fingers travel chiefly through the posterior cord by the musculo-spiral nerve and its interosseous branch to the extensors of the wrist and digits. From the fifth and sixth cervical nerves we make a jump to the first dorsal, which has an exactly opposite action. The movements it produces are that the hand closes firmly upon the apple, the wrist is twisted round into the prone position and flexed to the ulnar side. The forearm is extended, and the upper arm is retracted in the manner required to pull the apple from the tree. In these movements, if you put your hand upon your chest, you will find that the pectoral muscles are largely engaged, and they receive their nerves partly from the internal cord of the brachial plexus. Flexion to the ulnar side is produced by the ulnar nerve, and the dragging of the arm down is effected by the subscapular, teres major, and latissimus dorsi muscles, which are supplied by the subscapular nerves, and the triceps by which the arm is extended gets its nerve supply from the musculo-spiral. But these movements, especially if executed forcibly, as they would be if the apple were firmly attached, would bring the hand below the level of the mouth, and the prone position would keep the apple away.

We must now go back to the sixth cervical nerve, which we find will rectify this action, for it raises the arm inward and upward with the forearm flexed, so as to bring the hand to the mouth, supinated, and with the wrist and basal phalanges extended, so as to present the apple comfortably for eating. In effecting this movement the nervous impulses travel by the posterior thoracic, circumflex, musculo-cutaneous, musculo-spiral, and median nerves to the serratus magnus, deltoid, biceps, brachialis anticus, supinator longus, and extensors of the wrist and basal phalanges. The position of Adam's left hand in Raphael's picture shows this action in its middle stage, before it has carried the hand to the mouth. The few last phalanges of his fingers are flexed, and we may suppose that the flexion is effected by means of the median nerve, but it is just possible that their flexion may be due to mechanical pulling on the tendons by the extension of the wrist and basal phalanges just as the hand is opened in the well-known schoolboy trick by bending the wrist forcibly inward, and thus mechanically stretching the extensor tendons of the fingers. In this picture the action of the serratus magnus muscle in drawing

FIG. 15.—THE FALL OF MAN. (After Raphael's picture in the Loggia of the Vatican, Rome.) The position of Eve's left arm illustrates the action of the fifth cervical nerve, and that of her left hand the commencement of action of the first dorsal nerve. The position of Adam's left arm shows the action of the sixth cervical. The action of the hallux is well shown in Eve's right and Adam's left foot.

forward the shoulder and rotating the scapula so as to raise the shoulder is well seen, and the action of the muscle appears almost exaggerated. We have already found that it gets a branch from the fifth nerve as well as from the sixth. We may fairly suppose that the branch from the fifth is the channel for the impulses which cause the muscles to act as an inspiratory muscle when raising the arm to pluck the apple, while that from the sixth serves to excite the muscle to pull the shoulder forward. Now, here we have got, apparently, the movements required for plucking the apple and conveying it to the mouth, and yet we have got two nerves which seem superfluous—the seventh and eighth cervical. We may suppose the seventh to be brought into play later on, when the first pair recognized their nakedness, for its action in the monkey is to bring the hand over the pubis in the position of Eve's, as represented by Raphael in the Expulsion from Paradise (Fig. 14). We can not in this scheme find a place for the eighth nerve in the entirety of its action, as observed in monkeys, but the first part of the movement which it produces may be used in throwing away the refuse of food.

The mere fact that I have been unable to work this last nerve properly into this scheme shows you how imperfect it is, yet I trust that, as an attempt to hang together the facts—anatomical and physiological—it may not be without service as an aid to your memories, and still more as an inducement to you to find out the true relationships of the different parts of the body.

PROF. G. F. WRIGHT AND HIS CRITICS.*

By Prof. E. W. CLAYPOLE, B. A., D. Sc. (Lond.), F. G. SS. L. E. and A.,
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FOR more than twenty years a controversy on the antiquity of man has prevailed in the scientific world. This controversy is still far from decision. The origin of the human family is veiled in obscurity, and all efforts to discover our primeval ancestor have hitherto failed. The gloom and darkness enshrouding the past are not yet sufficiently dispelled by the light of science to reveal prehistoric man in his early stages.

The geologist and the archæologist have been chiefly engaged in the search. They have followed the trail of man to some distance and can tell us something about him within narrow limits. But beyond these their efforts have met with little success. At this point it seems as if some huge effacing hand had swept across the field and blotted out almost every trace of his existence.

And this is no mere imagination. A huge effacing hand has

* Man and the Glacial Period. By G. F. Wright. International Scientific Series. D. Appleton & Co.

swept across the field and wiped out the records written as with an iron pen on the rocks, and has engraven in their stead a palimpsest of its own. The Ice age is now a familiar topic, and its massive ice-sheet a reality to all. The continental glaciers which covered a great part of North America and Europe with ice thousands of feet thick, and enduring for thousands of years, literally swept from the face of the country the monuments of preceding life, leaving in their place its own memorials which the geologist is now learning to interpret.

Here is the unexpected barrier which meets the archæologist and the geologist in their investigations. They can follow the trail of man back into the Pleistocene era almost or quite to the edge of the ice. There it either becomes exceedingly faint or is lost altogether. In the tangled maze of glacial history the previous confusion is worse confounded, and the thin thread of evidence for man's existence is broken or lost.

The nature and date of the Glacial era and man's relation to it thus become important problems in the main issue, and it is these with which Prof. Wright's book deals. To some geologists the Ice age was single, to others it appears to have been double, triple, or even more complex. Some believe that man was contemporary with the later and even with the earlier stages of the era. Space will not allow us here to do more than mention these divergences of opinion, but so much was necessary in order to understand the scope of the work.

The appearance of Prof. Wright's little book has been the signal for a renewal of the controversy with fresh energy, not to say with acrimony, yet in it the ordinary reader would scarcely find any cause for commotion. It is for the most part merely a condensation of the same writer's larger work on the Ice Age in North America. Its aim is to lay before the general reader a short sketch of the present state of our knowledge of the Glacial era, and to briefly state the evidence bearing on man's existence during it or any part of it. The book is not sensational; it contains little or nothing that is new; it publishes no startling facts; it propounds no novel or strange theories, scientific or unscientific; it is simply, as it professes, a summary view over the field of glacial geology.

The author is well known to geologists by his share in the epoch-making work of tracing the southern limit of the ice-sheet across the North American continent. This was accomplished by him in connection with Lewis, Upham, Smock, Chamberlin, Cook, Leverett, etc., and, as far as the western Illinois State line, may now be considered definitely known. In this great work Prof. Wright may fairly claim a place among the first, menced his studies on the drift hills of Andover, Mass., as early as 1876, when his first paper was read before the Boston Society of Natural History. Largely through him the late Prof. H. Carvill Lewis was brought into the work, and our author's studies on the Muir Glacier in Alaska gave us most of our early knowledge of a region previously almost a *terra incognita* to science.

Qualifications thus won by hard work in the field secure for the author, Prof. Wright, no mean place among glacial geologists, and entitle him to at least respectful attention. It is therefore somewhat surprising to note the storm of criticism and even abuse with which the work has been assailed by certain geologists.

Far be it from us to deprecate criticism, even if severe. Equally far is it from the desire of the author. But we feel justified in the name of science in entering a protest, and a strong one, against the style and manner of the articles which have appeared in condemnation of the work and in denunciation of the writer.

In thus protesting against so unusual and apparently concerted an attack we do not wish in any way to defend the author from so much criticism as is just and courteous. The book is far from perfect. We can not acquit the writer of apparent haste in its completion. Besides inaccurate expressions there are in some places insufficient statements of the divergences of opinion. Many of these have been already pointed out, and have received all the blame that is due, and in no measured terms. The title, for instance, should have run, The Glacial Era and Man, for of its ten chapters only one is closely connected with human history. It is scarcely correct to write of the great interlobate moraines as medial (page 100). We presume that our author means that their material was carried on the ice during its flow. This was in great part true, but they did not exist as medial moraines at any time, and were only formed at the melting end of the ice-sheet. Nor do we think that any evidence worth consideration can be adduced in support of the supposition of a great southern subsidence to explain the origin of the loess in the Mississippi Valley. We think that Prof. Wright should have recognized the fact that northern drift had been reported from Kentucky many years before his visit (page 212), and the expression "I have traced the limit of southern bowlders for thousands of miles across the country" is certainly unfortunate. It is, perhaps, literally true in the sense intended, but it is liable to misconstruction, and has been misconstrued. We might also object to his use of the word "preglacial." In this, however, he has many companions among geological writers.

We may further add that his explanation of the relation of the *névé* to the glacier has been assailed with justice, and is quite indefensible. There is, however, little occasion here to expose the weak points of the volume, because this has already been done in a most excellent and exhaustive manner. The reviewers are certainly to be complimented on their acumen, and we trust that in a second edition Prof. Wright will take full advantage of the kindness of his lynx-eyed critics. We believe that he may comfort himself with the thought that the worst that could be said has been said concerning his little volume.

But while we admit that such faults as those above noted justify unfavorable criticism to the extent of the errors, we can not for a moment allow that they warrant the one-sided, persistent, and personal attacks that have been made on book and author. The style of several of these is, to say the least, extra-scientific. One of Prof. Wright's assailants has so far forgotten the amenities of debate and the consideration due to himself and his profession as to employ epithets which can only be correctly described as "Billingsgate." Not all, we are happy to say, or even the majority, have been so self-disrespectful. We will postpone this case for the present. Meanwhile we propose to dissect some of the other criticisms, which, being clothed in a more decent and reputable dress, may lawfully claim the right to appear in public.

Granting this freedom from indecent exposure of temper on the part of most of the hostile reviews, we yet can not acquit their authors of manifesting unnecessary severity and also of lacking that calm judicial spirit which alone can give value to a criticism. There is too little logic and too much passion manifested in their writing. We would remind such belligerents that contradiction is not logic, and that ridicule and contempt are not argument. To pooh-pooh an opponent's evidence may amuse the ignorant, but can not mislead the thoughtful. With these it is far more likely to recoil and hurt the cause in which it is employed. It is surprising and at the same time somewhat amusing to those outside of the fray to see weapons so unscientific employed in what professes to be a scientific discussion. To the public the onslaught made on Prof. Wright by chiefly official geologists savors too strongly of the old-time, intolerant, theological method of crushing a formidable rival by dint of concerted action or force in default of reason. This may be altogether an unwarranted inference; indeed, one can not readily admit even the supposition, but it is inevitable, and for it these writers alone are responsible.

Some of the critics have gone out of their way to make caustic remarks on the profession of the author. Surely they should be familiar enough with the records of Science to be aware that, in spite of all the obstacles which theology has thrown in her path, many theologians have risen superior to their environment, [illegible] m geology is deeply indebted. Without the labors of

Buckland, Sedgwick and Woodward, Bonney, Blake, Crosskey, Fisher and Renard, Haughton and Hitchcock, many valuable chapters would be missing from her literature. Instead of regretting that a theological professor should be found in the geological field, it would be more seemly to wish that there were more such men. Instead of showing apparent jealousy, all helpers should be made welcome. Official reserve and exclusiveness are out of place in science. The field is the world, the harvest is plenteous, and the laborers are all too few.

Especially inappropriate is the above objection when it comes from men whose time is largely occupied with the labors of administrative office, leaving only the spare hours for the study of geology. We freely admit that men whose lives are wholly given to geology should produce the greatest results. They have advantages possessed by no others. Concentration of thought and energy, command of funds, access to books, and assistance of many needed kinds, all these things are theirs. But the fact remains that the great bulk of the work always has been and still is done by volunteers, working for the most part at their own expense of time and money. The amateur is too often looked down upon by the professional, but it has happened over and over again that the professional has been glad to borrow the results of the amateur, and more than once has the amateur come out the victor in a contest. It was an amateur, Nicol, who maintained that the gneissic rocks of the west of Scotland were of Archæan age and not metamorphosed Silurian strata, and, though for fifty years the authority of Murchison and the British Geological Survey was arrayed against him and his single voice was drowned by their official shoutings, yet time has justified him, and the "Secret of the Highlands," lately wrung from the unwilling rocks, has been proclaimed by Nature in tones so loud that no combination or concert could prevent its being heard. It is folly, we assert, to attempt by any other means than fair and open argument to put down the amateur in science. He possesses a tenacity of life and purpose equal or superior to that of officials or professionals. Many of the brightest names on her roll are the names of amateurs, from those of Hugh Miller, the Scottish stonemason, and William Smith, "the father of English geology," to others in the present day, too numerous and too well known to be named here.

The chapter of Prof. Wright's book which has specially aroused the ire of the critics is on Relics of Man in the Glacial Period, where the author has collected all the instances from America that possess any importance in which traces of man have been reported from strata of probable or known glacial date. The evidence of each is set forth concisely yet clearly. Positive conclusions are not drawn, and the reader is cautioned against hasty judgment. It is not easy to see how the scanty and fragmentary evidence connecting man with the Ice age could have been more fairly stated. Only six examples in all are given, and no case is brought forward in whose favor a considerable mass of evidence can not be quoted. None is new. They have been before the scientific world and the general public more or less for several years, and their evidence, *pro* and *con*, has been sifted and resifted, so that its value can now be fairly well estimated. And we are audacious enough to believe that there are men as competent to estimate it as any of the self-appointed judges who have taken on themselves to sit in judgment on the author. Yet more, our temerity goes so far as to lead us to prefer the calm and temperate conclusions of such men to the contemptuous and almost passionate utterances of others, learned and able we admit, but evidently carried away by a common impulse or (we say it reluctantly, but the facts irresistibly suggest it) acting under instructions which they can not resist. Their zeal has outrun their discretion.

Coming down to details, we note that the critics are not always agreed among themselves. One of them, a distinguished archæologist,* admitting that "as a glacialist the author stands among the first in the country," goes on to assert that the well-known gravels at Trenton, N. J., where Dr. Abbott has been for years finding very rude argillite implements, are of doubtful date and "require more study before we can assign their probable age." But an equally distinguished geologist, "the head of the glacial division of the United States Survey," says "the Trenton gravel is strictly contemporaneous with the Belvidere moraine," thus making it coeval with the greatest extension of the ice. Not even Dr. Abbott himself has claimed a greater age for the gravels and their contained implements than this; and Prof. Wright is yet more moderate in his estimates, assigning them to the later or even to the last stages of the era of ice. Until, therefore, it is definitely proved that all the investigators are mistaken who believe that they have really taken these implements from undisturbed strata, we think our author is justified in his conclusions.

If it would not be too presumptuous in an outsider, we would remind the distinguished archæologist that the whole problem is not contained in the position of the tools. Other elements are concerned, and it is not logical to insinuate a doubt concerning one line of argument and to remain silent on all the rest, or to quote his own negative experience against positive testimony.

It would be tedious to dwell on the details of similar finds in

* Science, October 28, 1892.

Ohio and Indiana. The utter rejection and slighting of testimony because it does not come from experts is, in our humble judgment, a serious blunder. It is easy, by the assumption of superior knowledge and "later information," to discredit able, honest, and competent work by men who are termed, not with respect, "amateurs." We have already shown what science owes to amateurs. Let us take the further liberty—and we do so with the profoundest respect for the distinguished professionals concerned—of reminding them of the experience of their European brethren in a similar case. Fifty years have gone by since M. Boucher de Perthes found in the gravel near Amiens implements of human manufacture. His discoveries were published and received by the scientific world with complacent contempt and neglect, not to say opposition. "The gravels were modern," "the beds had been disturbed," "the implements had been recently inserted," "the whole story was fictitious," * and its author a "cheat," a "shyster," and a "charlatan," as nearly as French politeness could match these terms. But time rolled on, the evidence could not be shaken by neglect and contradiction; and when at last a committee was sent to the spot they returned unanimously convinced that the amateur was right, and that all the previously held theories of geologists on the antiquity of man must be reconstructed through the finding of these rude implements by M. Boucher de Perthes. History repeats itself, and we respectfully urge on Prof. Wright's critics the careful study of the little incident above quoted, and especially the momentous moral which it implies and which we leave them to draw.

The caution of our author is shown in his discussion on the most doubtful case, that from Claymont, Delaware, where an implement was reported by Mr. Cresson from the Philadelphia gravel underlying the Trenton gravel, and consequently of greater age. We need not remind our readers that the evidence demanded in support of every discovery of human relics increases rapidly with the implied distance of their date. This is just, and the language employed concerning the Claymont tool could scarcely have been more guarded. Prof. Wright says (page 258), "As there is so much chance for error and so little opportunity to verify the conclusion, we may well wait before building a theory upon it." His opponents could hardly desire more caution.

We may, however, linger awhile over the next instance—the well-known relics from Table Mountain, California. These were first announced by Prof. Whitney, in his report on the geological survey of that State, and others have since come to light. We can not here give details, but must content ourselves with saying

* See American Anthropologist, January, 1893.

that they were found in the auriferous gravel underlying a sheet of lava which flowed over them and has since been glaciated and cut through by the stream. Naturally, the occurrence of human relics, and relics of so late a type as were these, was not easily accepted by archæologists or geologists. Probability and prejudice were both on the other side. But both must yield before sufficient evidence; and we make bold to say that, in the face of the testimony now accumulated, skepticism is no longer reasonable. The objection raised against the discovery is unworthy of the able archæologist* from whom it comes. "They belong to a modern industry, and were probably left in their shafts by the aboriginal gold-diggers a few centuries before the conquest. The manner of their deposition alone proves this, and the case is given up by Prof. Haynes in his appendix to Prof. Wright's book."

We do not wish to be discourteous, but justice impels us to ask if this distinguished archæologist really expects the public, or the scientist accustomed to the weighing of evidence, to accept the insinuation of one who was not near the spot in preference to the sworn statement of one who was there, and testifies that he took the relics with his own hands out of the gravel, and that there was no disturbance (such as an aboriginal shaft) or natural fissure by which access could be obtained either there or in the neighborhood. Verily, to us this seems like "criticism run mad."

As to competency in a matter of this kind, we will hear Mr. G. F. Becker, in the Bulletin of the Geological Society of America, 1891, page 192:

"It has sometimes been objected to the authenticity of implements in the gravels that the finders, with the exception of Dr. H. H. Boyce, were miners and not scientific men. Now, so far as the detection of a fraud is concerned, a good miner, regularly employed in superintending the workings, would be much more competent than the ordinary geological visitor. The superintendent sees, day by day, every foot of new ground exposed, and it is his business to become thoroughly acquainted with its character; while he is familiar with every device for 'salting' a claim. The geological visitor finds a mine timbered and smoked. He can not fully acquaint himself with the ground, and is usually unfamiliar with tricks. It is therefore an argument in favor of the authenticity of implements that they have been found by miners. . . . There is, in my opinion, no escape from the conclusion that the implements actually occurred near the bottom of the gravels, and that they were deposited where they were found at the same time as the adjoining pebbles and matrix."

In reference to the above-quoted opinion of Prof. Haynes we

* Science, October 28, 1892.

must take the liberty of saying that it is logically irrelevant. Prof. Haynes is only discussing the "find" in its relation to Tertiary man, which is a totally different topic. The fallacy underlying most of the objections to the Californian relics is the tacit assumption that the glaciation of the lava beds was contemporaneous with that of the Northern States. This is unproved, and probably untrue. Its rejection may remove the chief difficulty.

Once more we must return to the charge. We regret to be obliged to criticise the same critic for another example of illogical reasoning, but, in view of the severity of the attack on Prof. Wright, we feel that the assailants should not and will not object to the counter-thrust.

The story of the Nampa image is now well known. It was told by Prof. Wright, in 1890 and 1891, to the Boston Society of Natural History, and by them published in their Proceedings. The image is a small figure of burnt clay, about one inch and a half long, which is said to have been brought up by the sand-pump from the surface of an old soil at the depth of three hundred and twenty feet below a sheet of lava fifteen feet thick. The "find" was not hastily and superficially examined. A long and careful inquiry and a visit were the means of eliciting the details, and collateral investigation was made into the reputation and antecedents of the informants. All this has been before the world for many months, but no refutation or rebutting testimony has been offered. Yet the following extract will show how contemptuously the investigation is tossed aside:

"Dr. Wright's last example is the feeblest of all—the Nampa image.* . . . It is sad to destroy illusions, but when this same image, with its story, was laid before a well-known government geologist, he at once recognized it as a clay toy manufactured by the neighboring Pocatello Indians, and the person displaying it replied, with engaging frankness, 'Well, now, don't give me away.'" †

Mark in this connection the fact that not a fragment of counter-evidence is brought. There is nothing, absolutely nothing, to shake the previous testimony. An anonymous letter could hardly be used in a court of law, yet here is not even so much as that. Merely an anonymous statement is brought forward solemnly by one who is supposed to be accustomed to serious investigation as a rebuttal of written and repeated testimony from men of stand-

* Science, October 28, 1892.

† Another version of this story is given by a second critic (see American Anthropologist, January, 1893), who reports the reply as follows: "Don't give me away; I've fooled a lot of fellows already, and I'd like to fool some more." The difference is not important, but it emphasizes the denial given below.

ing and reputation. It is not easy to believe that such a logical fallacy could come from such a source. The *ipse dixit* of a man in the position of this critic might be entitled to respect, but we have not even that. He can scarcely expect scientists accustomed, as the author, to look for arguments to accept this bald statement. It is difficult to treat it seriously. *Risum teneatis, amici?* Let him get from the "well-known government geologist," here and thus referred to, a full, exact, and certified statement of the conversation over his own signature, giving all details as he recalls them, what he said, where, when, and to whom; with what was said to him in reply and by whom, and the criticism will then be worth consideration. But, as it now stands, it is weaker and feebler than the weakest and feeblest of the cases which Prof. Wright has brought forward.

Of course, we can only guess who this well-known government geologist can be, but if circumstances indicate correctly it will, in our opinion, be long before any statement such as that above desired will be obtained from him to confirm this illogical objection to our author's express assertion. We will further say that the owner of the image positively and emphatically denies in writing having ever himself made the remark above anonymously quoted, and volunteers the further statement that he knows nothing whatever of the whole alleged occurrence.

Such insinuations, unaccompanied with evidence and intended to undermine confidence in the results of years of persistent work, are really beneath notice, save to expose their utter logical baselessness and the animus whose shadow is visible beneath and around them. Let us turn to some criticisms of a different kind.

There is another tone sometimes adopted, less undignified perhaps, but not less inappropriate and offensive, especially in a supposed scientific discussion. It may be called the "omniscient" style. It sounds as if coming from some lofty height wherefrom the writer can discern all the details of a struggle in which the unfortunate actor below is bearing an insignificant part. This style is a danger especially besetting men in official positions. The infallibility of office is well known and sometimes amusing. "No mistakes allowed." It is a form of apostolical succession not unknown in the realm of science. The mantle of Elijah is supposed to rest on Elisha, whether it fits or not. To those official geologists who so far forget themselves as to assume the air of superior knowledge, especially to the younger ones, we respectfully commend the wise and witty saying of Whewell, the great Master of Trinity, at Cambridge: "Be not too positive; we are all fallible, even the youngest."

Some of the remarks on Prof. Wright's book suggest the mental attitude above described. A positive statement is made on a moot point in science. Thus we read,* "It is demonstrated that the Ice age was prolonged and complex." Perhaps it was so. We express no opinion. But the distinguished glacialist who wrote it is well aware that not a few among his brother-geologists—men of experience, ability, and reputation perhaps equal to his own—totally disagree with him here, and believe that the evidence does not warrant so great an extension of the era. No doubt the question is settled in the mind of the writer and to his entire satisfaction, but he is guilty of misleading the public by thus baldly stating the proposition. Thus printed, it implies either that no one differs from him, or that those who do so differ are unworthy of mention or consideration. Logically, it is begging the question, for the whole controversy hinges on this point. It is more than this, it is committing the very error which he has charged on Prof. Wright. He says,† "Instead of pointing out clearly and fairly differences of opinion on vital points, Prof. Wright turns aside," etc. We can not find in the volume any assertion that the Ice age was a unit, though this is the view entertained by its author. On the contrary, fourteen pages are filled with the arguments on both sides, enabling a reader to form his own opinion. It is fair to expect the critic to shun the fault which he condemns. Yet here he has himself committed it.

Again, our distinguished critic boldly asserts,‡ "No geological expert of unquestioned competence has ever yet, so far as we can learn, found a single implement or stone flaked by man in a glacial formation in America which was clearly deposited contemporaneously with it." Possibly so. We here express no opinion on this or on any other moot point. But we may ask, By what right does he set himself up as a judge of the competence of all other workers who think that they *have* found such stones? Who, in his opinion, are experts? Where shall such men be found, and by what touchstone shall they be tried? Is official connection the grand *sine qua non?* The outsider is almost driven to this conclusion by the tone of the criticism. Are there no other men as competent as he who are of a different opinion? Is the mature judgment of long-standing workers who have earned by time and labor a right to speak to be waived aside in favor of the opinion of some single expert? And who shall testify to this expert's expertness? It would be ungenerous to assume that a little band of scientists seriously desire to extol themselves and each other by attempting to "sit down" on every one outside. Yet let us assure them that this is the conclusion to which their language leads. The air of dogmatic assumption and superiority that per-

* Dial, Chicago, November 16, 1892, p. 306. † Ibid. ‡ Ibid., p. 304.

vades many of the criticisms of Prof. Wright's book is dangerous to the freedom of scientific discussion.

In an unsigned review published in an issue of the Chicago Tribune in October, 1892, we read: "Prof. Wright believes that there was but one Ice epoch. In the present volume this question is so handled as to leave the impression that the general opinion of glacialists is in favor of but a single epoch." How true this charge is let the following extract show (page 109): "Do the phenomena necessarily indicate absolutely distinct Glacial epochs separated by a period in which the ice had wholly disappeared from the glaciated areas to the north? That they do is maintained by President Chamberlin and many others who have wide acquaintance with the facts. That they do not certainly indicate a complete disappearance of the ice during an extensive interglacial era is capable, however, of being maintained without forfeiting one's rights to the respect of his fellow-geologists." The criticism is anonymous, and we are thereby spared the disagreeable association of any name with a direct misrepresentation, due, let us hope, either to careless reading or previous writing.

To one of these two causes we should also probably assign the remark, "Mr. Leverett's work is ignored,"* whereas Prof. Wright quotes Mr. Leverett's work as correcting that of President Chamberlin in the delineation of the terminal moraine south of Lake Michigan (page 101).

Another of these experts † writes in the same omniscient style about the "unskilled observers whose difficulty is to distinguish between objects included in the ancient gravel when it was formed and those imbedded recently. . . . Neither of the four are geologists (*sic*), and they could not well have appreciated the need of extreme care." Any reader of the evidence can form his own opinion upon this assertion. Again, "Four of the rude specimens said by inexpert observers to have been found in place in glacial gravels," etc.; and again, "The unsafe matter furnished by inconsiderate bookmakers to a credulous public." This sort of writing would in ordinary mortals be called conceited and unbecoming, but probably from the pens of the self-appointed experts it is perfectly proper toward the amateur and the public. However, let it pass; there is more to come.

As if this were not enough, we read in the same place the following yet more unscientific statement: "The implement from Tuscarawas County, Ohio, can be duplicated from the refuse deposits of any of the great Indian quarry-shops of this country." This is an extraordinary assertion, surpassing in audacity any

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* Dial, Chicago, November 16, 1892, p. 306.

† American Antiquarian, January, 1893, pp. 35, 36.

previously quoted. We are familiar with the Newcomerstown flint, and can challenge the production of any reject from the neolithic refuse-heaps, or indeed of any fac-simile that could mislead a real expert on either continent. We are giving no opinion here on its nature or on its relation to the gravels in which it is found. We simply protest against the assumption by any one of the right to deny the competence of the oldest and most careful observers in favor of his own innuendo and without a tittle of evidence. It is idle to tell us that "gravels reset,"* that "flints may be introduced after deposition," that "stones may be broken by Nature so as to simulate the work of man," etc. All this we know, but we ask the reason for suspecting that these things have happened here and without detection. Without this the objections are mere insinuations from men who will not admit that others know more than themselves; effusions of the "omniscients" in the garb of "agnostics," if we may be pardoned for borrowing the style of the Emerald Isle.

We scarcely agree with some of the critics that it is unadvisable to take the public into confidence until final and positive results are obtained. This, again, savors too much of officialism. The reading part of the public is interested in the work of discovery not less than in the outcome, and is able and willing to watch its process. Prof. Wright was advised against publication by the "head of the glacial division," on the ground of the immaturity † of the investigation and the liability to teaching the public erroneous views. The ready sale of The Ice Age in North America, now in its third edition, is a proof that the public was ready and the time ripe, and few who have read it with ordinary care can fail to grasp the real condition of the problem. We think that any reader who deduces final and positive conclusions from the book has read it to little purpose. Suspense of judgment is not a state of mind congenial to the untrained or always found in the trained, but this must be the mental attitude of any reader of the work in regard to the great problem of which it treats. Anxious regard for the public is entirely supererogatory.

Moreover, if justification for such publication of incomplete work were required, it may readily be found in the example of the "head of the glacial division" himself, who very soon after his appointment published in the Second Annual Report a map of the terminal moraine of the second Glacial epoch. How incomplete this was may easily be seen by any one who will take the trouble to compare it with the latest work in the same field. Moraine after moraine has been added outside the terminal moraine,

* American Antiquarian, January, 1893, p. 35.

† Dial, January 1, 1893, p. 8.

chiefly by the labors of Mr. Leverett, until the terminal moraine now almost coincides, in Ohio at least, with the southern margin of the drift area.

Far be it from us to impute unworthy motives to any one of these critics. We would, if we could, believe that they are all impelled solely by a love of truth and a regard for the public good. But we regret that they have not made this less questionable. Criticism of a former colleague in terms so unsparing is sure, whether justly or unjustly, to be interpreted according to its obvious spirit. We unwillingly think of words so ugly as "jealousy," "conspiracy," "concerted attack," etc., but we warn these critics that they will hear them if they have not already come to their ears. They may fancy that they are the sole proprietors of the field, but there are men of science in the land whose voices will be heard in loud and earnest protest, and whose voices when heard will carry weight with their brethren and with the public. American geologists will not be silenced by official insolence or warned off their fields of investigation by "notices of trespass" from self-appointed owners. The whole tone of the discussion on one side is far from honorable to science, and will not redound to the credit of American geology.

We have said enough. We will not touch on that part of the controversy springing out of the author's connection with the United States Geological Survey. It may be right to estimate a man's work by the number of days for which he was paid.* This is probably the official method of reckoning, but we will remind the critic who dwells on this point that amateurs are in the habit of spending time and money very freely without hope of recompense and, indeed, without keeping any record. Probably this fact lies at the bottom of the discrepancy on which so much stress has been laid.

There is one article which demands a few special words. It comes from the pen of a much younger man than Prof. Wright, and allowance should perhaps be made on this ground. We observe that in his reply the professor seems to be conscious of this, and to have restrained his pen. But, after granting so much, we can not acquit this gentleman of forgetting the courtesy due to an older man and an older geologist than himself. Energy of expression may be forgiven in the heat of argument, especially if it arises from strength of conviction. Even authoritative and dictatorial assertion without condescending to give reasons, however illogical, is not unpardonable in an opponent. Hard blows received in fair fight may leave scars, but their memory does not last; and hard words hastily spoken, though not pleasant,

* Dial, January 1, 1893, p. 7.

seldom leave a lasting sore on the mind of a generous foe. Any such is usually healed by the ready and full apology which quickly follows.

But a combatant who stoops to employ weapons which his opponent disdains to use, places himself thereby outside of the pale of honorable warfare; and the controversialist who descends to the use of unparliamentary language in debate is self-excluded from further participation.

It is with regret that we write this, but it is due to all who cherish the honor of their science and the credit of American geologists to enter an earnest and serious protest against the adoption of a tone so bitter and language so unusual as those which characterize the article above referred to. We are unable to fully fathom the motives which led the writer to transgress so far the limits of judicial calmness and social courtesy, and we believe that his own manly feeling will sooner or later awaken and provoke his regret. Meanwhile the only result will be to arouse sympathy with the author, whose calm, dispassionate, and logical replies place the theologian-geologist on a marked vantage-ground above his professional but younger and overzealous brother. We regret that the American Anthropologist* has stooped to allow its pages to be disfigured with words which in no conceivable circumstances can be applicable by one scientist to another, or used by one in reference to another. It is difficult, without speaking too strongly, to characterize fitly so flagrant a breach of the unwritten code.

This critic has, of course, a perfect right to find fault, if he so desires, with any part or parts of the author's work. This he sees fit to do in regard to his measurements of the motion of the Muir Glacier. But he has done so in terms unnecessarily offensive and contemptuous. He contrasts the "blundering attempts" of Wright with the "excellent measurements" of Reid. The former gave seventy and the latter seven feet a day.† The difference is of course great and surprising; but the dogmatism of our young geologist is not very well timed, for admittedly the two measurements do not relate to the same part of the glacier. Moreover, we may be permitted to hazard the inoffensive remark on the other side that, after all, Prof. Wright's figures are more in harmony with some other known facts than are the smaller ones. We must presume that this critic is aware, though he has apparently for the moment forgotten, that, though the Alpine glaciers move at only a few feet daily in August, yet those of the arctic lands have a much more rapid rate. Thus the gigantic glacier of Jakobshavn, in Disco Bay, two and a half miles wide, has a move-

* American Anthropologist, January, 1893.

† Ibid., p. [illegible]

ment of fifty feet per day in the middle. The glacier of Karajak, four miles across, moves at thirty feet daily, while one at Upernavik travels at ninety-nine feet every twenty-four hours. Combining all these statements we recommend waiting before criticising.

The severe and caustic animadversions above criticised certainly show on the part of the critic a courage almost amounting to recklessness, but he has not always tempered his zeal with truth. In his anxiety to discover "unhistoric statements," as Prof. Huxley once called them, in Prof. Wright's book, he has not been sufficiently careful that his "finds" were in undisturbed strata, that they did not come from a talus, or had not been inserted at a later date. But what shall we say if they prove to have been inserted by himself for subsequent exhumation, Cardiff-giant fashion? Let us read what he says in the review here under consideration (page 92): "Prof. Wright conveys the implication that the Claymont argillite indicates the existence of early glacial or preglacial man, and that the Calaveras skull and the Nampa image in like manner indicate preglacial or Tertiary man, the implication being, however, deceptively guarded by indefinite expressions and meaningless cross-references."

We have already quoted (page 770) Prof. Wright's language regarding the Claymont tool, and will only express our surprise that any one possessing our critic's command of the English language could extract from it the above meaning.

As to the other two instances, we will trespass on our reader's patience by giving here also Prof. Wright's own words (page 299): "I can only say that the amount of erosion since the lava eruption of western Idaho is not excessive, and very likely may be brought within ten or twenty thousand years." And in regard to the Calaveras lava he writes (page 230), "The question of absolute time can not be considered separately without much further study." Then, following a suggestion of Prof. Prestwich, adopted by Mr. Becker, he infers, "not that man is so extremely ancient in California, but that many of these plants and animals have continued to a more recent date than has ordinarily been supposed."

Consideration of the above extracts on both sides renders it incomprehensible how Prof. Wright's language can be interpreted to imply a belief in *pre*glacial or Tertiary man. The whole tenor of his book is opposed to this belief, and those geologists who are familiar with the long rows of figures whereby this very critic is accustomed to express his date for the Ice age and the yet longer array which gives the date assigned by him to the *pre*glacial or Tertiary period, will be amused at his nervous apprehension here

ed about ten or twenty thousand years.

f the proselyte is proverbial, and the readiness with

is former faith. But this gentleman will excuse us for reminding him (memory is sometimes inconvenient) of his own words in 1888. His own views of palæolithic man were then as unsound as, according to him, are those of Prof. Wright to-day. In this very magazine he wrote,* "Among the most recent and satisfactory archæologic discoveries of this country are those of two chipped implements of black flint found in Ohio by Dr. Metz at Madisonville and Loveland, in deposits of loess and aqueo-glacial gravel which G. F. Wright has shown to represent a closing episode of the later Glacial epoch." Again, "Excluding all doubtful cases, there remains a fairly consistent body of testimony indicating the existence of a human population in North America during the later Ice epoch."

Much more might be quoted, but we will spare the feelings of our critic. It is not fair to taunt a man with change of mind. Every scientist should be open to conviction and therefore subject to change. But we do look for a more tolerant spirit from one who has so recently seen fit to change his own faith on an important subject. He has been converted from the error of his ways, and now looks down on his benighted brethren, not with pity, but with feigned contempt. We would fain know the causes of his conversion, but forbear to speculate, and will rather believe that his logical mind has yielded to arguments which he could not resist and which bade him destroy a faith which once he preached. Possibly the evidence derived from the new science of *Gee*-omorphy has been largely instrumental in working this transformation.

We will not repeat what we have already said about the divergent views on the nature of the Ice age, further than to remark for the benefit of this critic that Whewell's wise saw above quoted may be recalled with advantage here.

Nor will we further follow this extraordinary effusion. Most of its charges have been made by others in less offensive terms and already noticed in this paper. Suffice it to say that we find it hard to comprehend how a scientist could allow his better judgment to be so far entirely overridden. No surer indication of a bad case can be given than "calling names," and next time he enters the arena we advise our indignant champion to submit to the careful search of some calm and judicious friend who will see to it that he carries into the field no unknightly weapons concealed about his person—in other words, that he request a friend to aid him in confining his exuberance of language within due bounds by the expurgation of such idiosyncratic terms as "egotistical," "incompetent," "shyster," "dupe," "knave," "harpy," "betinseled charlatan," with others of a similar nature which are not usually found in the current vocabulary of his scientific co-workers.

* Popular Science Monthly, January, 1888.

One word in conclusion. We wish to make it distinctly understood that we here give no opinion on any of the subjects in dispute. Our purpose is twofold: first, to show the illogical positions in which several of the critics of the work have placed themselves; and, secondly, to expose the spirit which characterizes the reviews. Quoting from the American Geologist for February: "We at present content ourselves with a protest against the tone adopted by some of the critics and the air of assumption and of superiority which pervades their remarks. Both are eminently unbecoming to scientific literature and derogatory to the dignity of science. We may add that they are in striking contrast to the moderation and dignity of the replies.

"It is somewhat difficult . . . to discover the motive which has led to so violent an attack on a work which, after all, merely summarizes with caution the evidence as it stands and draws a qualified conclusion from it. Strange indeed is it to see the theologian in the van of the evolutionary army, with the geologist and the archæologist lingering in the rear."

THE MAORIS OF NEW ZEALAND.

By EDWARD TREGEAR.

MR. TREGEAR has furnished, in the shape of categorical answers to the code of questions sent out by Mr. J. G. Frazer, of the Council of the Anthropological Institute, a mass of information respecting those most interesting of savages, the Maoris of New Zealand. Culling out the more important statements and giving them current form, we obtain a picture of a race which has played an important part in the past history of the region they dwell in, and whose presence is in all probability destined to leave a permanent impression in the life of the colony in which they are being merged.

The Maoris are divided into tribes, which, coming from a common ancestry, are somewhat of a clannish character, and subtribes; a few of the names of which are derived from animals and objects. No sanctity is attached to the animal or plant from which the tribal name is derived, nor is there any superstition about killing or eating it. The tribes are not distinguished by differences of dress or mode of wearing the hair.

While particular ceremonies on the birth of a child are not common, certain priestly forms and incantations are observed
...lt cases occurring in notable families, during one of
... performed, the father has to plunge into the
...*apu* after confinement till the ceremonies

of purification are performed, of which there are two forms. In one form two fires are kindled—"new fires," made by the friction of wood—one for the gods and one for the priest-chieftainess. Fern root is cooked over the fire for the gods, waved over the child by the priest, and afterward placed in some sacred spot. If the female tribe-priest is present, she waves the fern root cooked on her fire, touches the baby in several places, and, pretending to eat the fern root without doing it, also puts it away. If she is not present, a lay figure is made of weeds to represent her. In the other form a number of clay balls, representing as many ancestral chiefs, are made by the priest, and little mounds, each named after a god, near them. The priest takes a branch, parts it, binds half round the baby's waist, chants his invocation; then sprinkles mother and infant by means of a branch, and chants again. When the song is finished he plants the branch, and if it grows the child will be a warrior. Then three ovens are made, one for the mother, one for the priest, and one for the gods, and food is cooked on them. A number of pieces of pumice are placed in a row and named for the child's ancestors. The priests offer food from the gods' oven to each stone in turn, of which they are invited to eat ("the soul" of the food), and with this the *tapu* is removed. Infanticide is not practiced, because there is room for all, and the tribes want boys for warriors and girls to be mothers.

At puberty the eldest son of a head chief is initiated into the secrets of priestcraft and witchcraft, with ceremonies that begin with a feast in which the people are not allowed to eat from dawn till dark. A shed is built, exclusively by chiefs, of palm branches, the number of sticks on each side of which must be equal, in which the old *Ariki* sleeps the first night. The young man is sent to him at dawn—naked, for fear his clothes may bring defilement. He is urged to sleep, while the priest watches for omens of jerkings. If an arm or leg jerks inward, it indicates luck; but if it jerk outward, the lad can not be taught. The incantations are repeated and the secrets are taught. The legends say that in the old land whence the Maoris came there was a college in which the young men were taught astronomy, agriculture, etc. A young chief's instruction was considered successful if he was able to strike a slave dead by repeating a charm. This statement may be disbelieved, the author remarks, "but *tapu* is an awful weapon. I have seen a strong young man die the same day he was *tapued;* the victims die under it as though their strength ran out as water."

Tattooing is practiced by all—the full tattooing of a brave taking place after he has distinguished himself in war. It is performed to the accompaniment of tattoo songs, and involves *tapus*. The person undergoing the process is prohibited from eating fish, unless the fish is held up to see the tattooing. No gourd or calabash must be eaten from if children have playfully made tattooing marks upon it. The priest and all the people are *tapu* on account of the blood during the operation, but the ceremony of making ovens is gone through, much as in the purification rites;

TATTOOED MAORI CHIEF.

and the *tapu* is transferred to the gods' food by the priest handling one of the hot stones of their oven.

Girls were given great license from a very early age in the matter of lovers. Some girls, however, were born proud, and either kept to one sweetheart or had none, but this was rare. When a girl married she became *tapu* to her husband. Any one outside the relation of brother and sister could marry, although marriage of first cousins was greatly disliked. Polygamy prevailed among those who could afford it, and whose circumstances or inclination led into it, "but as the tribe supported all in food, the mean men would be prevented, in some way or another, from having large establishments." Betrothal of children was common among people of high birth. "If no betrothal, there was generally a lot of talk and squabbling, every one in the tribe thinking he had a right to interfere, till at last the young couple, if lovers, would flee to the bush until their living together was agreed to. The girl generally began the courting. I have often seen the pretty little love letter fall at the feet of a lover—it was a little bit of flax made into a half knot; 'yes' was made by pulling the knot tight, 'no' by leaving the 'matrimonial noose' alone. . . . Sometimes in the *whare matoro* (the wooing-house), a building in which the young of both sexes assembled for play, songs, dances, etc., there would be at stated times a meeting; when the fires burned low, a girl would stand up in the dark and say, 'I love So-and-so—I want him for my husband.' If he coughed (sign of assent) or said 'yes,' it was well; if only dead silence, she covered her head with her robe and was ashamed. This was not often, as she generally had managed to ascertain (either by her own inquiry or by sending a girl friend) if the proposal was acceptable. On the other hand, sometimes a mother would attend, and say, 'I want So-and-so for my son.' If not acceptable, there was generally mocking, and she was told to let the young people have their house (the wooing-house) to themselves. Sometimes, if the unbetrothed pair had not secured the consent of the parents, a late suitor would appear upon the scene, and the poor girl got almost hauled to death between them all. . . . Girls have been injured for life in these disputes, or even murdered by the losing party. There was generally a show of force, more or less severe; but after she had been taken away, the parents came to see the pair, and when

MAORI WOMAN.

presents had been interchanged all were satisfied." It was sometimes the custom for a man who had many wives to lend one of them to a guest whom he wished to honor greatly.

Disease was supposed to be caused by the entry of an evil spirit into the body or by the anger of some deity or demon. Curses were sought through exorcisms, etc., by the priest; while for certain affections special methods of medical treatment were used, apparently with considerable success. Wounds were generally left to themselves, after broken pieces of spear or bone had been extracted; and they healed in a manner that a European could hardly credit.

To avoid having the home *tapued* by death, chiefs when dying were carried into some shed. At the sound of the wail from the wives and relatives, friends gathered and cut themselves with sharp shells and pieces of flint—women in the face, and men on one side of the neck. The hair was cut off on one side, while a few long locks were sometimes left untouched as a memorial of the departed. The burden of the lament was, "Go on, we follow." The friends, who came from long distances to mourn, wore wreaths of green leaves or lycopodium. Sometimes the body was buried; in other parts of the country it was placed in a little house with the greenstone club, etc., of the deceased; sometimes in two pieces of a canoe placed upright together, the corpse being tied in a sitting posture on a grating through which the decomposed parts fell; at other times it was placed in a small canoe and set up in the branches of a tree. Slaves were killed sometimes, and the chief wife strangled herself, to be buried with her lord. A *taro* root was placed in the hand of a dead child that it might have food for its journey to *Reinga;* food was also buried with a chief. The exhumation took place from a year to two years after death, with intricate ceremonies, including the consecration of the spade with which the body was dug up, the charms for the binding up of the bones, for the scraping, for the bearers, lustrations of those engaged, lifting the *tapu* from them, etc. The bones were scraped, anointed, decorated, painted, and set with feathers. When they had been seen and wept over by all the relatives, they were packed away in the dark ancestral burial cave, or else thrown into some inaccessible rift or deep chasm, lest some enemy might get hold of the skull, to taunt it or to use it as a baler for a canoe. Fish-hooks made from the jaws, and flutes, pins, etc., from the bones, were supposed to be terrible insults to the relatives. Hence the secret sepulture.

...er must be revenged by every member of the tribe until ...d been obtained. A chief, when dying, left as his ...der of revenge for his people to carry out, and ...nate some one person to devote himself to this especial purpose. Such death orders were looked upon as sacred commands. Vengeance, or propitiation by bloodshed, could be obtained by assaulting a tribe which had nothing to do with the cause of quarrel; but, generally, the tribe or family of the murderer was singled out and a vendetta was declared.

While all of a man's movable property was his own, in consequence of the law of *muru* or plunder, a chief had little he could really call his own, except his personal ornaments, weapons, etc., which were *tapu* by touching his sacred body. A chief could *tapu* a certain thing by saying, "That canoe is my backbone," etc. Then, unless one was of greater power than he, it was untouched, and became really, for all practical purposes, the chief's bodily part. Fire was obtained by friction of wood, and when used for "common fire," was kept lighted as long as possible. Fire-sticks were carried to start new fires with, and new fires were made on all solemn occasions. A chief, too, must have his own sacred fire to sit by, lest some inferior person may have used it, or have used some of his fire to light another on which food was cooked. This would be metaphorically cooking the chief himself. The women and men ate apart, and generally each man ate apart; and eating was all done in the open air, because food would *tapu* the house, and so *tapu* any one entering it. Cannibalism was common formerly, and was accounted for by the desire for revenge—cooking and eating his body being the greatest of insults that could be put upon an enemy. If the person eaten had been a redoubtable enemy, his head was dried as a trophy, and his thigh bones were made into flutes; otherwise the bones were thrown away. Hunting was of but little account, for there were no large animals, but fishing was invested with a network of ceremonies and *tapus*.

MAORI KING WITH HIS GREENSTONE CLUB.

Previous to engaging in war the omens were consulted by taking a number of fern stalks to represent spears, and others to represent the warriors. The spears were thrown at the stalks representing the warrior chiefs singly. If the spear fell on his left side, the man would fall; if on the right, he would live. Then sticks named for enemies were thrown at others named for the men, women, and children who were to remain behind, lest they should

MAORI SALUTATION.

be attacked in the absence of the warriors. A young chief on his first war party received a special baptism, when he and his companions had to stand naked in the water and be sprinkled and charmed. Until he had passed through this ceremony and the bloodshedding he was a nobody. All men on a war party were *tapu* to women, and had to do their own cooking because there were no women along; but they were very particular that food should not be passed by one in front of another, or put near a weapon, or touched by the right hand. When the fight was over the men formed in ranks, three deep, each headed by a priest, who received from every man a portion of hair which he had cut from his victims, and waved it as a wave-offering to the war god while the party sang the war song. Approaching their own tribal land, they performed the ceremony of "turning round to look back." A hole having been dug for each slain enemy chief's head, turning round toward the hostile land the priests waved and shook the heads as a challenge, and to allow them to bid farewell; after which followed other ceremonies, closing with the lifting of the *tapu* from the warriors.

A curious point in the settling of ranks was that the son was greater than his father, because, holding rank by both father and mother, he was the result of two great people coming together, while his father was only one great person.

The games of the Maoris included kite-flying, tops, cat's cradle, skipping rope, ducking one another, swing (peculiar in character), dart-throwing, wrestling, diving, ball, twirling a disk, various games played with the fingers and hands, a kind of hunt the slipper, slinging, stilts, draughts, proverbs, hide and seek, a game played by boys standing on their heads and marking time with their feet, and dancing. A certain legend is of great interest because it mentions a variety of other amusements, but more so on account of its antiquity. It is known both in Samoa and New Zealand, although so many centuries have elapsed since the separation of the tribes that Samoan is incomprehensible to a Maori.

Omens were drawn from convulsive startings in sleep, and the twitching of the arms and legs outward and inward. Tripping the foot on starting and getting the feet between the toes filled with fern were evil. An itching chin denoted that something oily would be eaten. An ember popping out of fire or the singing of gas from burning wood were ominous. Aërolites, meteors, and the approach of the moon to a large star were unlucky. The unpremeditated stretching out or stepping out with the right hand or foot was accepted as an omen. Omens were drawn from the flight of birds and from dreams, when the soul was supposed to have left the body and wandered in *Te Reinga*. In illness the soul journeyed away and was on the brink of crossing to hades, but returned if the man lived. Messages were sent by the dying to friends gone before. The souls passed from south to north till they came to the extreme northwest point of New Zealand, to *Te Reinga*, the spirit's leap. Here the soul leaped into the sea or slid down the trunk of a tree, the *pohutukawa*. Hence the saying for one dead, "He has slid down the pohutukawa"—and passes to Po (hades). It was only the soul of an offering, as of food, which was accepted by the gods. When the fairies accepted certain jewels, they only took the souls of the ornaments, while the material jewels were returned to the votor. Weapons have not souls exactly, but the weapons which have been used in war have a wonderful *mana* or prestige, power, or influence. Some weapons have come down from the gods, and have their genealogies of owners up to chaos. Such weapons sometimes prophesy, sometimes shift about. They would kill with their subtle power the inferior person who dared to touch them. The souls of the departed were not exactly worshiped, for Maoris hardly had the idea of worship, or were not humbly minded enough to worship. They offered death sacrifices, but it was rather with the idea of pacifying the evil deities and paying honor to a chief than of adoration.—*From the Journal of the Anthropological Institute.*

EDUCATION OF OUR COLORED CITIZENS.

BY MAUD WILDER GOODWIN.

WHAT shall we do with the negro? This is not a question of philanthropy, but of self-interest and self-protection. The negro has come to stay. The race at present numbers some seven or eight millions, and actually holds the balance of power numerically in several of the Southern States.

The Black Belt, as it is to-day, is a menace to the country from Mississippi to Maine, because it is black with the darkness of idleness and ignorance and immorality. It must soon be decided whether it shall grow darker and darker, or shall come to shine, bright as the Belt of Orion, with the light of intelligence and industry. The problem touches all who believe that good government rests on good citizenship, and good citizenship on individual enlightenment, that education is the tortoise which supports Atlas in his task of holding up the world.

We are confronted by a solid mass of ignorant citizens, nominally if not actually in possession of the ballot, and potent to make or mar the fabric of the republic. This mass is not decreasing, but increasing. What is to be done about it? Whether we care for the negro or his welfare matters not. If we care for the nation, we must give this question earnest consideration. We are entitled to hold the most divergent opinions on the subject, but we are not entitled to indifference, that fatal policy of letting alone growing evils which has wrecked so many communities.

There can be no divided opinion on the desirability of educating citizens of any race or color. The problem, then, so far as the negro is concerned, resolves itself into three questions: Is he capable of being educated? What system of education best meets his temperament and condition? and How can such education be given him?

To put the last two questions is, of course, to assume an affirmative answer to the first. Assuredly the negro can be educated. We may assume so much of a horse or a dog. How far, is another story, as Rudyard Kipling would say. All speculation on the comparative intellectual capacity of the black race is idle. Any accurate estimate must be based on data which, in the nature of things, can not be available for some centuries to come.

To the closest observers at the South the progress of the negro appears, on the whole, remarkable, though statistics might be prepared to present a different view. It is a well-worn truth that civilization is classification, and so it is proving with the blacks. Some of them have progressed. Some have reverted almost to barbarism. Slavery itself was in its time a great school of civilization. It held a semibarbarous race in close contact with their superiors. When that bond was loosened, those negroes who had the fiber of freedom in them stood erect in independent manhood; the others sank to earth in abject hopelessness.

Twenty-eight years have elapsed since the close of the war. Those years have solved many problems and harmonized many differences, but they have not solved the problem of lifting the mass of the blacks to the plane of intelligent citizenship. There is much secret sympathy at the North with the suppression of the negro vote, because it is believed that it is not so much the result of race prejudice as of the determination of an intelligent minority not to be ruled by an ignorant and degraded majority. To begin civilization with the ballot is like beginning the Bible with Revelations; it is reading backward. Let us not reopen the question of the wisdom of the Government when, hurried on by the passions of both North and South, it armed the negro with the ballot as his sole protection. That is done. Our problem is before us. As the Oriental proverb runs: "To-day is ours; yesterday and to-morrow belong to God."

The negro must be educated; but how? Education is a good word, but, unfortunately, vague. It may include everything from the alphabet to the whole sweep of arts and letters. It may be general or technical; physical, mental, or moral. Let us try to arrive at a more definite understanding of it. There is perhaps no better parallel for the education of a race than the education of a child, only for every five years we must take five hundred. Men *fall* into vice but they *climb* into virtue. Nothing could be more unreasonable than to expect to see any marked change from the conditions engendered by slavery in so brief a period as thirty years; yet we hear the accusation constantly made against the negro that he is still a lazy, idle vagabond. Perhaps he is, but it is only another illustration of Franklin's parable, wherein Abraham is represented as wishing to cast the wanderer out of his tent because he will not worship Jehovah. But the Lord rebuked Abraham, saying, "Have I not borne with thee these ninety and nine years, and couldst thou not bear with him one night?"

Scarcely a day, as history measures time, has elapsed since the negroes, trained for centuries to depend on others for the means of livelihood, found themselves flung rudely into the grim struggle for existence. Not a foot of land was given them by the Government. No one ever heard of a negro reservation. They were left naked to their enemies, not the white men round them, but those far more relentless foes, the accursed slave habits, the inheritance of generations. The fatal weakness of slavery to the enslaved lies in the fact that its teachings strike at the root of character by eliminating the idea of moral responsibility. No soul, no sin. If the marriage tie may be broken at the will of the master, assuredly it will be at the pleasure of the slave. If the servant is a chattel, there is force in his logic that in converting chicken into slave, he is only changing the form of property. The virtues of the slave are unquestioning obedience and passive resignation. The fundamental virtues of the freeman are self-assertion and active, unflinching resistance to any attack on his rights.

The close of the war saw millions of slaves suddenly enfranchised. How were they to be safely translated from one condition to another, to enjoy liberty without running into license, to defend themselves without offending others—in a word, to become good citizens? To the great good fortune of the negro the contraband camp at Hampton, Va., was placed under the control of General Samuel C. Armstrong—a man fitted for his position, not only by having served in the war as a leader of black troops, but by having passed his boyhood as the son of a missionary in the Hawaiian Islands. Through this early training he had an opportunity of studying close at hand the evolution from barbarism of a dark-skinned Polynesian people strongly resembling in many ways the negro in America.

Describing his early experiences, he wrote, years afterward: "On horseback and in canoe tours with my father and alone around those grandly picturesque volcanic islands, inspecting schools and living much among the natives (then generally Christianized), I noticed how easily the children learned from books, how universally the people attended church and had family prayers—always charmingly hospitable; and yet that they lived pretty much in the old ways, all in one room, including the stranger within their gates, who usually had, however, the benefit of the raised end and a curtain. They seemed to have accepted, but not to have fully adopted, Christianity; for they did not have the conditions of living which make high standards of morality possible."

While heartily in sympathy with the effort to Christianize these people, he was forced to see and deplore the process of pietizing without moralizing, which was repeated later under his eye in the camp-meetings of the South. No heathen is so difficult to deal with, as the negro who has run through the whole gamut of religious experience and still retains his original weakness for pilfering watermelons.

General Armstrong's scientific study of the negro led him early to the belief that the only hope for the black lay, not in being helped, but in being taught to help himself; not in being pauperized, but in being civilized. He made up his mind that any system of training, to be successful, must be symmetrical, and must take into account the equal development of heart, hand, and head. It was to work out this theory that he consented to take charge of the school for freedmen which was gradually evolved from the camp at Hampton. Here, on the spot rich in historical memories, where freedom first came to the slave through Benjamin F. Butler's famous order declaring him contraband of war, on the shores of the broad bay where the Monitor and the Merrimac closed in their deadly embrace, General Armstrong opened his educational campaign. It was not the first time he had thought of such a scheme.

"A day-dream of the Hampton School nearly as it is," he says, "had come to me during the war a few times; once in camp during the siege of Richmond, and once one beautiful evening on the Gulf of Mexico, while on the wheel-house of the transfer steamship Illinois, *en route* for Texas, with the Twenty-fifth Army (negro) Corps for frontier duty on the Rio Grande River, whither it had been ordered, under General Sheridan, to watch and if necessary defeat Maximilian in his attempted conquest of Mexico.

"The thing to be done was clear: to train selected negro youth who should go out and teach and lead their people, first by example, by getting land and homes; to give them not a dollar that they could earn for themselves; to teach respect for labor; to replace stupid drudgery with skilled hands; and, to these ends, to build up an industrial system, for the sake not only of self-support and intelligent labor, but also for the sake of character. And it seemed equally clear that the people of the country would support a wise work for the freedmen."

Time has more than justified his foresight. It has proved his plan not alone a wise way, but the only way out of the difficulty. This is the answer to the question, What kind of education is best for the negroes? First, such an industrial training as shall make them masters of their own faculties; then an economic training teaching them how to save and how to spend money; and afterward as high an intellectual education as they shall show capacity and desire for. That will take care of itself. The first essential in making the blacks independent is to make them home-owners and property-holders. This is not a difficult task, for the negroes have a land hunger. The difficulty lies in their improvident habits, which too often result in mortgaged houses and farms.

The emancipation of the slaves in America threatened to follow the same course as the emancipation of the serfs in Russia, where the boons of liberty turned to a calamity and a curse. Slavery, under masters made often considerate by habit, was exchanged for an industrial slavery far more bitter. The emancipated Russian serfs straightway fell into the toils of usurers, who first established and then foreclosed mortgages on the little farms granted to the newly enfranchised. At the South, too, the mortgaged farm has been a weapon of tyranny. Once let a negro own his ground and he is indeed free; once let him own a mortgage on a white man's farm and he is master of the situation. Such is the witness borne by Booker Washington, that eloquent young colored man who, coming to Hampton with fifty cents as his entire capital, worked his way through the school and went out to found a similar institution at Tuskegee, Alabama. He is in himself the best illustration of the progress of the race; and the best hope for the future was unintentionally expressed by a Southern white man, who, after seeing him pass on the street, exclaimed with an oath, "By ——! it's all I can do to help saying '*Mister*' to him."

Booker Washington is firm in the faith that his brothers will never succeed until they learn to depend on themselves, and that self-dependence is best fostered by the ownership of land. A property-owning negro is not only secure of his rights, but he has a vital interest in the stability of government, and thus becomes a citizen in the fullest sense without distinction of race or color. No one man has done as much as General Armstrong to bring about this great industrial revolution. Here is the testimony of the Rev. S. J. Barrows:

"General Armstrong has built a new Uncle Tom's cabin, and it is very different from the old. You may see the difference in the Black Belt. There is the old one with its one door and perhaps no window; and then, not far away, is the new one built by the Hampton graduate, two stories high perhaps, nicely carpeted and furnished, neat spreads on the table, and something better than 'hog and hominy' to eat, a cabinet organ in the room, books on the shelf. Such a home is a beacon-light in the community to diffuse intelligence and the spirit of order and progress. That is what Hampton is doing. It is building homes and schools all through the South. What a cloud of witnesses we should have, could we summon those seven hundred graduates, each one bringing the implements of his trade—the carpenter with his saw, the blacksmith with his hammer, the harnessmaker with his knife, the farmer with his hoe! What a long line there would be of the graduates alone! And then add the one hundred and twenty-nine thousand pupils they have taught and the two thousand teachers again that have been drawn from this army of pupils! It would take two days for them all to march through the streets of Boston!"

A man once excused himself for begging from Dr. Johnson by explaining, "You see, my dear sir, I must live." "Really," replied the sturdy old doctor, "I don't see the necessity." Now, it is a cold fact in political economy that the killing off of one third of the black population at the South would probably prove a benefit to civilization. It would work like the thinning out of a forest jungle, leaving room for the sun and air to reach the survivors; but the law has not yet authorized this process of scientific weeding out of the unfittest. The question is not, Shall the negro poor live? but How shall they live? Pauperism does not stop procreation. The next generation will be called upon to solve our problem several times multiplied.

Pauperism not only breeds paupers: it kills thrift. Nothing is so extravagant as poverty. It is a universally acknowledged fact among shopkeepers at the South that the black customers are the best customers. None care so little what price is put upon an article, none inquire so little into intrinsic values, and none are so heedless of the adaptation of the purchase to the needs. Some wit has observed, on the difference between men and women as shoppers, that men will pay two dollars for a one-dollar article which they want, whereas women will pay one dollar for a two-dollar article which they *don't* want. The negro combines the weakness of both. Every traveler in the South smiles over the new buggy standing beside the shanty which owns neither stable nor horse; the gorgeous plush album, guiltless of pictures, but treasured in tissue paper by the poor woman who can scarcely make the rags meet across her breast. There is a humorous side to it, but there is a pathetic side, too, in that unquenchable thirst for beauty which is part of the Oriental nature. The negro really feels what the rest of us say in jest, "Give us the luxuries of life, and we'll do without the necessaries." Lazy, improvident, unpractical, the black man as a worker is brought into competition not only with the Southern whites, but with the Yankees—those Phœnicians of the Western world who drive bargains as naturally as the negro drives a mule, who haggle over the price of a postage-stamp, who rise early and go to bed late out of breath from the pursuit of the nimble sixpence. The negro is a Rip Van Winkle who has suddenly waked into a dizzy world of prosperity and progress. He can not hope at present to compete for the prizes, but is he therefore to be counted out as a factor in the world's work? "Not so," says General Armstrong, and as a proof of it he points to the achievements of Hampton.

That school which first rose on his vision that summer night on the Mexican Gulf, now stretches its substantial arms of stone and brick and iron to the water's edge. Its smoking chimneys, its ringing forges, its whirr of wheels, all bespeak the busy life within. In each one of the forty buildings connected with the school some form of education is being carried on. At one angle stand the Huntington Industrial Works, where lumber passes from the felled log into finished carpentry under the hands of joiners and carpenters. The boys who have been trained in this school will never be at a loss to get work. They can put up their own houses and those of their neighbors, and teach by example and precept in their turn. Wheelwright and blacksmith shops stand close at hand. Dressmaking establishments and cooking schools meanwhile are training women to equal usefulness.

Hampton stands, above all, for industrial education. The institutions at Petersburg, Nashville, and Atlanta are all working for the education of the colored race. Some of them have technical schools, but it is at Hampton alone that industrial training and manual labor form the keystone of the educational arch. The students here are taught not only to work, but to be proud of working; and when the higher education is earned it is worth more because it is founded on the solid basis of hand work. Thoroughness and accuracy, the two great qualifications for scholarship, are taught at the carpenter's bench and the blacksmith's forge. But the artisans are not left untaught in other things. The night school is crowded every evening with eager learners of two races. Negroes and Indians study side by side, with benefit to both races. Their horizon is widened by the interchange of experiences from such diverse regions as the West and South, the prairie and the cotton field. The habits of the wandering tribes and the sons of the soil are full of interest to the observers, and, even as children learn from each other more readily than from grown people, so these child races are teaching and training one another.

When the Indians were introduced into the school, some fifteen years ago, while the Hon. Carl Schurz was Secretary of the Interior under Hayes, it was feared that the discipline and general morale of the institution would suffer. These, on the contrary, have steadily improved. General Armstrong was one of the first educators to adopt the principle of student-government. The boys, Negro and Indian, are formed into a battalion. Cases of insubordination are dealt with by a court martial detailed from among the officers, who report their sentence for the approval of the faculty of the school. The system is admirably adapted to its purpose. It develops both discipline and a sense of honor. To compel a boy, under ordinary circumstances, to report the conduct of his comrades is to make him a spy and informer, but when he acts as guard or sentinel he falls at once into the attitude of military obedience.

Nothing in the conduct of the school shows keener insight into the character of the negro than the establishment of this semi-military basis of organization. A uniform, gay with straps and brass buttons, is dear to his heart. His feet keep step instinctively to the tap of the drum, and the flag behind which he marches is a perpetual reminder to him that he is an integral part of a great nation which expects something from him in return for the freedom and citizenship which it has bestowed. This military drill has a still more far-reaching influence in stimulating that ability for organization which is one of the latest developments of civilization. Here the negro is manifestly deficient. He fights and works well under the command and oversight of his superior, just as the Sepoys have been found in India to need not only English officers but a few English regulars to supply the backbone as well as the brains—literally, the sinews of war. This mental and moral muscle is just what Hampton is supplying, teaching the negro first to help himself and then to lend a hand to others, to organize, to teach, and to command.

The normal school is the highest grade in the Hampton Institute. It has four classes—the intermediate, the junior, the middle, and the senior. At the end of the middle year the students who desire to make teaching their life work are sent away for a year of practice, from which they return with a more adequate notion of the needs of their people and the advantages open to them at Hampton. So much insisted on is this duty of missionary work of instruction in the Black Belt and other strongholds of ignorance in the South, that the teachers say that the graduates whom they meet in New York and other Northern cities occupying positions of ease and profit are so ashamed of shirking their duties that they cross the street and strive to avoid encountering their old instructors, whose just expectations they have thus disappointed.

Every institution, some one has said, is the shadow of one man, and Hampton is the shadow of General Armstrong. He has been not alone the founder, but the upbuilder. It is his eloquence which has drawn forth the gold from the pockets of the rich and transformed it into brick and mortar and books and models for the benefit of his experiment.

Phillips Brooks, whose great heart went out to all greatness, said of General Armstrong: "He has touched the fountains of generosity in stingy men. He has taught men the glory and the beauty and the happiness of being stewards of the Lord. He has made men feel as they never dreamed of feeling. Such has been the power of his speech that the frozen streams have melted and the currents have flowed joyously, singing as they went, and men have thanked him for teaching them to be generous." But no one man, however eloquent or however able, could have created that industrial village at Hampton. It is the product of organized enthusiasm. Individual enthusiasm is the old flint and spark of the savage, which struck fire only by direct contact and after much friction. Organized enthusiasm is the electric light with the whole energy of the battery behind it. It is this organized enthusiasm of many people in many places which has made Hampton what it is. General Armstrong's genius has lain in understanding how to utilize emotion to be sure that it turned a crank and did not escape in steam. For twenty-five years he has toiled and thought and fought for the school — now traveling hither and yon through the North to collect funds, and then flying back to inspire and direct the work at the South. No man could stand such a strain forever, and last year, in Boston, paralysis laid its warning hand on that tireless brain and said, "Be still!" But nothing short of death itself can enforce that command. The brain and voice are busy still, but not with their old-time energy. Now he is calling for aid. "He has," as Mrs. Julia Ward Howe said, "been through two wars—the war of fire and bloodshed, and the war of faith and zeal." Now he is struck down, like Moses, at the entrance to the promised land of success, and asks only to see into it.

To each age its own problems. The men and women of General Armstrong's generation were carried above and beyond themselves by the impulse of a great, soul-stirring cause. The young people of to-day can never know the electric thrill of patriotism which ran through the country in successive shocks from the first gun echoing from Sumter to the solemn day of Lincoln's death. But there is a heroic work for them to do:

> "New occasions teach new duties,
> Time makes ancient good uncouth;
> They must upward still and onward,
> Who would keep abreast of truth."

"The Boys in Blue did a fearful but necessary work of destruction," said Lincoln of the heroes of Gettysburg. "It is for us to finish what they began. Their task was *de*struction; ours is *con*struction. Theirs was the emancipation of the slave; ours the enlightenment of the citizen." So widespread has been the feeling of the dignity and worth of the work done in this great cause at Hampton, that it has taken form in an association bearing the name of the founder of the school, and known as the Armstrong Association. Its whole purpose is to support the industrial education of the negro and, incidentally, of the Indian. It aims to be national, not sectional, and should prove a strong bond between North and South. It does not propose to contribute a cent toward philanthropy or charity at the South. Hampton Institute is no more a charitable institution than Yale or Harvard. It is a noble educational plant insufficiently endowed. Its alumni are poor;

they can give it only gratitude and sympathy, and, as some cynic has observed, the bonds of sympathy bear no coupons. This criticism, however, is only a surface truth, for no cause ever failed for lack of funds, if it had enough vital sympathy behind it.

There is a lake on a mountain-top in Missouri, without visible outlet or inlet, which yet rises and falls several feet. What is the explanation of the mystery? It is fed by an ebbing and flowing underground river. So it is with great enterprises. They are borne on the current of popular enthusiasm—unseen, it may be, but never unfelt. So it is with Hampton. Its success hangs on popular support, and on its success hangs the experiment of industrial education as a solution of the negro problem.

This is a great national question. It intimately concerns the white population at the South, whose welfare, whether they will or not, is bound up with that of the blacks, so that the sarcastic advice, "Educate your masters!" becomes literal counsel of the truest and wisest kind. Nor are we of the North indifferent observers. So bound together is this nation by the iron bands of railroads and telegraph wires that the issue of affairs in the most distant South is of vital interest to us. Let it not be said of the thinkers of to-day as of those blind ones who watched the condition of France before the Revolution, that the philosophers were duller than the fribbles. Let us clearly recognize the difficulty and complexity of the problem with which we have to deal, and then let us address ourselves to its solution soberly, earnestly, and unremittingly.

A DISCUSSION has arisen concerning the manner in which the Egyptian tombs may have been lighted for the execution of the elaborate paintings that are found in them. Any light that would smoke appears to be ruled out, for it could not have failed to leave its mark, which is not there. Mr. Newman, an American artist, who has spent several winters on the Nile, studying and painting tombs and temples, has not been able to suggest any other solution of the problem than the use of the electric light. Mr. W. Flinders Petrie is not yet ready to invoke the electric light, but believes that sunlight was sent into the dark passages by the use of mirrors. He says: "A very small amount of reflected sunshine is enough to work by. I have taken photographs at Gizeh (which require far more light than is needed by a painter or sculptor) by means of four successive reflections of sunshine from common sheets of tin plate, such as biscuit-tin lids. These four reflections sent the light round corners, into what was absolutely dark space, a distance of over thirty feet, and the effect was brilliant to the eye. I feel certain, therefore, that with larger reflectors there would be no difficulty whatever in lighting any part of the Kings' Tombs more brightly than by small lamps."

AN American, Mr. Henry, in Longuyon, France, has constructed a clock entirely of paper, which has run regularly for two years, with no greater variation than a minute a month.

THE INADEQUACY OF "NATURAL SELECTION."

By HERBERT SPENCER.

STUDENTS of psychology are familiar with the experiments of Weber on the sense of touch. He found that different parts of the surface differ widely in their ability to give information concerning the things touched. Some parts, which yielded vivid sensations, yielded little or no knowledge of the size or form of the thing exciting it; whereas other parts, from which there came sensations much less acute, furnished clear impressions respecting tangible characters, even of relatively small objects. These unlikenesses of tactual discriminativeness he ingeniously expressed by actual measurements. Taking a pair of compasses, he found that if they were closed so nearly that the points were less than one twelfth of an inch apart, the end of the forefinger could not perceive that there were two points: the two points seemed one. But when the compasses were opened so that the points were one twelfth of an inch apart, then the end of the forefinger distinguished the two points. On the other hand, he found that the compasses must be opened to the extent of two and a half inches before the middle of the back could distinguish between two points and one. That is to say, as thus measured, the end of the forefinger has thirty times the tactual discriminativeness which the middle of the back has.

Between these extremes he found gradations. The inner surfaces of the second joints of the fingers can distinguish separateness of positions only half as well as the tip of the forefinger. The innermost joints are still less discriminating, but have a power of discrimination equal to that of the tip of the nose. The end of the great toe, the palm of the hand, and the cheek, have alike one fifth of the perceptiveness which the tip of the forefinger has; and the lower part of the forehead has but one half that possessed by the cheek. The back of the hand and the crown of the head are nearly alike in having but a fourteenth or a fifteenth of the ability to perceive positions as distinct, which is possessed by the finger-end. The thigh, near the knee, has rather less, and the breast less still; so that the compasses must be more than an inch and a half apart before the breast distinguishes the two points from one another.

What is the meaning of these differences? How, in the course of evolution, have they been established? If "natural selection" or survival of the fittest is the assigned cause, then it is required to show in what way each of these degrees of endowment has advantaged the possessor to such extent that not infrequently life has been directly or indirectly preserved by it. We might reasonably assume that in the absence of some differentiating process, all parts of the surface would have like powers of perceiving relative positions. They can not have become widely unlike in perceptiveness without some cause. And if the cause alleged is natural selection, then it is necessary to show that the greater degree of the power possessed by this part than by that, has not only conduced to the maintenance of life, but has conduced so much that an individual in whom a variation had produced better adjustment to needs, thereby maintained life when some others lost it; and that among the descendants inheriting this variation, there was a derived advantage such as enabled them to multiply more than the descendants of individuals not possessing it. Can this, or anything like this, be shown?

That the superior perceptiveness of the forefinger-tip has thus arisen, might be contended with some apparent reason. Such perceptiveness is an important aid to manipulation, and may have sometimes given a life-saving advantage. In making arrows or fish-hooks, a savage possessing some extra amount of it may have been thereby enabled to get food where another failed. In civilized life, too, a seamstress with well-endowed finger-ends might be expected to gain a better livelihood than one with finger-ends which were obtuse; though this advantage would not be so great as appears. I have found that two ladies whose finger-ends were covered with glove-tips, reducing their sensitiveness from one twelfth of an inch between compass points to one seventh, lost nothing appreciable of their quickness and goodness in sewing. An experience of my own here comes in evidence. Toward the close of my salmon-fishing days, I used to observe what a bungler I had become in putting on and taking off artificial flies. As the tactual discriminativeness of my finger-ends, recently tested, comes up to the standard specified by Weber, it is clear that this decrease of manipulative power, accompanying increase of age, was due to decrease in the delicacy of muscular co-ordination and sense of pressure—not to decrease of tactual discriminativeness. But not making much of these criticisms, let us admit the conclusion that this high perceptive power possessed by the forefinger-end may have arisen by survival of the fittest; and let us limit the argument to the other differences.

How about the back of the trunk and its face? Is any advantage derived from possession of greater tactual discriminativeness by the last than by the first? The tip of the nose has more than three times the power of distinguishing relative positions which the lower part of the forehead has. Can this greater power be shown to have any advantage? The back of the hand has scarcely more discriminative ability than the crown of the head, and has only one fourteenth of that which the finger-tip has.

Why is this? Advantage might occasionally be derived if the back of the hand could tell us more than it does about the shapes of the surfaces touched. Why should the thigh near the knee be twice as perceptive as the middle of the thigh? And, last of all, why should the middle of the forearm, middle of the thigh, middle of the back of the neck, and middle of the back, all stand on the lowest level, as having but one thirtieth of the perceptive power which the tip of the forefinger has? To prove that these differences have arisen by natural selection, it has to be shown that such small variation in one of the parts as might occur in a generation —say one tenth extra amount—has yielded an appreciably greater power of self-preservation, and that those inheriting it have continued to be so far advantaged as to multiply more than those who, in other respects equal, were less endowed with this trait. Does any one think he can show this?

But if this distribution of tactual perceptiveness can not be explained by survival of the fittest, how can it be explained? The reply is that, if there has been in operation a cause which it is now the fashion among biologists to ignore or deny, these various differences are at once accounted for. This cause is the inheritance of acquired characters. As a preliminary to setting forth the argument showing this, I have made some experiments.

It is a current belief that the fingers of the blind, more practiced in tactual exploration than the fingers of those who can see, acquire greater discriminativeness: especially the fingers of those blind who have been taught to read from raised letters. Not wishing to trust to this current belief, I recently tested two youths, one of fifteen and the other younger, at the School for the Blind in Upper Avenue Road, and found the belief to be correct. Instead of being unable to distinguish between points of the compasses until they were opened to one twelfth of an inch apart, I found that both of them could distinguish between points when only one fourteenth of an inch apart. They had thick and coarse skins; and doubtless, had this intervening obstacle so produced been less, the discriminative power would have been greater. It afterward occurred to me that a better test would be furnished by those whose finger-ends are exercised in tactual perceptions, not occasionally, as by the blind in reading, but all day long in pursuit of their occupations. The facts answered expectation. Two skilled compositors, on whom I experimented, were both able to distinguish between points when they were only one seventeenth of an inch apart. Thus we have clear proof that constant exercise of the tactual nervous structures leads to further development.*

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* Let me here note in passing a highly significant implication. The development of nervous structures which in such cases takes place, can not be limited to the finger-ends.

Now if acquired structural traits are inheritable, the various contrasts above set down are obvious consequences; for the gradations in tactual perceptiveness correspond with the gradations in the tactual exercise of the parts. Save by contact with clothes, which present only broad surfaces having but slight and indefinite contrasts, the trunk has but little converse with external bodies, and it has but small discriminative power; but what discriminative power it has is greater on its face than on its back, corresponding to the fact that the chest and abdomen are much more frequently explored by the hands: this difference being probably in part inherited from inferior creatures, for, as we may see in dogs and cats, the belly is far more accessible to feet and tongue than the back. No less obtuse than the back are the middle of the back of the neck, the middle of the forearm, and the middle of the thigh; and these parts have but rare experiences of irregular foreign bodies. The crown of the head is occasionally felt by the fingers, as also the back of one hand by the fingers of the other; but neither of these surfaces, which are only twice as perceptive as the back, is used with any frequency for touching objects, much less for examining them. The lower part of the forehead, though more perceptive than the crown of the head, in correspondence with a somewhat greater converse with the hands, is less than one third as perceptive as the tip of the nose; and manifestly, both in virtue of its relative prominence, in virtue of its contacts with things smelt at, and in virtue of its frequent acquaintance with the handkerchief, the tip of the nose has far greater tactual experience. Passing to the inner surfaces of the hands, which, taken as wholes, are more constantly occupied in touching than are the back, breast, thigh, forearm, forehead, or back of the hand, Weber's scale shows that they are much more perceptive, and that the degrees of perceptiveness of different

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If we figure to ourselves the separate sensitive areas which severally yield independent feelings, as constituting a network (not, indeed, a network sharply marked out, but probably one such that the ultimate fibrils in each area intrude more or less into adjacent areas, so that the separations are indefinite), it is manifest that when, with exercise, the structure has become further elaborated, and the meshes of the network smaller, there must be a multiplication of fibers communicating with the central nervous system. If two adjacent areas were supplied by branches of one fiber, the touching of either would yield to consciousness the same sensation: there could be no discrimination between points touching the two. That there may be discrimination, there must be a distinct connection between each area and the tract of gray matter which receives the impressions. Nay more, there must be, in this central recipient tract, an added number of the separate elements which, by their excitement, yield separate feelings. So that this increased power of tactual discrimination implies a peripheral development, a multiplication of fibers in the trunk-nerve, and a complication of the nerve-center. It can scarcely be doubted that analogous changes occur under analogous conditions throughout all parts of the nervous system—not in its sensory appliances only, but in all its higher co-ordinating appliances up to the highest.

parts correspond with their tactual activities. The palms have but one fifth the perceptiveness possessed by the forefinger-ends; the inner surfaces of the finger-joints next the palms have but one third, while the inner surfaces of the second joints have but one half. These abilities correspond with the facts that whereas the inner parts of the hand are used only in grasping things, the tips of the fingers come into play not only when things are grasped, but when such things, as well as smaller things, are felt at or manipulated. It needs but to observe the relative actions of these parts in writing, in sewing, in judging textures, etc., to see that above all other parts the finger-ends, and especially the fore-finger-ends, have the most multiplied experiences. If, then, it be that the extra perceptiveness acquired from extra tactual activities, as in a compositor, is inheritable, these gradations of tactual perceptiveness are explained.

Doubtless some of those who remember Weber's results, have had on the tip of the tongue the argument derived from the tip of the tongue. This part exceeds all other parts in power of tactual discrimination: doubling, in that respect, the power of the forefinger-tip. It can distinguish points that are only one twenty-fourth of an inch apart. Why this unparalleled perceptiveness? If survival of the fittest be the ascribed cause, then it has to be shown what the advantages achieved have been; and, further, that those advantages have been sufficiently great to have had effects on the maintenance of life.

Besides tasting, there are two functions conducive to life, which the tongue performs. It enables us to move about food during mastication, and it enables us to make many of the articulations constituting speech. But how does the extreme discriminativeness of the tongue-tip aid these functions? The food is moved about, not by the tongue-tip, but by the body of the tongue; and even were the tip largely employed in this process, it would still have to be shown that its ability to distinguish between points one twenty-fourth of an inch apart, is of service to that end, which can not be shown. It may, indeed, be said that the tactual perceptiveness of the tongue-tip serves for detection of foreign bodies in the food, as plum-stones or as fish-bones. But such extreme perceptiveness is needless for the purpose—a perceptiveness equal to that of the finger-ends would suffice; and further, even were such extreme perceptiveness useful, it could not have caused survival of individuals who possessed it in slightly higher degrees than others. It needs but to observe a dog crunching small bones, and swallowing with impunity the sharp-angled pieces, to see that but a very small amount of mortality would be prevented.

But what about speech? Well, neither here can there be shown any advantage derived from this extreme perceptiveness. For making the *s* and *z*, the tongue has to be partially applied to a portion of the palate next the teeth. Not only, however, must the contact be incomplete, but its place is indefinite—may be half an inch further back. To make the *sh* and *zh*, the contact has to be made, not with the tip, but with the upper surface of the tongue; and must be an incomplete contact. Though, for making the liquids, the tip of the tongue and the sides of the tongue are used, yet the requisite is not any exact adjustment of the tip, but an imperfect contact with the palate. For the *th*, the tip is used along with the edges of the tongue; but no perfect adjustment is required, either to the edges of the teeth, or to the junction of the teeth with the palate, where the sound may equally well be made. Though for the *t* and *d* complete contact of the tip and edges of the tongue with the palate is required, yet the place of contact is not definite, and the tip takes no more important share in the action than the sides. Any one who observes the movements of his tongue in speaking, will find that there occur no cases in which the adjustments must have an exactness corresponding to the extreme power of discrimination which the tip possesses: for speech, this endowment is useless. Even were it useful, it could not be shown that it has been developed by survival of the fittest; for though perfect articulation is useful, yet imperfect articulation has rarely such an effect as to impede a man in the maintenance of his life. If he is a good workman, a German's interchanges of *b's* and *p's* do not disadvantage him. A Frenchman who, in place of the sound of *th*, always makes the sound of *z*, succeeds as a teacher of music or dancing, no less than if he achieved the English pronunciation. Nay, even such an imperfection of speech as that which arises from cleft palate, does not prevent a man from getting on if he is capable. True, it may go against him as a candidate for Parliament, or as an "orator" of the unemployed (mostly not worth employing). But in the struggle for life he is not hindered by the effect to the extent of being less able than others to maintain himself and his offspring. Clearly, then, even if this unparalleled perceptiveness of the tongue-tip is required for perfect speech, this use is not sufficiently important to have been developed by natural selection.

How, then, is this remarkable trait of the tongue-tip to be accounted for? Without difficulty, if there is inheritance of acquired characters. For the tongue-tip has, above all other parts of the body, unceasing experiences of small irregularities of surface. It is in contact with the teeth, and either consciously or unconsciously is continually exploring them. There is hardly a moment in which impressions of adjacent but different positions are not being yielded to it by either the surfaces of the teeth or their edges; and it is continually being moved about from some of them to others. No advantage is gained. It is simply that the tongue's position renders perpetual exploration almost inevitable; and by perpetual exploration is developed this unique power of discrimination. Thus the law holds throughout, from this highest degree of perceptiveness of the tongue-tip to its lowest degree on the back of the trunk; and no other explanation of the facts seems possible.

"Yes, there is another explanation," I hear some one say: "they may be explained by *panmixia*." Well, in the first place, as the explanation by *panmixia* implies that these gradations of perceptiveness have been arrived at by the dwindling of nervous structures, there lies at the basis of the explanation an unproved and improbable assumption; and, even were there no such difficulty, it may with certainty be denied that *panmixia* can furnish an explanation. Let us look at its pretensions.

It was not without good reason that Bentham protested against metaphors. Figures of speech in general, valuable as they are in poetry and rhetoric, can not be used without danger in science and philosophy. The title of Mr. Darwin's great work furnishes us with an instance of the misleading effects produced by them. It runs:—The Origin of Species by means of Natural Selection, or the preservation of Favored Races in the Struggle for Life. Here are two figures of speech which conspire to produce an impression more or less erroneous. The expression "natural selection" was chosen as serving to indicate some parallelism with artificial selection—the selection exercised by breeders. Now selection connotes volition, and thus gives to the thoughts of readers a wrong bias. Some increase of this bias is produced by the words in the second title, "favored races;" for anything which is favored implies the existence of some agent conferring a favor. I do not mean that Mr. Darwin himself failed to recognize the misleading connotations of his words, or that he did not avoid being misled by them. In chapter iv of the Origin of Species he says that, considered literally, "natural selection is a false term," and that the personification of Nature is objectionable; but he thinks that readers, and those who adopt his views, will soon learn to guard themselves against the wrong implications. Here I venture to think that he was mistaken. For thinking this there is the reason that even his disciple, Mr. Wallace—no, not his disciple, but his co-discoverer, ever to be honored—has apparently been influenced by them. When for example, in combating a view of mine, he says that "the very thing said to be impossible by variation and natural selection has been again and again effected by variation and artificial selection"; he seems clearly to imply that the processes are analogous and operate in the same way. Now this is untrue. They are analogous only within certain narrow limits; and, in the great majority of cases, natural selection is utterly incapable of doing that which artificial selection does.

To see this it needs only to de-personalize Nature, and to remember that, as Mr. Darwin says, Nature is "only the aggregate action and product of many natural laws [forces]." Observe its relative shortcomings. Artificial selection can pick out a particular trait, and, regardless of other traits of the individuals displaying it, can increase it by selective breeding in successive generations. For, to the breeder or fancier, it matters little whether such individuals are otherwise well constituted. They may be in this or that way so unfit for carrying on the struggle for life, that, were they without human care, they would disappear forthwith. On the other hand, if we regard Nature as that which it is, an assemblage of various forces, inorganic and organic, some favorable to the maintenance of life and many at variance with its maintenance—forces which operate blindly—we see that there is no such selection of this or that trait, but that there is a selection only of individuals which are, by the aggregate of their traits, best fitted for living. And here I may note an advantage possessed by the expression "survival of the fittest"; since this does not tend to raise the thought of any one character which, more than others, is to be maintained or increased; but tends rather to raise the thought of a general adaptation for all purposes. It implies the process which Nature can alone carry on—the leaving alive of those which are best able to utilize surrounding aids to life, and best able to combat or avoid surrounding dangers. And while this phrase covers the great mass of cases in which there are preserved well-constituted individuals, it also covers those special cases which are suggested by the phrase "natural selection," in which individuals succeed beyond others in the struggle for life by the help of particular characters which conduce in important ways to prosperity and multiplication. For now observe the fact which here chiefly concerns us, that survival of the fittest can increase any serviceable trait only if that trait conduces to prosperity of the individual, or of posterity, or of both, *in an important degree*. There can be no increase of any structure by natural selection unless, amid all the slightly varying structures constituting the organism, increase of this particular one is so advantageous as to cause greater multiplication of the family in which it arises than of other families. Variations which, though advantageous, fail to do this, must disappear again. Let us take a case.

Keenness of scent in a deer, by giving early notice of approaching enemies, subserves life so greatly that, other things equal, an individual having it in an unusual degree is more likely than others to survive, and, among descendants, to leave some similarly endowed or more endowed, who again transmit the variation with, in some cases, increase. Clearly this highly useful power may be developed by natural selection. So also, for like reasons, may quickness of vision and delicacy of hearing. Though it may be remarked in passing that since this extra sense-endowment, serving to give early alarm, profits the herd as a whole, which takes the alarm from one individual, selection of it is not so easy, unless it occurs in a conquering stag. But now suppose that one member of the herd—perhaps because of more efficient teeth, perhaps by greater muscularity of stomach, perhaps by secretion of more appropriate gastric juices—is enabled to eat and digest a not uncommon plant which the others refuse. This peculiarity may, if food is scarce, conduce to better self-maintenance, and better fostering of young, if the individual is a hind. But unless this plant is abundant, and the advantage consequently great, the advantages which other members of the herd gain from other slight variations may be equivalent. This one has unusual agility and leaps a chasm which others balk at. That one develops longer hair in winter, and resists the cold better. Another has a skin less irritated by flies, and can graze without so much interruption. Here is one which has an unusual power of detecting food under the snow; and there is one which shows extra sagacity in the choice of a shelter from wind and rain. That the variation giving the ability to eat a plant before unutilized, may become a trait of the herd, and eventually of a variety, it is needful that the individual in which it occurs shall have more descendants, or better descendants, or both, than have the various other individuals severally having their small superiorities. If these other individuals severally profit by their small superiorities, and transmit them to equally large numbers of offspring, no increase of the variation in question can take place: it must soon be canceled. Whether in the Origin of Species Mr. Darwin has recognized this fact, I do not remember, but he has certainly done it by implication in his Animals and Plants under Domestication. Speaking of variations in domestic animals, he there says that, "Any particular variation would generally be lost by crossing, reversion, and the accidental destruction of the varying individuals, unless carefully preserved by man" (Vol. II, 292). That which survival of the fittest does in cases like the one I have instanced is to keep all faculties up to the mark, by destroying such as have faculties in some respect below the mark; and it can produce development of some one faculty only if that faculty is predominantly important. It seems to me that many naturalists have practically lost sight of this, and assume that natural selection will increase *any* advantageous trait. Certainly a view now widely accepted assumes as much.

The consideration of this view, to which the foregoing paragraph is introductory, may now be entered upon. This view concerns, not direct selection, but what has been called, in questionable logic, "reversed selection"—the selection which effects, not increase of an organ, but decrease of it. For as, under some conditions, it is of advantage to an individual and its descendants to have some structure of larger size, it may be, under other conditions—namely, when the organ becomes useless—of advantage to have it of smaller size; since, even if it is not in the way, its weight and the cost of its nutrition are injurious taxes on the organism. But now comes the truth to be emphasized. Just as direct selection can increase an organ only in certain cases, so can reversed selection decrease it only in certain cases. Like the increase produced by a variation, the decrease produced by one must be such as will sensibly conduce to preservation and multiplication. It is, for instance, conceivable that were the long and massive tail of the kangaroo to become useless (say by the forcing of the species into a mountainous and rocky habitat filled with brushwood), a variation which considerably reduced the tail might sensibly profit the individual in which it occurred; and, in seasons when food was scarce, might cause survival when individuals with large tails died. But the economy of nutrition must be considerable before any such result could occur. Suppose that in this new habitat the kangaroo had no enemies; and suppose that, consequently, quickness of hearing not being called for, large ears gave no greater advantage than small ones. Would an individual with smaller ears than usual survive and propagate better than other individuals in consequence of the economy of nutrition achieved? To suppose this is to suppose that the saving of a grain or two of protein per day would determine the kangaroo's fate.

Long ago I discussed this matter in the Principles of Biology (§ 166), taking as an instance the decrease of the jaw implied by the crowding of the teeth, and now proved by measurement to have taken place. Here is the passage:—

"No functional superiority possessed by a small jaw over a large jaw, in civilized life, can be named as having caused the more frequent survival of small-jawed individuals. The only advantage which smallness of jaw might be supposed to give, is the advantage of economized nutrition; and this could not be great enough to further the preservation of men possessing it. The decrease of weight in the jaw and co-operative parts that has arisen in the course of many thousands of years, does not amount to more than a few ounces. This decrease has to be divided among the many gene[illegible] that have lived and died in the interval. Let us admit that the weight o[illegible]s diminished to the extent of an ounce in a single generation (which is a large admission); it still can not be contended that the having to carry an ounce less in weight, or the having to keep in repair an ounce less of tissue, could sensibly affect any man's fate. And if it never did this—nay, if it did not cause a *frequent* survival of small-jawed individuals where large-jawed individuals died, natural selection could neither cause nor aid diminution of the jaw and its appendages."

When writing this passage in 1864, I never dreamt that a quarter of a century later, the supposable cause of degeneration here examined and excluded as impossible, would be enunciated as not only *a* cause, but *the* cause, and the sole cause. This, however, has happened. Weismann's theory of degeneration by *panmixia*, is that when an organ previously maintained of the needful size by natural selection, is no longer maintained at that size, because it has become useless (or because a smaller size is equally useful), it results that among the variations in the size, which take place from generation to generation, the smaller will be preserved continually, and that so the part will decrease. And this is concluded without asking whether the economy in nutrition achieved by the smaller variation, will sensibly affect the survival of the individual, and the multiplication of its stirp. To make clear his hypothesis, and to prepare the way for criticism, let me quote the example he himself gives when contrasting the alleged efficiency of dwindling by *panmixia* with the alleged inefficiency of dwindling from disuse. This example is furnished him by the *Proteus.*

Concerning the "blind fish and amphibia" found in dark places, which have but rudimentary eyes "hidden under the skin," he argues that "it is difficult to reconcile the facts of the case with the ordinary theory that the eyes of these animals have simply degenerated through disuse." After giving instances of rapid degeneration of disused organs, he argues that if "the effects of disuse are so striking in a single life, we should certainly expect, if such effects can be transmitted, that all traces of an eye would soon disappear from a species which lives in the dark." Doubtless this is a reasonable conclusion. To explain the facts on the hypothesis that acquired characters are inheritable seems very difficult. One possible explanation may indeed be named. It appears to be a general law of organization that structures are stable in proportion to their antiquity; that while organs of relatively modern origin have but a comparatively superficial root in the constitution, and readily disappear if the conditions do not favor their maintenance, organs of ancient origin have deep-seated roots in the constitution, and do not readily disappear. Having been early elements in the type, and having continued to be reproduced as parts of it during a period extending throughout many geological epochs, they are comparatively persistent. Now the eye answers to this description as being a very early organ.* But waiving possible interpretations, let us admit that here is a difficulty—a difficulty like countless others which the phenomena of evolution present, as, for instance, the acquirement of such a habit as that of the *Vanessa* larva, hanging itself up by the tail and then changing into a chrysalis which usurps its place—a difficulty which, along with multitudes, has to await future solution, if any can be found. Let it be granted, I say, that here is a serious obstacle in the way of the hypothesis; and now let us turn to the alternative hypothesis, and observe whether it is not met by difficulties which are much more serious. Weismann writes:

"The caverns in Carniola and Carinthia, in which the blind *Proteus* and so many other blind animals live, belong geologically to the Jurassic formation; and although we do not exactly know when, for example, the *Proteus* first entered them, the low organization of this amphibian certainly indicates that it has been sheltered there for a very long period of time, and that thousands of generations of this species have succeeded one another in the caves.

"Hence there is no reason to wonder at the extent to which the degeneration of the eye has been already carried in the *Proteus*, even if we assume that it is merely due to the cessation of the conserving influence of natural selection.

"But it is unnecessary to depend upon this assumption alone, for when a useless organ degenerates, there are also other factors which demand consideration—namely, the higher development of other organs which compensate for the loss of the degenerating structure, or the increase in size of adjacent parts. If these newer developments are of advantage to the species, they finally come to take the place of the organ which natural selection has failed to preserve at its point of highest perfection." †

On these paragraphs let me first remark that one cause is multiplied into two. The cause is stated in the abstract, and it is then re-stated in the concrete, as though it were another cause. Manifestly, if by decrease of the eye an economy of nutriment is achieved, it is implied that the economized nutriment is turned to some advantageous purpose or other; and to specify that the nutriment is used for the further development of compensating organs, simply changes the indefinite statement of advantage into a definite statement of advantage. There are not two

* While the proof of this article is in hand, I learn that the *Proteus* is not quite blind, and that its eyes have a use. It seems that when the underground streams it inhabits are unusually swollen, some individuals of the species are carried out of the caverns into the open (being then sometimes captured). It is also said that the creature shuns the light; this trait being, I presume, observed when it is in captivity. Now obviously, among individuals carried out into the open, those which remain visible are apt to be carried off by enemies; whereas, those which, appreciating the difference between light and darkness, shelter themselves in dark places, survive. Hence the tendency of natural selection is to prevent the decrease of the eyes beyond that point at which they can distinguish between light and darkness. Thus the apparent anomaly is explained.

† Essays upon Heredity, p. 87.

causes in operation, though the matter is presented as though there were.

But passing over this, let us now represent to ourselves in detail this process which Prof. Weismann thinks will, in thousands of generations, effect the observed reduction of the eyes: the process being that at each successive stage in the decrease, there must take place variations in the size of the eye, some larger, some smaller, than the size previously reached, and that in virtue of the economy, those having the smaller will continually survive and propagate, instead of those having the larger. Properly to appreciate this supposition, we must use figures. To give it every advantage we will assume that there have been only two thousand generations, and we will assume that, instead of being reduced to a rudiment, the eye has disappeared altogether. What amounts of variation shall we suppose? If the idea is that the process has operated uniformly on each generation, the implication is that some advantage has been gained by the individuals having the eyes $\frac{1}{2000}$ less in weight; and this will hardly be contended. Not to put the hypothesis at this disadvantage, let us then imagine that there take place, at long intervals, decreasing variations considerable in amount—say $\frac{1}{20}$, once in a hundred generations. This is an interval almost too long to be assumed; but yet if we assume the successive decrements to occur more frequently, and therefore to be smaller, the amount of each becomes too insignificant. If, seeing the small head, we assume that the eyes of the *Proteus* originally weighed some ten grains each, this would give us, as the amount of the decrement of $\frac{1}{20}$, occurring once in a hundred generations, one grain. Suppose that this eel-shaped amphibian, about a foot long and more than half an inch in diameter, weighs three ounces—a very moderate estimate. In such case the decrement would amount to $\frac{1}{1440}$ of the creature's weight; or, for convenience, let us say that it amounted to $\frac{1}{1000}$, which would allow of the eyes being taken at some fourteen grains each.* To this extent, then, each occasional decrement

* I find that the eye of a small smelt (the only appropriate small fish obtainable here, St. Leonards) is about $\frac{1}{150}$ of its weight; and since in young fish the eyes are disproportionately large, in the full-grown smelt the eye would be probably not more than $\frac{1}{200}$ of the creature's weight. On turning to highly-finished plates, published by the Bibliographisches Institut of Leipzig, of this perenni-branchiate *Proteus*, and other amphibians, I find that in the nearest ally there represented, the caducibranchiate axolotl, the diameter of the eye, less than half that of the smelt, bears a much smaller ratio to the length of the body; the proportion in the smelt being $\frac{1}{25}$ of the length, and in the axolotl about $\frac{1}{50}$ (the body being also more bulky than that of the smelt). If, then, we take the linear ratio of the eye to body in this amphibian as one half the ratio which the fish presents, it results that the ratio of the mass of the eye to the mass of the body will be but one eighth. So that the weight of the eye of the amphibian will be but $\frac{1}{1600}$ of that of the body. It is

would profit the organism. The economy in weight to a creature having nearly the same specific gravity as its medium, would be infinitesimal. The economy in nutrition of a rudimentary organ, consisting of passive tissues, would also be but nominal. The only appreciable economy would be in the original building up of the creature's structures; and the hypothesis of Weismann implies that the economy of this thousandth part of its weight, by decrease of the eyes, would so benefit the rest of the creature's organization as to give it an appreciably greater chance of survival, and an appreciably greater multiplication of descendants. Does any one accept this inference?

Of course the qualifications of data above set down can be only approximate; but I think no reasonable changes of them can alter the general result. If, instead of supposing the eyes to have disappeared wholly, we recognize them as being in fact rudimentary, the case is made worse. If, instead of two thousand generations, we assume ten thousand generations, which, considering the probably great age of the caverns, would be a far more reasonable assumption than the other, the case is made still worse. And if we assume larger variations—say decreases of one fourth—to occur only at intervals of many hundreds or thousands of generations, which is not a very reasonable assumption, the implied conclusion would still remain indefensible. For an economy of $\frac{1}{800}$ part of the creature's weight could not appreciably affect its survival and the increase of its posterity.

Is it not then, as said above, that the use of the expression, "natural selection," has had seriously perverting effects? Must we not infer that there has been produced in the minds of naturalists, the tacit assumption that it can do what artificial selection does—can pick out and select any small advantageous trait; while it can, in fact, pick out no traits, but can only further the development of traits which, *in marked ways*, increase the general fitness for the conditions of existence? And is it not inferable that, failing to bear in mind the limiting condition, that to become established an advantageous variation must be such as will, other things remaining equal, add to the prosperity of the stirp, many naturalists have been unawares led to espouse an untenable hypothesis?—*Contemporary Review.*

[*To be concluded.*]

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a liberal estimate, therefore, to suppose that its original weight in the *Proteus* was $\frac{1}{1000}$ of that of the body. I may add that any one who glances at the representation of the axolotl, will see that, were the eye to disappear entirely by a single variation, the economy achieved could not have any appreciable physiological effect on the organism.

FREE PLAY IN PHYSICAL EDUCATION.

BY M. FERNAND LAGRANGE.

TO all the dangers that threaten the health of the child in existing systems of education, the best and only remedy to oppose is the regular practice of physical exercises. This remedy can, however, be efficacious only provided the exercises are well chosen and applied according to a rational method. Here we meet a serious difficulty in the fact that many persons do not appreciate the importance of the choice of a method, and are hostile to changes in the systems already adopted. "It is contended," once said a university dignitary in our presence, "that our children should take exercise, because hygiene requires it. But what bearing has it on their health to make them march this way and that way, play at the bars, or perform in a trapeze? Select for them the most convenient exercise to apply, and the problem of physical education will be by so much simplified."

In order that the reader may judge intelligently concerning the controverted question of the choice of a method of physical education, it is indispensable to cast at least a rapid glance upon the different forms of usual exercises, and to compare their tendencies and spirit. The immense number of bodily exercises, which it is impossible to describe here or even to enumerate in full, may be referred, if we regard their spirit rather than their details, to two methods—the natural and artificial. Exercises in the former method are inspired by instinct, and demand movements very similar to those which one would execute spontaneously if he were left to himself. The method is called play, and constitutes a kind of regulation of acts to which the human being is naturally inclined. The child, for instance, has a natural inclination to walk, jump, run, and throw whatever he has in his hand, and attention has been turned to give the execution of all these acts a purpose that shall make them interesting.

The other method of exercise, called gymnastics, proceeds in a different way. It is more scientific and systematic than play. It does not start from the observation of the instinctive tendencies of the human being, but from the study of the conformation of his body. It does not say the child is disposed to walk, jump, and throw stones; let us therefore give it opportunity to perform all these acts. But the body is divided into so many articulations and contains so many muscles; let us move each of these joints in turn, bring each of these muscles successively into play, in order that all the constituent parts of the human machine may receive their quota of exercise. Gymnastics proper, basing itself on knowledge of the anatomy of the human body, has devised more or less ingenious processes for methodically exercising the muscular groups of each region. It has exercises for the arms, for the legs, the trunk, the head, and the pelvis; for the flexor muscles and for the extensors, etc. There are several systems of gymnastics. The Swedish system is characterized by simplicity of movement and moderation in effort. The French system is conceived on the opposite theory of raising the physical aptitudes of the man to the highest point of development. With this purpose it seeks ingenious combinations designed to make each movement represent a difficulty to be conquered; and it contrives expedients for augmenting the effort of the muscles and invents muscular acts to which the man is not naturally inclined.

The natural and artificial methods have very distinct and very characteristic tendencies. The most commonplace example will permit us to show clearly the divergence of their processes. Put a man before a vertical pole and tell him to climb to the top. Left to his instinct, he will utilize all the means of action of which Nature has given him command. He will hug the pole with his arms and legs, and will use his feet and hands. It is the natural process and the easiest one. But if he is a gymnast he will have no use for his legs. He has been taught to climb poles with his hands alone. This is an artificial method to which no one feels naturally disposed, because it increases the difficulty of the movement. Here, then, we find a marked difference between the two methods—one avoids difficulties, the other seeks them.

The essential character of our gymnastics is, therefore, that it demands much more intense muscular effort than the pupil is naturally inclined to, and more difficult movements than his instinctive ones. It tends, for that reason, to make him stronger and more adroit than it was in his nature to become. It is a method of improvement more capable than any other of forming chosen subjects. It has the faults of its qualities; it perfects the man, but at the expense of hard work of which not all men are capable; it may form choice gymnasts, but it forms very few. If it is applied to physical education, we find very few children capable of executing at first, or without long preliminary efforts, the movements which it calls for. Most pupils are discouraged by the difficulties at the beginning, and those who acquire a taste for it are those who are best endowed physically, the strongest, or precisely those who can do best without it. This select minority I admit acquires superior physical capacity, but weak subjects, or those of any medium strength, find no benefit in the gymnastics, for the simple reason that they do not practice it. Repelled by the difficulties of the beginning, they refuse to attempt new efforts and continue in their first impression, which was bad and discouraging. Through all their life they have an aversion to exercise, because exercise was presented to them in the wrong way, under an arid and difficult form.

Thus, our artificial methods of gymnastics are not favorable to the physical education of children, because they are athletic and not hygienic methods. They look especially for strong subjects to make champions of them, when a good hygiene should look for weak subjects to make strong ones of them. We must not forget that the weak form the large majority of the children of the present generation. Our children, so precocious now in their mental development, are far behind in their bodily growth. They need methods of education adapted to their weak physical aptitudes. This is the capital fault of artificial and difficult methods; they do not bring exercise within the reach of children. They are, properly speaking, methods of "selection." They subject children to a sort of trial, taking the strongest to make athletes of them, but leaving the weakest, or the great majority, delivered to all the physical and moral woes that are derived from want of exercise.

It is obvious that difficult exercises can not be recreative. This is still a great reproach to our gymnastics when we undertake to apply it to children subjected to school work, and who have so great need of amusement and distraction in the intervals between their studies. It is not a relaxation that the brain of the child can find in these methodical exercises, but one lesson more added to so many others. Among the movements of our gymnastics, those which are not hard enough to discourage the child by a long apprenticeship are so destitute of interest that they repel by their monotony. Such, for example, are the "floor" exercises. Forty children ranged in three lines wait with erect body and fixed eye the command of the master. Then all together, at his order, turn the head, first to the right, then to the left. They count aloud one, two, three; and, while counting, extend their arms, bend them, raise them, drop them; then the legs have their turn, and finally the trunk and loins. All these motions are very hygienic; but where is there a place for transport and joy in that cold discipline that fixes the features and effaces the smile, in those insipid gestures of which the slightest distraction would destroy the grouping? Yet, to the pupil, pleasure is not only a moral satisfaction, it is a hygienic element indispensable to his health. Under the influence of constraint and weariness the vital functions languish, nutrition is retarded, the nervous centers grow torpid. To impose on a child exercises in which he will find no pleasure is more than a want of solicitude—it is an offense against hygiene.

All methods of physical education must reckon with the necessity of giving some kind of attraction to the movements, even to the most useful and best-chosen ones. It is interesting, when we travel abroad, to observe the efforts made in different countries to reach this aim of rendering exercise attractive. It is also often curious to notice the ingenuity that is devoted to seeking for singular means of palliating the aridity and monotony of systematic exercises.

The pre-eminently recreative exercise is play. This natural gymnastics brings with it an attraction that animates the most indifferent and gives inspiration to the most phlegmatic. And what a contrast there is between pupils exercising in play and those upon whom a systematic gymnastics is imposed—between English school children, for example, and French! In France, to everybody's sorrow, the children seem to have a horror of motion. Left to themselves, as soon as they are out of the schoolroom, they walk along slowly in couples or gather in groups in the corners of the yard; and they pass the time in chatting, in "philosophizing." Gymnastics is obligatory, it is true, on some days and at certain hours; but a witness of the lesson will be struck with observing that hardly four or five pupils out of thirty execute their exercises conscientiously. The others present themselves in their turn, but hardly outline the movement. The professor incites them, urges them; and they go back to their places after having made an imitation of an effort. In the English colleges no regulation makes exercise obligatory, and every one is free to dispense with it or engage in it at will. But all give themselves up to it with incredible ardor. Weak and strong, young pupils or students twenty years old, all show an equal passion for those plays in the open air, now neglected in France, for which gymnastics has been so unfortunately substituted. To form an idea of the enthusiasm they display one should visit Eton or Harrow, Oxford or Cambridge, and see those immense lawns occupied after lunch by crowds of young men in the costume of the game, dividing into groups, forming into gangs, and organizing their parties without losing a minute. I have still in vision the spectacle of a game of football played in my presence by students of Cambridge. Nowhere else have I ever seen such enthusiasm and such spirit, such disregard of falls and blows. The play of ball as thus practiced might constitute in itself alone a complete means of physical education, so fully does it bring into action all the bodily qualities and all the active moral faculties of the players. What vigor in starting the ball, what agility in getting it and bearing it to the goal! What address also in avoiding the throng of opponents who would bar the passage, and what suppleness in gliding through their arms without losing the precious trophy! And if in the struggle the vanquished champion falls to the ground, we see him rebound like the ball itself, touching the turf and beginning his race more ardently than ever, and forgetting to feel where he was hurt.

This striking contrast between the apathy of French youth and the ardor of English youth is easily explained by the passionate attraction of their games, as compared with the depressing aridity of methodical gymnastics. There is no need of invoking difference of races. In the time when we, too, had our national games French youth were as impassioned with tennis, mall, and barette as the Anglo-Saxons are now with lawn tennis, cricket, and football. But the taste for sport was lost with us from the moment the attempt was made to introduce a more methodical and, as it was believed, more perfect form of exercise. The coincidence will not be denied by any one; but there was more than a coincidence in it—there was a relation of cause and effect. If this is still doubted, it will be enough to refer to the revival of the taste for physical exercises that was manifested all at once in our universities when efforts were made a few years ago to introduce open-air sports; and this taste is becoming so decided that some persons are already apprehensive that the more serious studies may suffer by the diversion of interest from them. To the other qualities of superiority of games over gymnastics is added the fact that they are performed in the open air.

Some advocates of gymnastic athletics bring the objection against plays that, while they furnish attractive and easy exercises, their facility itself proves that they do not require a great expenditure of muscular force, and are not, consequently, serious exercises. To show how slight is the foundation for this objection, let us take an ancient typical French game, tennis, and give a summary analysis of it. Going from a gymnasium, where young athletes have been pulling hundred-pound chest-weights, the sight of a game of tennis will certainly not at first give the impression of a "serious" exercise; and one will, perhaps, be tempted to smile at comparing with the effort of gymnasts that of players chasing a minute projectile of twenty grammes with their rackets. Yet the most rugged man, after an hour of this exercise, will be dripping with perspiration, gasping, and will find himself next morning feeling bent all up. One must try it for himself to realize the expenditure of force called out by this exercise, in which the effort is so little apparent. In the exercise of tennis the work is not limited to the motion of the arm in striking the ball. A well-applied racket-stroke requires the bringing of the whole body into action. In the active chase for the ball all the muscles, from the feet to the head, unite in a common effort, or, as the physiologists say, in a *synergy*, which seems to detach the body from the ground and throw it upon the projectile. The stroke of the racket is a "resultant," or the sum of a series of partial efforts which are evolved at once in the arm and shoulder, the vertebral column and the thighs; and the stroke of the racket in itself does not represent the whole expenditure of force occasioned by the game. To it should be joined the motions preceding it and preparatory to it, or the player's changes of attitude. All those who have held the racket know how rapidly these motions have to be made. In less than a tenth of a second one must look ahead and up to catch the ball on the fly, or stoop to take it on the bound, or bend to one side to hit it a back stroke. In these rapid changes of attitude the center of gravity of the body is abruptly displaced, and equilibrium can not be preserved without bringing a large number of muscles into energetic play. The muscles of the thorax, the loins, and the pelvis contract and bring the bony parts forming the framework of the body into close action upon one another. The lower limbs, without leaving the ground, also furnish a considerable interior labor, the purpose of which is to assure the player a solid footing, a stability essential to the force of the racket-stroke; and even the feet seem to fasten themselves to the ground, with the assistance of the toes.

Thus, in the game of tennis, the exercise is distributed among a large number of muscles, and this fact enables us to explain how the effects of work may be very much accentuated without our being conscious of having made great efforts. In giving racket-strokes we make infinitely less efforts than in raising heavy chest-weights, yet we do not perform less work in a game of tennis than in a practice of gymnastic athletics.

In all natural movements we use a large number of muscles at once, and we sometimes bring into action those which are very remote from the point where the work appears to be localized. Active games constantly tend to the division of the work among a large number of muscles. This is the consequence of their very character of natural exercises. Being copied from instinctive acts of which they are simply the methodical regulation, they all present the same character of causing the human machine to execute much work without demanding much effort from it. The operation of the motions adopted by gymnastics proper is different. That does not tend, in general, to seek out the associations of muscles, called in physiology *synergies*, but rather to avoid them, with the view of augmenting the effort of the muscles that are brought into play by suppressing the co-operation of the other muscles.

The property of games is, then, to cause the production in the human body of much work without great effort. Now, the hygienic quality of exercise is not effort, but rather work. The more work we do, the more we stimulate the great vital functions.

and, notably, the respiration and the circulation of the blood. But, while work renders these two functions more active, effort, on the contrary, restrains them. By a mechanism we can not study here all intense effort reacts upon the lungs, the heart, and the large blood-vessels. When we try to raise a heavy weight, or to break between our hands a stick that offers a strong resistance, we feel the muscles of the breast and the abdomen hardening and violently compressing the lungs, as well as the heart and the large blood-vessels. Respiration is suspended, the blood flows back toward the veins, and we see them swelling on the neck and forehead. This violent pressure is not always without danger.

We have selected tennis, the most celebrated and the most French of games, as the type of our demonstration. All games in which projectiles are thrown, or the ground is skipped over, are but variants of tennis, and conclusions drawn from it are valid also as to them.

There are numerous other simple and easy games which are none the less hygienic. The most elementary of all, the game of tag, which children improvise as if by instinct—as also do young animals—is not less efficacious than the most elaborate sports to stimulate respiration and the circulation of the blood. It is because these games represent, in the aggregate, much work. At each step in running, the child takes from the ground and lifts to a certain height above it a relatively considerable weight, that of the body. Now, we know that work in mechanics is estimated by multiplying the weight of the mass raised by the height to which it is lifted. Though the body is lifted only a little at each step in running, yet as these steps are renewed as often as four or even six times a second, we see what number of kilogrammetres a game of tag a quarter of an hour in length may represent. This considerable work is accomplished without effort, because the legs, the thighs, and the pelvis, which co-operate in executing it, are re-enforced by the strongest muscular masses of the body. But while the "effort" passes unperceived by the muscles in the running child, the "work" makes its general effects plainly felt in the organism. The least attentive observer has remarked how running accelerates the circulation of the blood, and especially how it stimulates respiration and magnifies the heaving of the ribs, which is the essential cause of the bellows movement which draws the air into the chest. We might say that in the running child the organ that works most is just the one that it is most important to develop, the lung.

It would be superfluous to pursue the analysis further. We have seen that games, although attractive and easy, are not less serious exercises than our methodical analysis, and that they are in every respect agreeable to the hygienic exigencies of children.

These conclusions, we know, will raise numerous protests, both from specialists whose convictions they may wound and whose interests they may conflict with, and among amateurs of gymnastics to whom those exercises are dear, because they are agreeable to their abilities and tastes. They are, on the other hand, in harmony with the opinion of the most eminent men who have occupied themselves with education, hygiene, and physiology. Herbert Spencer gives preference, among all the methods of physical exercise, to "free play"; and M. Marey, in his report on the work of the Commission of Gymnastics, of which he is president, points out to the Minister of Public Instruction the inconveniences of gymnastics, which is, in his opinion, "only a makeshift to be kept up till the time when we can find a practicable means of substituting exercises really adapted to the abilities and hygienic needs of the child—that is, open-air games."

It is, however, very far from our thought to suggest that methodical gymnastics should be wholly discontinued. That form of exercise, which is not adapted to children or to very young persons, is excellent for those who have completed their growth, and who have time and taste for developing their muscles to the extreme. Gymnastics is an excellent preparation for the military service, and may be of great aid to those who desire to harden themselves by training to the life of the regiment. But it is early enough to begin it in the eighteenth year—that is, after school studies are over.

In short, artificial and difficult exercises are to natural exercises what, in mental education, the higher instruction is to primary and secondary instruction. Physical education has its "grades" as well as mental education, and we commit an error when we reverse them.—*Translated for The Popular Science Monthly from the Revue des Deux Mondes.*

THE Abors, of Burma, have great faith in pig's liver as an oracle. Colonel Dalton, of the English East Indian service, says that, finding that some members of the tribe desired to ascertain by this test the reason of his visiting them, he suggested that a simple plan would be to judge by his words and looks; to which they retorted that the words and faces of men were fallacious, but pig's liver never deceived them.

"BOG BUTTER" was the subject of a recent paper by the Rev. J. O'Laverty before the Royal Society of Antiquaries in London. The author said that a roll in his possession found at the depth of twelve feet in a bog, wrapped in a coarse cloth still retaining the print of fingers, had a taste of cheese. The property of bog-burying conveying a cheesy flavor to butter, or making it rancid, has been mentioned by other writers, and is referred to in an old couplet.

CONSERVATION OF THE MACKEREL SUPPLY.

BY ROBERT F. WALSH.

DURING the past few years there has been a serious scarcity of mackerel off the northern Atlantic coast, or rather the fishermen have been unable to capture such large numbers of this fish as had been their custom in former years. This falling off in the mackerel "catch" has a marked effect upon the fish-food supply of our markets. Scarcity of any commodity tends to increase the prices of articles which are used for similar purposes; hence, not only has mackerel become a fish of luxury—because of its scarcity—but the prices of most other fishes have been advanced correlatively with the decrease in the general fish supply caused by the partial failure of the mackerel fishing during the past few years.

Recognizing this, the United States Fishery Commissioners inquired into the subject, but arrived at no definite conclusions, either with regard to the causes of this scarcity of mackerel, or as to how the supply could be increased to the former standard. However, some enterprising owners of fishing schooners having a knowledge of the enormous "banks" of mackerel that frequent the southern Irish coast at certain seasons, equipped their vessels for the ocean voyage and sent them across the Atlantic to fish for mackerel in Irish waters. In the matter of capturing large quantities of fish—superior to that which is caught in the western Atlantic—they were successful; but the question is undecided as to whether or not a continuance of the experiment would be financially judicious.

To my mind it seems clear that the sending of vessels to the Irish coast to capture fish for this market could not be profitably continued; but I believe that I can point out, not only the causes which led to the failure of the mackerel fishing upon this coast, but also show—from practical observation of the habits of mackerel and the methods of fishing for them—how the supply off the northern Atlantic coast could be readmitted.

The solution of such a problem as this can not be arrived at by any theoretical examination of the question. Study of the habits of the fishes, through centuries, and practical observation of their movements and instincts, can alone guide one in arriving at satisfactory conclusions. And, in order that my statements may receive due consideration, I think it not unwise to premise that at the Fisheries Exhibition in London, in 1883, I read a paper upon this subject before a special International Conference, and was awarded for it one of the few "grand diplomas of honor" which were conferred by the "commissioners appointed by her Majesty's Government."

I shall elucidate the subject of the causes of the apparent diminution in the mackerel supply off this coast by an example which will *de facto* point out how this fish can be readmitted as an economic sea product for our food supply; and in so doing I shall draw almost entirely from my research in the matter as contained in the paper to which I have referred.

About thirty years ago the mackerel fishery off the southern Irish coast was first (in this century) prosecuted as a great industry. Fishing vessels came there from Scotland, England, the Isle of Man, and from France, to reap the silvery harvest of the ocean; and the few rude native craft which then existed were rapidly multiplied into hundreds of beautiful yacht-like fishing vessels. For twenty years the mackerel fishing—which begins in March and continues until the end of June—prospered almost phenomenally, and many of the boat-owners and fishermen, both native and foreign, amassed comparative wealth, as did also the ship-builders and net and rope makers. The town of Kinsale, county of Cork, which is the headquarters of the industry, enjoyed a prosperity during those years strangely at variance with the decaying condition of other Irish towns; but in 1880 this great fishery was temporarily destroyed, through sheer ignorance of the habits and instincts of the mackerel, by the avarice of the boat-owners and fishermen of the Isle of Man.

It occurred in this way: All the fishermen of this great fleet—over one thousand fishing vessels, each carrying eight to ten men and more than two miles of netting—were aware that the mackerel came from the Atlantic, in the southwest and west, toward their spawning ground off the southern Irish coast at this season. But the Manx fishermen and owners were not satisfied with reaping a good harvest from March to June. The fish fetches a much larger price early in the season, and they decided that they would "try" for them farther west than the usual fishing ground, before the season opened off Kinsale and Baltimore. The result was disastrous. For two years the "early boats" succeeded well; but in the third year the entire mackerel fishing along the coast was a failure, and it was not until May and early in June that good catches were made off the "grounds" outside Kinsale. Then the price was low, as the fish was too full of roe, or "spent" after spawning, to be shipped to foreign markets in good condition, and one after another the boat-owners and fishermen and merchants fell before the unprosperous wave. The fact of the mackerel not turning up until late in the season caused sore distress among the eight or ten thousand persons engaged in the industry; but it had one good effect—it stopped the too early fishing; and now, after eight years of failure, prosperity is again beginning to dawn upon the southern Irish fisheries.

It must be obvious to the most ordinary reader that the cause which led to this temporary failure was the too early interception of the mackerel while on the way to their spawning ground. Why this should be, I shall explain more interestingly; for in elucidating the subject I shall have to call attention to the peculiar habits and instincts of the mackerel, which, upon the authority of early official documents, we learn were suspected, if not known, by the fishermen of the south of Ireland more than two centuries ago.

When alluding to the instinct of the mackerel I did so in a manner that might possibly lead a reader to suppose that they possess the same unreasoning prompting to action that do all animals, whether it be that that instinct warns them of danger, safety, or the presence or propinquity of food or pleasurable object. But there is one all-important factor of common instinct which is *partially* absent in the mackerel—viz., danger; for, although when they are interrupted on the way to their spawning ground they avoid the place where their shoals were broken—oftentimes for many years—and execute the arc of a circle around the danger spot on their succeeding journeys to the spawning ground, it is a most curious fact that when close to their haunts they swim blindly and without any apparent unreasoning prompting or instinct of danger onward, nor do they struggle to free themselves from the meshes of the net as do all other fishes.

There can be no doubt whatever about this absence, or rather partial absence, of the instinct of danger in the mackerel.

Another peculiar trait of this member of the *Salmonidæ* family is that mackerel do not feed upon their own young as do most other fishes; and often, in the autumn, when the "harvest mackerel" (a smaller species than the "season" mackerel, and usually, but erroneously, supposed to be all males) frequents the waters close to the shore, I have seen them rush wildly through a shoal of sprats or brit, with which young mackerel often swim, devouring them upon all sides, but studiously avoiding those of their own family. Indeed, the *petite* mackerelettes do not seem to be at all so alarmed as their companions, who spring out of the water in their terror and swim scatteringly in every direction. This, too, is undoubtedly instinct upon the part of both the juvenile mackerel and his larger brother. But that fact does not importantly concern the purpose of this article.

I have shown that they possess instinct of both a perfect and imperfect order, and I have proved that, because of the interception of the shoals while on their way to the spawning ground in the spring, they abandon their usual course and travel perhaps hundreds of miles in a semicircle to reach the haunts where the roe is deposited. Of course, I have given only one example, and that one which came under my own observation during the years from 1880 to 1892; but I shall now go back more than two hundred years and add to my personal knowledge the experience of the fishermen of that time, as recorded in the Annals of Kinsale, which old manuscripts I had the very great pleasure and privilege of being allowed to make a thorough examination of in 1882 and 1883.

Even in recent years, here, as well as in Ireland, the fish *savants* sought to place the cause of the scarcity of mackerel at every door but the correct one. One man would say, "They are being overfished"; another, "They are most uncertain in their comings and goings, and have no fixed or permanent haunts or spawning grounds"; and yet a third would advance the *theory* (for, mind you, all these men are simply theorists in the science of ichthyology) that "mackerel only frequent certain localities on the coast at irregular periods."

All three theories are wrong; and I shall prove that not only have they fixed spawning grounds and haunts, but that they have been known to frequent one "ground" for over two hundred years without the intermission of a season, and that it is only such accident as continued interception of their progress toward that ground *too early in the season* that prevents their being captured in large quantities in the same places and at the same time every year.

Early in the seventeenth century "enormous catches of pilchards, mackerel, and herring" were obtained off the southern Irish coast. At that time the mackerel season occurred precisely at the same time in each year as it does now, and the great spawning grounds were located then in exactly the same place as they are to-day. This of itself goes far to prove that the habits of mackerel, in this wise at all events, are practically unchangeable; but we must advance more particularly into the matter to arrive at a positive rock foundation for my statements. In the seventeenth century the native fishermen fished in open boats, "with rude and inadequate appliances." But then, too, a fleet of French fishing smacks came annually from Dieppe, Havre, Boulogne, and the many small villages and towns lying between these cities, to reap the mackerel harvest in the ocean outside Kinsale. These Frenchmen had fishing appliances much superior to those of the Irish. In fact, I demonstrated clearly in 1883 that the most improved modern inventions for the capture of mackerel are not importantly superior to the gear used by the French fishermen in Irish waters nearly three hundred years ago. And it is in this connection that the connecting link between the mackerel fisheries or mackerel habits and instincts of the seventeenth and nineteenth centuries can be plainly demonstrated.

In September, 1675, the fishermen of Kinsale, smarting under the continued absence of mackerel "from their shore . . . until the harvest time" for two seasons, held a meeting at which it was concluded and resolved that "the enormous nets of the Frenchmen" broke the shoals "and the mackerel became frightened and sought other grounds." Thereupon they petitioned the king, through Secretary Burchard, . . . that "a fleet of three hundred sail of French have for many months, in this season, beleaguered our coast. They have nets, each of them half a league in length. And they fish *four* OUR mackerel and pilchards to such a degree that our nets can not catch any more." The petition then goes on to state that "in consequence of the great length of the nets" (of the Frenchmen) "the shoals are broken and the mackerel refuse to come again in that way." This petition was drawn up and signed in Kinsale in September, 1675, and it goes to prove that so far back as the seventeenth century the mackerel frequented the same "grounds" that they do to-day; and that for the same reason as they did in 1883, they resented the interference of the Frenchmen at a too early period in their migration toward the spawning ground and disappeared from the coast *at this point.* That they were captured late in the season is told in the following quotation, dated September 7, 1675: "Notwithstanding that the mackerel disappeared from this coast in the spring, because of the depredations of the French, they have turned up again in enormous numbers and fat at their old haunts outside the Old Head to the westward."

This proves my original statement that mackerel have a distinct and permanent spawning ground; and it is a strong weapon in my assertion that want of knowledge of the habits of the fish is solely responsible for its scarcity either in this or in the Irish market.

But it is needless to prolong this argument. It is established without question that the habits and instincts of mackerel are the same that they were three hundred years ago, and that during all these years they sought the same spawning grounds and resented interference with their progress toward them by making a detour. In this detour lies the secret of the erroneous idea that "the mackerel are leaving the coast." They are not. They will reach their spawning grounds, no matter how far they swim; and, when they are near to them, nets, of whatever construction, can not deter their progress.

The moral of this is simple. To me it is as plain as the sun at noon. It is this: If we wish to capture mackerel, we must do it in season. Nature sends them to us then, and we should profit by their approach; but we must not use unnatural methods or times to reap the harvest.

And now let us examine more particularly the bearing which this elucidation of the habits of the mackerel in the eastern Atlantic has upon the waning mackerel fisheries of the eastern American seaboard. Unfortunately, we have not the same specific data which are furnished in the Annals of Kinsale to compare the earlier conditions. In fact, we have no authentic records of mackerel fishing with nets earlier than the first decade of this century; and, as says Mr. R. Edward Earll, in his exhaustive report, it was not until 1826 that the New England mackerel fisheries were prosecuted with any appreciable success. Prof. Brown Goode and Captain Collins, of Gloucester, have also added most important contributions to the history of the mackerel off this coast; and, as all these efforts are contained in the official reports of the United States Commissioners of Fish and Fisheries I shall confine my own observations within the limits of the official records of their research. The mackerel fishery off the New England coast extends from the northern end of the Gulf of Maine to Cape Cod, and it has been ascertained that their spawning ground lies between the Shoals of Nantucket and the Bay of Fundy. A general fishing, however, is carried on from the shoals southward as far as the Chesapeake Bay. Mackerel were first fished for in these waters off the New England coast; and when in 1870, the older appliances were discarded by the majority of the fishermen and the purse-seine adopted, enormous numbers were captured by the men who fished outside Gloucester. Discovering, however, that the fish could be captured earlier in the season farther south, the more enterprising among the fishermen tried the waters as far south as the Chesapeake and Delaware Bays, and succeeded admirably for several seasons. Then, in 1878, the men who remained on the New England ground, and who continued to use the old appliances—drag and gill nets—discovered that the supply of mackerel was becoming irregular and smaller, and, believing that this scarcity and irregularity of the fish were caused by the use of the purse-seine, they protested against the use of that style of net in precisely the same manner as did the Irish fishermen petition against the "long nets of the French" in 1675.

The protest of the Gloucester men had no effect; the Southern fishery was continued uninterruptedly for several seasons more, and finally the mackerel seemed to have disappeared from the coast in the same manner as they did from the Irish coast from 1883 to 1892 during the spring season; and in the same manner also they reappear off their New England spawning grounds in the late summer. I omitted to state that the season mackerel is caught in American waters in the same months that they are in seaon off the Irish coast, viz., March to June.

From this simple statement of the history of the New England and northern Atlantic mackerel fisheries, I believe that the most obtuse reader will deduct the fact that the apparent disappearance of that fish from our coast is solely due to the same causes which were observed and which I have explained concerning the Irish mackerel fisheries; and I believe, and I think it is apparent from what I have written, that, in order to conserve a bountiful supply of mackerel in these waters, they should not be intercepted on their way toward their spawning grounds, certainly not until they begin to appear off the Shoals of Nantucket.

The analogy between the errors of the fishermen and the habits and instincts of the mackerel, upon both sides of the Atlantic, will be seen to be curiously coincidental; and to my mind it seems clear that similar precautions would surely bring about similar results.

It is a clear case of judgment and patience. I should probably have said want of judgment; for want of judgment, seasoned by avarice, is the sole cause of the apparent disappearance of mackerel from this coast. The habits and instincts of the mackerel are practically unchangeable; and if our fishermen only study a little more the habits of the fishes, and accustom their expeditions to the necessities compelled by these natural sequences, our food supply—in the matter of mackerel or other fish—will not measurably diminish.

TRACES OF A VANISHED INDUSTRY.

BY JOHN GIFFORD.

A LINE drawn across New Jersey from Long Branch to Salem separates a peculiar peninsula known as "South Jersey." This rudely triangular region is bounded by the ocean, Delaware Bay and River, and the rich farm lands on the outcrops of the marl-beds.

This territory is slightly undulating, little cultivated, and sparsely inhabited. There are sandy parts covered with pitch pines. Being unfit for cultivation, this should be left in forest, to regulate the climate and hold the sand in place. The pines are pioneers. They prepare the soil for other plants, and when cut are quickly replaced by oaks and other trees. There are loamy and gravelly parts worthy of careful cultivation, yielding excellent fruits and vegetables.

There are low, boggy sections, in which flourish cedars, magnolias, maples, mistletoe-stunted gums, and the like. Many of these lowlands are fit for meadows and berry bogs. A striking feature of this region are the dark and dense swamps of white cedar. The tree is tall, straight, and sharp-pointed, yielding a soft, white, durable wood. In the humus of the swamp, which is often several feet in thickness, one tree supports another, and, if a few are cut, others fall in every direction. An old cedar-swamp bottom, through which there is a running stream, is usually selected for a cranberry bog. Many acres of swamp land are covered with huckleberries in plenty and of fine quality. There are bushy, semi-marshy areas, with here and there a straggling pine. In such places many rare and beautiful plants, for which the region is famous, are found, and, in spite of the flies and mosquitoes, they have long been a favorite resort of enthusiastic botanists.

There are also the salt marshes, called "mashes" by the haymen and baymen, extending for many miles along the coast and bays, the rich black soil of which may some day be drained and tilled. It freshens when banked and sluiced. These marshes, endless to the eye, are intersected by many bays, salt-ponds, thoroughfares, and winding creeks, bordered with rustling reeds, resounding with the twitterings of many meadow-wrens, the cacklings of mud-hens, and cries of many birds of the snipe order. They are aglow in season with pink, white, and yellow flowers, and flecked at times with the sails of boats moving in the creeks and bays. These meadows yield thousands of tons of salt and black grass, which is still in many places cut with the scythe and carried by two men with "hand poles" to the square, clumsy scows which are partly rowed and partly drifted to the landings.

Many miles of salt meadow separate the mainland from the narrow strips of sand beach bordering the sea, the white glimmering sands of which, covered in places with large hollies and red cedars, are washed hither and thither by the waves and piled by the winds in dunes. These beaches, on which are located the famous seashore resorts to which thousands flock for recreation, are separated by many inlets, through which the tides sweep swiftly.

Here and there are the gray, unsightly boles of trees which have been killed, and whole strips of woods blasted and blackened by fires which rage at times in these regions.

Few spots are favored with more rivers and streams along which the scenery is wilder. Their waters are yellowish-red in color at first, but become black later, owing to changes in the peaty matter which they contain. Years ago these streams were dammed, to supply the power with which to move the clumsy, old-fashioned bellows to pump air into the furnaces in the manufacture of iron from "bog ore."

The sand of the hills of South Jersey is yellowish in color, because of the iron which it contains. When firmly cemented together by large quantities of iron compounds, a durable ferruginous sandstone or conglomerate is formed, which is the principal building stone of the region. In contact with decomposing organic materials, ferric oxide, the insoluble reddish coloring matter in the hills, is reduced to ferrous oxide, which combines with carbonic acid to form a carbonate of iron, which is soluble in water containing an excess of carbonic acid. Thus it is carried by the water to the bogs, where the carbonic-acid gas is exchanged for oxygen and the iron is precipitated in the form of ferric oxide; but, if there is a large quantity of decomposing peat present, it is deposited in the form of ferrous carbonate. Thus the so-called "bog iron ore" is formed.

The "raising" of this ore and the manufacture of iron therefrom was the leading industry of South Jersey during the early part of this century. Charcoal was the fuel used and coalings were common throughout the "Pines." An active coaling is now seldom seen. Shells were hauled by wagon or rowed and poled by scow from the seashore for a flux, the oyster then being of more value for that purpose than for food. Better oysters could be picked from those shell heaps than can be bought at the stands to-day. In a memorandum kept by the "master ore-raiser" for one of the largest furnaces there are many interesting notices of large quantities of clams and rum bought and sold, but the oyster is never mentioned. These account-books were decorated with the pictures of soldiers and warships, showing well the prevailing thought of those days.

There was then an extensive trade between South Jersey and the West Indies, exchanging lumber and iron for rum, sugar, and molasses, in spite of the pirates who were ever at home in the thoroughfares, bays, and crooked channels of the coast. Scattered here and there along these streams are the remains of what were once centers of a flourishing industry. In some places the furnaces and forges have been completely obliterated and forgotten; in others only bits of black slag remain; while in others the ruins are still standing. At the head of the Tuckahoe River there is a crumbling stack, at Allaire there are ruins, and at Weymouth the course of a canal may be traced by which the ore was brought to the furnace from the bog.

The places were connected by stage routes, along which at regular intervals were the famous "jug taverns" of old, the ruins of which in many localities may still be seen. They are now in the midst of the forest, and, like the remains of the forges and furnaces, are sad reminders of more prosperous days. To-day one may wander for miles along these old overgrown roads without seeing a single human habitation.

In 1766 a furnace was built at Batsto, one of the first and at one time the largest in this country. Batsto is in the heart of the

"Pines," at the head of Mullica River. Battles were fought at Chestnut Neck near the mouth of this river, at one time a large and prominent settlement, and cannon balls, old pennies, and pebbles oddly decorated on one side have been found on the beach. Skeletons of men have been bared by the winds, which some think are those of soldiers and others of Indians, since it was once an Indian village, as is indicated by potsherds, broken shells, flints, and other signs scattered all over the surface of the ground. Munitions of war were cast there for the Revolution. General Greene himself owned a twelfth interest in the Batsto furnace, but sold out his share when he entered the army.

Extending northward from the Mullica River are the "Plains," a desolate region inhabited at one time, they say, by wild hogs, pine robbers, and pirates.

Weymouth was another important place. Materials were forged there for the War of 1812, and street lamps standing to-day in Philadelphia and waterways in Mobile were molded there.

Scattered here and there throughout the "Pines" were active, thriving "bloomeries." Now all is silence, save for the noises of the woods. Instead of the buzz of the mill and the commotion of men at work, there can now be heard only the chirping of insects and the song of the cheewink by day and the croaking of toads and frogs at night. The ruins of forges and furnaces, the large, dilapidated houses, the overgrown roads, the wharves, the sluices, the piers, the old fences, and the masses of black coal-dirt on the landings where vessels once came for wood and charcoal, are all evidences of what the country was when iron was made from "bog ore." In the houses and ample barns even of more recent date the spiders have woven their webs, the wasps have mudded the walls, and the rats scamper at home through the deserted rooms. Many orchards are untrimmed and sterile, many meadows flooded, and many fields overgrown with briers and Indian grass.

After the death of the iron manufacture South Jersey passed into another industrial stage—the making of glass. The glory of this industry is also passing, and ruins of old factories are not uncommon.

Those furnaces and forges mark the infancy of the iron industry in America—an industry which has made this century "the age of iron." Its local decline was natural and unavoidable—due to an inadequate supply of ore, a crude manner of manufacture, and difficult means of transportation.

ERNEST RENAN.

SKETCH OF HIS LIFE AND WORK.

BY GABRIEL MONOD.*

NOTHING could be simpler, or more of a piece, than the life of Ernest Renan. Study, teaching, and the joys of family life are its whole fabric, and fill it from end to end. For diversions, a little travel and the pleasures of conversation—friendly dinners, and a few frequented *salons*. Twice, indeed—urged by the thought that a man of his standing owed something of his time and strength to the public service—he solicited the popular vote: once in 1869, as deputy for the Seine and Marne; and again in 1876, as senator for the Bouches du Rhône. But he carried into these electoral contests no trace of the fever of ambition, and when he saw that he was not likely to command a spontaneous majority he retired from the field without vexation and without regret.

He was a native of Tréguier (Côtes du Nord), one of those ancient episcopal cities of Brittany which have retained their ecclesiastical character even down to our own time. The humble house is still to be seen, close under the great cathedral founded by St. Yves, where Renan was born on the 27th of February, 1823, and the little garden, planted with fruit trees, where he played when quite a child, letting his eyes wander over the still and sad horizon of the hills which skirt the river bank. His father—a captain in the merchant navy, who also carried on a small trade—was of ancient Breton descent, the name of Renan being that of one of the oldest of the Armorican saints. He transmitted to his son the dreamy imaginative nature and the disinterested simplicity of his race. His mother was of Lannion, a little commercial town which has nothing of the monastic look of Tréguier. Pious as she was, she had an elasticity and joyousness of nature which her son inherited from her, and which he attributed to her Gascon origin. Renan has too often insisted on the co-existence of the two natures in himself—the Breton seriousness and the Gascon vivacity—for us to venture to contradict him on this point; but the serious side of him was first and last and strongest in all he wrote, or did, or thought.

For the rest, life began for him austerely, and more than austerely; it was hard and painful. While he was yet a child, his father was lost at sea; and it was only by the most self-denying economy that his mother could provide for the education of her

* From his article in the Contemporary Review.

three children. But Renan had no grudge against his destiny for giving him these years of privation; he was grateful for having been brought up in the knowledge and love of poverty. All his life he loved the poor, the humble, the common people. He never turned his back on the lowly relatives he had left in Brittany. Down to the last years of his life he loved to visit them; and it is characteristic of him that he kept the little home of his childhood just as it was. His sister Henrietta, twelve years his senior—a woman as remarkable for her force of mind and character as for her passionate tenderness of heart—worked hard for her family, giving lessons first in Tréguier, then at a school in Paris, then in Poland, and all the while watching with a sort of motherly solicitude the progress of this young brother, whose gifts she had already recognized. Young Ernest was meanwhile doing his "humanities" under the good priests in the seminary at Tréguier—a gentle and studious scholar, carrying off all the first prizes as a matter of course, and seeing before him no larger future than that of a simple and learned priest among his own people, with perhaps, at last, a canonry in some cathedral. But it so happened that his sister had met in Paris a young, brilliant, and ambitious abbé, M. Dupanloup, who had just been appointed head of the seminary of Saint Nicolas du Chardonnet, and who was looking out for clever recruits. She spoke to him of her brother; and the result was that, at fifteen and a half years old, Ernest Renan found himself transplanted to Paris, where he astonished his new masters by his marvelous facility of acquisition and the early maturity of his mind, and, after passing through his course of philosophy in the seminary of Issy, was entered at Saint Sulpice for his theology. Saint Sulpice was then the only seminary in France which kept up the tradition of the severer studies, and which, in particular, taught the Oriental languages. Its teachers—especially the eminent Orientalist, Father Le Hir—recalled, by the austerity of their life and the profundity of their learning the great scholars of the Church in the seventeenth and eighteenth centuries. Renan rapidly became the friend, and then the rival of his masters, who discerned in him one of the future glories of their house, and little guessed that the very lessons he received there were to separate him from it forever.

The crisis, when it came, was a purely intellectual crisis. By training him in comparative philology and criticism, and by encouraging the scrutiny of the sacred writings, the priests of Saint Sulpice had placed in the hands of their young disciple the most formidable instrument of negation. His quick intelligence, lucid, penetrating, and sincere, perceived at once the weakness of the theological structure on which rests the whole weight of Catholic doctrine. All that he had learned at Issy of natural science and philosophy served to re-enforce the doubts inspired by historical and linguistic criticism as to the infallibility of the Church and the Scriptures, and the teaching which makes the Christian revelation the central fact of history and the explanation of the universe. It was a heart-breaking process, since it was to carry disappointment and dismay, not only to the teachers he venerated but to a mother whom he tenderly loved; but he did not hesitate for a moment to take the step imposed upon him by honesty and conscience. He left the peaceful asylum which had held out to him the promise of an assured future, for the hard life of an assistant schoolmaster in the Quartier Latin, and began, at twenty-two, to prepare for the examinations necessary to his entering on the career of a professor. At this difficult juncture his sister came to his aid. Her own thoughts and her own studies had already brought her to the same negative views with regard to the Catholic religion, though she had steadily avoided unsettling her brother's mind with her doubts; and when he opened his heart to her, and told her his reasons for quitting the seminary and renouncing the priesthood, she received the news with joy, and sent him her savings—some twelve hundred francs—to help him over his first difficulties.

But he had no need to exhaust this reserve fund. With his extraordinary powers and the knowledge he had already acquired, he soon made himself an independent position, and henceforth he went on from one success to another. The record of his achievements during the five years which followed his withdrawal from Saint Sulpice (1846–1850) is simply astounding. He passed through all his university degrees, from the B. A. to the "agrégation" in philosophy, where he took a first in 1848; he took the Volney prize the same year at the Académie des Inscriptions for an important work on the general history and comparative grammar of the Semitic languages, and another prize two years later for an essay on the study of Greek in the middle ages; he made a tour of research among the Italian libraries, whence he brought back his *thèse de doctorat*—a book on Averrhoes and Averrhoism, which contains an admirable history of the introduction of Greek philosophy into the West by the Arabs; and at the same time he published an essay on the origin of language, and composed a considerable work on the Future of Science, which was not published till 1890.

This book, written in the space of a few months by a young man of twenty-five, already embodies all the ideas on life and the world which he elaborated in detail in his later writings; but they are here affirmed in a tone of enthusiastic conviction which became more and more modified as he went on, though the basis of his teaching remained unchanged. He hails the dawn of a new era, in which the scientific conception of the universe shall take the place of the metaphysical and theological. Natural science, and especially the historical and philological sciences, are to be not only the liberators of the human mind, but also the guides of human life. Politics, ethics, education—all are to be regenerated by science. Science is to establish the reign of justice among men, and to become the source and final form of religion.

It was by the advice of Augustin Thierry and M. de Sacy that Renan suppressed this volume, in the fear that its hard and dogmatic tone might repel the reader, and that its ideas would prove too new and too daring to be accepted all at once. Besides, Augustin Thierry was uneasy at seeing his young friend ready to give away at a stroke his whole intellectual capital. He persuaded him to dispense it in detail in the Revue des Deux Mondes and the Journal des Débats. And thus it was that Renan became the first of our essayists, giving currency to his most audacious conceptions, and to all the discoveries of comparative philology and rationalistic exegesis, under the light, easy, and accessible form of literary and philosophic criticism. They were republished in the volumes entitled Moral and Critical Essays, Studies in Religious History, and New Studies in Religious History. His literary fame grew fast, while his learned works obtained for him, in 1856, at the age of thirty-three, the membership of the Académie des Inscriptions.

From the year 1851 onward he was attached to the Bibliothèque Nationale; and this modest post, together with the growing income derived from his works, had enabled him to marry. This marriage had very nearly been the occasion of another dramatic episode in his private life. He had lived, since 1850, with his sister Henrietta; their fellowship of thought and feeling had grown with their fellowship in life and work; and Henrietta—who supposed that in abandoning the Church for science her brother had but exchanged one priesthood for another—had never dreamed that anything could separate them. When he told her of his intended marriage, she betrayed such acute distress that he determined to renounce the project which caused her so much unhappiness; and it was Henrietta herself who flew to Mlle. Scheffer and entreated her not to give up her brother, and Henrietta who hurried on the marriage, the mere idea of which had been too much for her self-control. The marriage did not, after all, involve her separation from her brother. She attached herself passionately to his children; and when he and his wife made a journey to Phœnicia on an archæological mission she accompanied them, and stayed with her brother when Madame Renan was obliged to return home. These few months of dual life were her last happiness. They were both attacked by fever at Beyrout.

She died, while he, prostrated by the malady, was too ill to realize his loss. In the little biographical sketch, which is his most exquisite work, and one of the purest masterpieces of French prose, he has given her portrait to posterity and made us share his loss.

He brought back from Syria not only the inscriptions and archæological observations published in his Phœnician Mission, which appeared in numbers from 1863 to 1874, but also the first sketch of his Vie de Jésus, which forms the first volume of the great work of his life, L'Histoire des Origines du Christianisme, in seven octavo volumes. The religious questions had always seemed to him the vital questions of history, and the ones which most needed the application of the two essential qualities of the historian—critical acumen, and that divination of the imagination which resuscitates the men and civilizations of the past. It was upon Christianity, the greatest religious phenomenon of the world, that Renan turned the whole resources of his erudition, of his poetic insight, and artistic skill. He was afterward to complete the work by adding to it, by way of introduction, a History of Israel, of which three volumes have been already published, and the remaining two are finished and ready for the press.

The appearance of the Vie de Jésus was not only a literary event but a social and religious fact of vast import. It was the first time that the Life of Christ had been written from a purely laical point of view and apart from any supernatural conceptions, in a book destined not for doctors and theologians but for the general public. In spite of the infinite delicacy with which Renan presented his idea, the softened and reverent tone in which he speaks of Christ—or, possibly, even on account of that delicacy and reverence—the scandal of it was colossal. The Catholic clergy felt at once that this form of incredulity, expressing itself with all the gravity of science and all the unction of piety, was far more formidable than the flippancy of Voltairianism; and coming, as it did, from a pupil of the ecclesiastical schools, the sacrilege and the heresy were complicated with treason and apostacy. The Imperial Government, which in 1862 had nominated him Professor of Semitic Philology in the Collége de France, had the cowardice to revoke the nomination in 1863 in deference to the clamor set up in the clerical camp, but innocently offered him, by way of compensation, a curator's post at the Bibliothèque Nationale. "Pecunia tua tecum sit" (thy money be with thee) was Renan's reply to the minister who offered it; and freed henceforth, by the extraordinary success of his book, from material cares, the "European blasphemer," as Pius IX called him, went quietly on with his work. It was not till after the fall of the empire, in 1870, that his chair was given back to him. Not only did he occupy it thenceforward till his death, but he became in

1883 the honored head of the great scientific establishment from which he had once been driven with indignity.

Forced, by the publication of the Vie de Jésus, into the arena of religious conflict, Renan never stooped to polemics. He kept the quiet of his thoughts, untouched by all this wrangling; and he continued to speak of Christianity and the Catholic Church with the same even fairness—I may say more, with the same respectful though independent sympathy. The English public had an opportunity of appreciating these high qualities of intellectual liberty and calm when, in 1880, he gave his Hibbert lectures on Rome and Christianity, and another admirable lecture on Marcus Aurelius, at the Royal Institution—a lecture in which he anticipated the generalization of the last and finest volume of his Origines du Christianisme.

The year 1870 marks an important epoch in the life of Renan. It was, indeed, the year of a new crisis. From the moment when he emancipated himself from his first foster-mother, the Church, and from his ecclesiastical education, Germany had been the second foster-mother of his mind. As he had broken with the Church without ceasing to recognize her greatness and the services she had rendered, and still renders, to the world, so now he suffered, not without pain, the relaxation—almost the rupture—of the moral ties which bound him to Germany; but he never repudiated the debt of gratitude he owed her, nor ever sought to depreciate her virtues and her merits. He gives eloquent expression to his feelings in his letters to Dr. Strauss in 1871, in his speech on his reception into the French Academy, and in his letter to a German friend in 1878. At the same time a new development took place in his political conceptions. An aristocrat by temperament, and a constitutional monarchist in opinion, he found himself called to live in a democratic society and under a republic. Convinced as he was that the great movements of history have their real origin in the very nature of things, and that one can influence one's contemporaries and one's compatriots only by accepting the tendencies and conditions of the time, he was able to reconcile himself to the democracy and the republic, and to appreciate their advantages without ignoring their difficulties and their dangers.

Henceforth, therefore, Renan was in full possession of his powers and in full harmony with his time. Emancipated from the Church, he was the interpreter of free thought in its loftiest and most learned form, in a country which regarded clericalism as the most formidable enemy of its new institutions. Emancipated from Germany, and finding in the very misfortunes of his country a stimulus and a spur to his patriotism, he sought to make his writings the most perfect expression of the genius of France. Emancipated from all the fetters of extinct political systems, he offered to a new France the counsels and the warnings of a clear-sighted and devoted friend. In his writings there was no ground on which he did not venture. In the midst of his great historical and exegetical work, his translations of Job, Ecclesiastes, and the Song of Songs, his superintendence of the difficult undertaking of the Corpus Inscriptionum Semiticarum, his contributions to the literary history of France—contributions which are triumphs of minute and accurate erudition—and while drawing up, year by year, for the Asiatic Society, a survey of all the new works on Oriental subjects, he was giving to the world his views and his visions of the universe and humanity, of life and of morals, now under the severer form of the Philosophic Dialogues, now in the light and softly ironical guise of the dramatic sketches—Caliban, L'Eau de Jouvence, Le Prêtre de Némi, L'Abbesse de Jouarre; and, in addition to all this, he was working hard at the reform of the higher education, and finding time to write those exquisite fragments of autobiography which are collected under the title Souvenirs d'Enfance et de Jeunesse.

In this expansion of all his faculties of thought and action, favored by the triple life of the study, the world, and the family, Renan was happy; and his joy in life and its activities gave to his philosophy a sunny optimism which might at first sight seem hardly reconcilable with the absence of all certitude, all metaphysical or religious conviction. People were surprised and a little shocked to find the author of the Moral and Critical Essays, the writer of those unforgettable pages on the dreamy melancholy of the Celtic races, the critic who poured reprehension on the frivolity of the Gaul and the *bourgeois* theology of Béranger, preaching at times a gospel of light-heartedness which Béranger himself would not have disavowed, and regarding life as an amusing entertainment of which we are at once the puppets and the spectators, and the wires of which are pulled by an amused but indifferent Demiurge. To many readers Renan became the mere apostle of dilettanteism, for whom religion was but an empty dream of the imagination or the heart, morality but an assemblage of conventions and conveniences, and life an illusive phantasmagoria which one must not be duped into taking seriously.

Nevertheless, those who best knew his work—and, above all, those who best knew his life—knew that this dilettanteism, this apparent epicureanism, did not really lie at the foundation of his mind and heart; that it was in part the result of the inward contradiction between his deeply religious nature and his conviction that there is no such thing as knowledge, except of phenomena, no such thing as certitude, except of finite things; and, for the rest, he was too sincere to affirm anything on subjects which could not be brought within the range of positive cognizance. His life

—the habitual attitude of his nature—was that of a Stoic, a Stoic without haughtiness and without rigidity, and with no idea of proposing himself as a model for others. His optimism was not the beatified self-satisfaction of a frivolous mind, but the chosen and cultivated optimism of the man of action, who feels that, in order to act, one must believe that life is worth living, and that some things are worth doing. Never was there a man more deeply benevolent, serviceable, and kind than Ernest Renan, however he accused himself of coldness in the service of his friends. Never was there a more scrupulous devotee of duty, public and private, faithful to the verge of heroism to every undertaking to which he had committed himself, accepting no office of which he could not fulfill all the obligations, and defying, toward the end of his life, the sharpest sufferings, in order to discharge to the last his professional duties. This apparently light-hearted man was subject for many years to attacks of a most painful illness; but he never allowed them to interfere with the integrity of his thought, or to hinder the accomplishment of the tasks which he had set himself. The last months of his life bore witness to the reality of his stoicism. He had often expressed the wish that he might die without pain and without any enfeebling of the mind. He had, indeed, the happiness of retaining his faculties to the last; but pain was not spared him. He dreaded it beforehand, as depressing and degrading; when it came, he did not allow himself to be depressed or degraded by it. From the month of January he knew that there was no hope; he told his friends so; and he asked nothing more but time and strength to finish his lectures and complete the works already in hand. He wished once more to visit his beloved Brittany; then, feeling himself grow worse, he insisted on returning to Paris, to die at his post as head of the Collége de France. His death took place there on the 2d of October.* During these eight months he suffered incessant pain, sometimes so severe that he could not speak; but he was still gentle and affectionate to those around him, trying to cheer them, and telling them that he was happy. The very day of his death he found strength to dictate a page or two on Arabic architecture to his wife. He congratulated himself on having attained his seventieth year—"the normal life of man, according to the Scriptures." One of his last utterances was: "Let us submit ourselves to these laws of Nature, of which we ourselves are one of the manifestations. The heavens and the earth remain."

To those who have known him, he leaves an ineffaceable memory. There was nothing in his personal appearance to suggest that irresistible charm. Short of stature, with an enormous head

* 1892.

set deep between wide shoulders, afflicted all too early with an excessive stoutness which made his gait heavy, and was the cause —or the symptom—of his mortal malady, he seemed to those who saw him only in passing an ugly man. But you had to speak with him but a moment, and all that was forgotten. You noticed at once the broad and powerful forehead, the eyes sparkling with life and wit, and yet with such a caressing sweetness, and, above all, the smile which opened to you all the goodness of his heart. His manner, which had retained something of the paternal affability of the priest, the benedictory gesture of his plump and dimpled hands, and the approving motion of the head, were indications of an urbanity which never deceived, and in which one felt the nobility of his nature and his race. But the indescribable thing was the charm of his speech. His portentous memory kept him supplied with new facts to contribute on every subject, while his splendid imagination and the originality and distinctness of his ideas enriched his often paradoxical conversation with flights of poetry, with illustrations and comparisons the most unexpected, and now and then with prophetic glimpses into the future. He was an incomparable story-teller. The Breton legends, passing through his lips, acquired an exquisite flavor. He had no liking for discussion, and has often been satirized for the facility with which he would give his assent to the most contradictory assertions. But this complaisance toward other people's ideas, which had its source in a politeness not always quite free from disdain, did not prevent him from firmly maintaining his opinion when any serious question was in debate. He detested controversy.

One merit he had which no one dreams of disputing. He was beyond comparison the greatest writer of his time; and he is one of the greatest French writers of all time. Brought up on the Bible, the Greek and Latin classics, and the standard authors of France, he had accustomed himself to a fashion of speech, at once simple and original, expressive without oddity, and supple without languor; a style which, out of the somewhat restricted vocabulary of the seventeenth and eighteenth centuries, could sufficiently furnish itself to render every subtlest shade of modern thought—a style ample, sparkling, and sweet beyond all parallel.

In the region of the learned studies Renan has not been a creator. Neither in philology, nor in archæology, nor in exegesis, has he made any of those great discoveries, or founded any of those systems, which renew the face of science. But no other man can lay claim to an erudition at once so universal and so precise as his. Language, literature, theology, philosophy, archæology, and even natural history—no branch of human knowledge was alien to him. His profound acquaintance with the past, together with the magic gift which enabled him to clothe it with flesh and

make it stand upon its feet, made him an
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EDITOR'S TABLE.

THE INSOLENCE OF OFFICE.

SHAKESPEARE, who knew a good deal, in enumerating some of the ills of life, coupled with "the insolence of office," "the spurns that patient merit of the unworthy takes." For a present-day commentary on these familiar texts we refer our readers to the article by Dr. E. W. Claypole, which appears in this number, under the title of Prof. G. F. Wright and his Critics. Prof. Wright is a man who has for many years past been devoting so much of his time as he could spare from other duties to the study of a certain class of geological phenomena—those connected with the so-called Glacial period. Not being aware that there was any apostolical succession in science, but thinking rather that it was a field which any one might enter and cultivate to the best of his ability, Prof. Wright did not seek any official consecration for his labors, but simply went ahead, read all he could read, saw all he could see, worked over his materials as carefully as he knew how, and after some time produced a book which had the good fortune to be favorably received both in this country and in Europe. This book was guarded in statement, modest in tone, and scientific in method and spirit. The learned world found a good deal in it that was of value, and general readers must have deemed it interesting, for, though only four years old, it has already passed into a third edition. There was nothing in this, one would suppose, to provoke the wrath or jealousy of other scientific workers. Nevertheless, in a certain quarter, wrath was stored up for the author; the storm center was at the national capital, and its core, if we may use the expression, was in the Geological Survey. Of all arrogant things in the world official science is perhaps the most arrogant, and of all obstructive things official science is perhaps the most obstructive. The gentlemen of the Survey, or a number of them at least, were outraged to think that, while they were pottering in the leisurely fashion natural to Government officials over the questions in which they deigned to interest themselves, a man like Prof. Wright, who devoted only a portion of his time to geology, should have the audacity to come forward and express his views on one of those questions. They did not at first attack his book on The Ice Age in North America, but they apparently determined to watch the subsequent movements of this dangerous man, and, if occasion offered, to empty on him the vials of their official displeasure. The occasion was given by the publication ot his book on Man and the Glacial Period; and then, all along the line, began a withering—or what was meant to be a withering—fire of criticisms on the professor and his work as a geologist. His one unpardonable sin would seem to have been that he had taken the word of scientific prophecy out of the mouths of the priestly caste at Washington. Had he only kept silence, they would, in their own good time, have told the world as much as it was good for it to know about the Glacial epoch and the antiquity of the human race. But, by his untimely publications, he had disturbed their sacred broodings over these momentous problems, and made it necessary for them to raise a warning cackle—like the sacred geese of Rome—to save the citadel of scientific truth from sack and pillage. Is it any wonder that the cackle was noisy and harsh and unamiable? Under circumstances so distressful how could it be otherwise? Sóme samples of it are given in Dr. Claypole's article, which will be found most instructive reading by all who care to know in what terms official science is pleased to express itself when its ire is roused, and also what extensive means a widely ramifying body like our national Geological Survey possesses for attacking and discrediting the work of individual scientific laborers that happens to have been conducted on lines which the ruling spirits of that body do not approve.

The question arises, How much does the country really want of this kind of thing? In granting an appropriation for the Survey did it mean to endow a Holy Inquisition or a Sacred Congregation of the Index? We think not. The methods of such institutions make neither for the moral dignity nor for the advancement of science.

TEACHING NOT A FUNCTION OF GOVERNMENT.

The articles which Dr. J. M. Rice is contributing to The Forum on the public-school system of this country tend to bear out our contention in these columns, a couple of months ago, that but a small part of the special teaching ability existing in the community finds its way into the public schools. Speaking of the schools of this city, Dr. Rice says: "The typical New York city primary school, although less barbarous and absurd than the one just described, is nevertheless a hard, unsympathetic, mechanical drudgery school, a school into which the light of science has not yet entered. Its characteristic feature lies in the severity of its discipline—a discipline of enforced silence, immobility, and intellectual passivity." After describing how certain lessons are given, the writer goes on to say: "By the use of this method the child is actually prevented from exercising his reasoning faculties, and reading is converted into a pure and simple process of memorizing word-forms." Think of it: taxes being taken, and an elaborate system maintained, with the ultimate result of actually impairing the intellectual powers of the children! But that, we fear, is not the only damage. What must be the effect on the moral nature of "hard, unsympathetic, mechanical" methods? What must be the reaction from the remorseless discipline which Dr. Rice declares to be the "characteristic feature" of these schools? There can be little doubt that such a discipline hardens the nature, and that it must actually incline many to criminality there is too much reason to fear.

"It is not difficult," says Dr. Rice, "to account for the low standard of the New York schools; indeed, under existing conditions, it would be surprising if the instruction were of a higher order." He then proceeds to describe those conditions. In the first place, there is no incentive to teach well. Upon this point we feel like remarking that to say that a teacher has "no incentive to teach well" presents to our mind nearly the same incongruity as to say that a preacher has no incentive to preach well. We are far from maintaining that a teacher is not the better for incentives, but if there is any profession which might supply its own incentives, it seems to us to be that of teaching. It is certainly not too much to say that the true teaching spirit must be sadly lacking when teachers do not take sufficient interest in their work to do it at least to the best of their ability. The fact, of course, is that the position of teacher under our public-school system is sought after just as any other public office would be. The man who goes to Washington, to Albany, or to the City Hall, in search of an office, does not, in general, canvass very narrowly his fitness for the office; what he canvasses is the fitness of the office for him from a pecuniary point of view; and so precisely with the offices which our school boards have to bestow. To return, however, to the lack of incentive. This lack consists chiefly in the fact that no penalty or disadvantage attends poor teaching. "In New York city," we read, "teachers are rarely discharged even for the grossest negligence and incompetency. In order that a principal may be discharged, sixteen of the twenty-one members of the Board of Education must vote against her; and, for many reasons, it is practically impossible to secure that number of adverse votes."

The other conditions to which Dr. Rice refers as unfavorable to the production of a high type of teaching are, briefly, lack of proper supervision, a generally chaotic system of administration, and the predominance of private or political influence in connection with the selection of teachers and principals. "In selecting principals," we are told, "expert qualifications are not taken into account. Indeed, as a rule, the newly appointed teachers are better, professionally, than the principals. . . . Nearly all appointments are made by 'pulls,' merit being a side issue." This is bad, but we are not at the end yet of our discouragements. "In regard to the public," Dr. Rice observes, "the mere fact that things are muddled as they are proves that the citizens take no active interest in the schools." Strictly speaking, is it to be expected that they should? People take an active interest in things that they can directly and more or less visibly control; but this is not the case with the public schools. The action of the individual citizen upon the schools is a most indirect action, the result of which can seldom if ever be distinctly traced. Again, people take an active interest in things that immediately affect their comfort or welfare, but either no interest or a much diminished one in things that affect them only indirectly and perhaps remotely. Thus, if a man has a letter detained to his injury in the post office, he will promptly complain, because he knows that his complaint will probably bring home the fault and the responsibility to some particular individual, and secure, if not compensation for his loss, at least an increase of attention to avoid similar errors. He acts because his interests are directly affected, and because his action may be expected to produce some immediate effect of a beneficial kind. How different all this is from the case of a citizen whose children are not being as well educated as they might be in a public school, but, on the contrary, are being made the victims of a "hard, unsympathetic, mechanical" routine! What is *he* going to do about it? How, indeed, can he establish the fact in the first place? Must he not wait until somebody like Dr. Rice comes along to tell him about it, and if somebody else—some official of the Board of Education, or some partisan of the board—confidently pronounces Dr. Rice a crank and a busybody, how is the citizen going to decide? Then, supposing he does decide that the education is bad, what is next to be done? Why, canvassing and electioneering, with the interminable vista they open up of deals and dickers, of flatulent talk and endless mystification! Dr. Rice sees all this as well as we do, for what does he say? "That the schools of small cities may be improved in a comparatively short time is a matter that has been repeatedly demonstrated; but *how to improve the schools of large cities is a problem that has never been solved*."

We have left ourselves space to say but a few words of Dr. Rice's experiences in Boston. There he found better administration, owing principally to the fact that ward politics are kept at a greater distance. There incompetent teachers are removed as soon as their incompetence becomes manifest. And yet we read that "the Boston primary schools belong, in my opinion, to the purely mechanical drudgery schools. . . . The teaching is highly unscientific, and the teachers, though not really severe in the treatment of the pupils, are nevertheless cold and unsympathetic." In "one of the best" of the seven primary schools that Dr. Rice visited he found the reading in the highest (third year) class "expressionless, thoughtless, and mechanical." On the other hand, the Boston grammar schools were found, on the whole, to be highly efficient—a circumstance, however, which can in no sense be regarded as an offset to the inferior condition—if Dr. Rice's criticisms are well founded—of the primary schools.

To our mind it is perfectly plain that the modern world has not yet discovered the true method of grappling with the educational problem, and that sooner or later it will have to revert to individual responsibility and individual effort for its solution. We do not deny that relatively satisfactory results may here and there be reached under the present system; but any system which to a large extent prevents the special talent that is available for a given task from being applied to that task is fatally defective; and that, as we conceive, is the case with state education. The born educators, those possessing by nature the aptitudes and the sympathies required for educational work, those who could—granted, of course, proper training—redeem such work from drudgery and make it a true process of thought and soul development, will not in general take service in state-directed schools, and, at the same time, they will be debarred, by the competition of the state, from what would be their most congenial employment. Such is the dilemma; and the conclusion to which it points is that some day we must retrace our steps, and make education the business of the family to be obtained as other good things are obtained—as all best things are obtained—by effort and sacrifice.

THE AMERICAN PSYCHOLOGICAL ASSOCIATION.

The first regular meeting of the American Psychological Association, a short account of which is given on another page, was a very significant gathering. It is an evidence of the fact that a common bond of scientific interest in the study of mental phenomena is now sufficiently strong and sufficiently extended to warrant a comprehensive organization. This most disputed field of mental science has, in recent years, been rendered subject to an increasing extent to scientific methods, and a psychological laboratory is no longer regarded as a curiosity, but as an essential department in every higher institution of learning. It is notable that, since the foundation, some ten years ago, of the first laboratory, by Prof. G. Stanley Hall, at Johns Hopkins University, others have been instituted one after the other, so that at the present time there are more such laboratories in this country than in Europe. It was only natural that, when Prof. Hall became the President of Clark University, the formation of a strong psychological department should have been one of the prominent subjects to engage attention. Soon afterward, laboratories were founded by Prof. Cattell at the University of Pennsylvania, later at Columbia College; by Prof. Jastrow, at the University of Wisconsin, and at other institutions; and within the past year Harvard has set a noble example by equipping a magnificent laboratory and securing for its director that eminent psychologist, Prof. Muensterberg, of Freiburg. Yale has likewise founded a laboratory, and placed Prof. Scripture at its head; and another laboratory is soon to be opened in another prominent Eastern college. Nor does the list end here; it includes a dozen more colleges of various degrees of prominence. All this gives evidence of wide interest in a strictly scientific method of research, and promises to make the study of psychology something far different from what it has hitherto been. The organization of this small but influential body of men engaged in this work is therefore significant of a tendency of modern thought which seems destined to become particularly important in the development of American education. The society will find a welcome among the general body of scientific men, and its proceedings, while perhaps not very widely read, will undoubtedly constitute a worthy contribution to American scholarship.

LITERARY NOTICES.

The Life of Joshua R. Giddings. By George W. Julian. Chicago: A. C. McClurg & Co. Pp. 473. Price, $2.50.

Hardly anything can strike the student of history more impressively than the realizing sense which he gains on reading the story of one of the old heroes of the antislavery controversy, such as Mr. Giddings was, of the utter unlikeness of the conditions of the present time in this country and the questions with which it is now occupied, to those which prevailed before the war, within the active memory of men still in the vigor of life. The review furnishes an astounding revelation of the extent to which we have made history within a generation, and of the completeness of the overthrow that has overtaken a force that was once autocratic in its dominance. Mr. Giddings entered the national House of Representatives in December, 1838, and served there continuously till March 4, 1859. When his service began, the "twenty-first (or 'gag') rule," which forbade the discussion of slavery in the House, and under which the hearing of petitions against it was refused, had been in force two years, and John Quincy Adams was beginning the war against it which he pursued to ultimate victory. Mr. Giddings's attention had only been directed to the national importance of the slavery question in the previous year, and he and Mr. Wade, his law partner, afterward famous in the Senate, had joined in the formation of an antislavery society of four members. In the House of Representatives, John Quincy Adams and William Slade, of Vermont, were the two members whose views on slavery were in harmony with his. After their retirement, Mr. Giddings for a time stood alone. He early perceived the shape which the question was destined to assume, and made it his mission, as Mr. Julian remarks, "to watch the encroachments of slavery upon the rights of the people of the free States, and to hold the slave masters strictly to their own avowed principle, that the existence and continuance of slavery depended solely on the authority of the States in which it existed. Wherever he saw this principle violated, he felt it to be his duty to lift up his voice in its defense." Recognizing the constitutional guarantees, while he construed them with the utmost strictness, he never suggested interference within the sphere of State jurisdiction. He began his "defense," during his first session, with an attack on the slave trade in the District of Columbia. The direct consideration of the subject being forbidden, a bill making an appropriation for building a bridge across the Potomac, and sundry memorials against antislavery petitions, furnished the occasion for his argument; and no opportunity was neglected afterward to press the forbidden sentiments upon the attention of the legislators. He was "cut" in society; attempts were made to engage him in quarrels; he was threatened with bodily violence; and he bore all bravely and with dignity. A resolution of censure was passed against him without his being given an opportunity to define his position. He resigned at once, went back to his constituents, and was triumphantly re-elected, to return with a new commission to deliver his message more earnestly and bravely than before. At last he missed a renomination—not too soon, Mr. Julian thinks, as he surveys the record in the light of history—and was succeeded by another, with principles like his own. The dominating fact in his life was moral earnestness, which was the master key to his character, inspired and invigorated all his faculties, and assured him the confidence of his constituents. In Mr. Julian, his son-in-law, and a Congressman who also participated for many years in the antislavery controversy, he has found a most competent and appreciative biographer. Experience since the war has shown that our country is threatened by other evils, hardly less aggressive and arrogant than the one which Mr. Giddings fought; but resistance against them, under all discouragements, can not be more hopeless than his contention seemed during most of the time he was making it. The final triumph of the cause he advocated, over apparently insurmountable obstacles, makes appear more practicable the contention of those who are warring upon the abuses and tyrannies of the present.

Psychology. By William James. New York: Henry Holt & Co. (American Science Series, briefer course). Pp. 478.

The author's chief aim in preparing this abridgment of his larger work on the Principles of Psychology has been to make it more directly available for class-room use. For that purpose he has omitted several chapters and rewritten others; has left out the polemical and historical matter, the metaphysical allusions and purely speculative passages, the book references, and most of the quotations of the larger work; and has added brief chapters on the various senses. By these changes he believes that his presentation of the subject as a "natural science" has gained in clearness by its extrication from so much critical matter and its more simple and dogmatic statement. His definition of psychology is "the description and explanation of states of consciousness as such." As a natural science it, in common with the other natural sciences and in spite of the fact that further reflection leads to idealism, assumes that a world of matter exists altogether independently of the perceiving mind. Besides this it assumes additional data peculiarly its own, and leaves it to more developed parts of philosophy to test their ulterior significance and truth. These data are thoughts and feelings, or transitory states of consciousness, and knowledge, by these states of consciousness, of other things. Mental facts can not be properly studied apart from the physical environment of which they take cognizance. Mind and world have been evolved together, and in consequence are something of a mutual fit. The special interactions between the outer order and the order of consciousness, by which this harmony has been brought about, have been the subject of evolutionary speculations, which, though they can not so far be said to be conclusive, have refreshed and enriched the subject, and brought all sorts of new questions to the light. The conception that the immediate condition of a state of consciousness is an activity of some sort in the cerebral hemispheres, which underlies the physiological psychology of recent years, is the working hypothesis of this book. After the chapters on the senses, structure and function of the brain, and general conditions of neural activity, the subjects of habit, the stream of consciousness, the self, attention, conception, association, the sense of time, memory, imagination, perception, the perception of space, reasoning, emotion, instinct, will, and psychology and philosophy are discussed; and the conclusion is reached that psychology does not yet stand on solid ground, but is waiting for its Galileo and Lavoisier.

Abraham Lincoln. The True Story of a Great Life. By William H. Herndon and Jesse W. Weik, with an Introduction by Horace White. New York: D. Appleton & Co. Two vols. Pp. 331 and 348. Price, $3.

Mr. Herndon's theory of a biography is that it should tell the whole truth; not give prominence to certain traits or events which flatter a little or brighten the glory of the subject, and withhold others which may have been equally potent in determining the character and fortunes because they are of a darker nature, and may infuse a little unpleasantness into the picture; but to give both sides, and to each incident, whether pleasant or unpleasant, its due prominence, according to the magnitude of its effect on the life as a whole. To him the biographies in the Bible are models, in which none of the faults and offenses of those who are otherwise held up as noble characters are extenuated, but each is related in all its enormity. Mr. Herndon was the life-long intimate friend of Mr. Lincoln and his law partner for many years. He regarded him with a genuine, enthusiastic, personal admiration. He contemplated the book for twenty years, but not being a literary man made little progress in composing it till he put it into the hands of Mr. Weik, whose habits and training were favorable to its successful execution. His purpose is to deal with Mr. Lincoln individually and domestically—as a lawyer, as citizen, and as statesman. Especial attention is given to the history of his youth and early manhood; and in this to give some things that other biographies do not have. "The endeavor is to keep Lincoln in sight all the time; to cling close to his side all the way through—leaving to others the more comprehensive task of writing a history of his times. I have no theory of his life to establish or destroy. Mr. Lincoln was my warm, devoted friend. I always loved him, and I revere his name to this day. My purpose to tell the truth need occasion no apprehension, for I know that 'God's naked truth,' as Carlyle puts it, can never injure the fame of Abraham Lincoln. It will stand that or any other test, and at last untarnished will reach the loftiest niche in American history." Of Mr. Herndon's fitness for this task, Mr. Horace White says, in the introduction which he contributes: "What Mr. Lincoln was after he became President, can be best understood by knowing what he was before. The world owes more to William H. Herndon for this particular knowledge than to all other persons put together. It is no exaggeration to say that his death, which took place at his farm near Springfield, Ill., March 18, 1891, removed from earth the person who of all others had most thoroughly searched the sources of Mr. Lincoln's biography, and had most intelligently and also lovingly studied his character. He was generous in imparting his information to others. Almost every life of Lincoln published since the tragedy at Ford's Theatre has been enriched by his labors. He was nine years the junior of Mr. Lincoln. Their partnership began in 1843, and it continued until it was dissolved by the death of the senior member. Between them there was never an unkind word or thought." Mr. Weik, the co-author, was for several years indefatigable in exploring by personal investigation the course of Lincoln's life, never satisfied with taking anything at second hand, but following everything up to its source. Mr. Horace White has enriched the book by contributing personal recollections of his association with Mr. Lincoln during the debates with Douglas—by which Mr. Lincoln's fame was established.

How shall my Child be taught? Pp. 276. The Spirit of the New Education. Pp. 282. By Louisa P. Hopkins. Boston: Lee & Shepard.

The material of these volumes consists of various papers and addresses written by a supervisor of the Boston public schools. They are not merely theoretical, but embody the results of a fruitful experience in primary teaching and in the training of teachers. Altogether they present a plea for the natural method of education, which, although the oldest form of instruction, is now called "new," as opposed to the prevailing mode of memorizing from text-books. No better comment can be made on this reform in teaching than that of Colonel Higginson: "The difference between a natural and an arbitrary method of acquiring knowledge is simply the difference between rowing with the current or against it." The desire of the child sent to school is generally to observe, to question, and to construct. He is for the most part taught to look only at his books, to be quiet, and to make nothing. It is in the primary and preparatory schools that learning by rote still flourishes. At the beginning and end of our educational system we have given up artificial culture; we have object lessons in the kindergarten, the laboratory, and lecture in the university. Meanwhile, manual and industrial training act as wedges for the introduction of freedom in the intermediate schools.

The new method is not only the better way to educate, it also helps to mold character. The object of education is even more important than the form. The way in which the school thrusts aside responsibility for moral development is exemplified in the boy who "could lie, steal, and swear unchecked, but, if he chewed gum in school, got an awful thrashing." Here the method of teaching is morally operative. If the child's activities are not repressed, but directed toward some absorbing work, there will be little occasion for misconduct. In any case, petty discipline defeats itself and corporal punishment is the resource of the teacher who has failed.

How shall my Child be taught contains discourses upon primary teaching, an account of a year's experiment in training, parables on Nature and life, and oral lessons in arithmetic and science. In illustrating mental action there is an astonishing note to teachers. The author directs that the distinction between mind and brain shall be fully shown by citing cases of unconscious cerebration: "They will then know that the mind is quite distinct from the brain, and the soul can live without this body"!

In The New Education there are practical papers upon physical and manual training, the moral problem, Froebel's theories, the school curriculum, elementary science, character and school education, citizenship, and industrial reform. More speculative are those upon the education of the soul, our divine relationships, and woman as an educator. From the latter we learn that "woman is provided with sensitive, man with muscular tissue," and also that "woman looks into the mystical unseen." Possibly this does not include clairvoyance or spirit-rapping, but is only a poetical phrase for some indefinable power contingent upon the finer feminine structure.

The Nationalization of Health. By Havelock Ellis. London: T. Fisher Unwin. New York: G. P. Putnam's Sons. Pp. 244. Price, $1.25.

The author pleads in this book that the primary conditions of health should be recognized as of first importance to the community; and he regards it as a blot on modern civilization, setting it in an unfavorable light as compared with such civilizations as the Roman and Moorish, that they are so neglected, as the chief element of rottenness in it. "We postpone," he says, "laying the foundations of our social structure in order to elaborate its pinnacles. We are acquainted with all possible openings for commerce through the world; we have explored the psychological ramifications of sentiment; and we do not know the course of the main sewers in our city, and we pollute the sources of the water we drink. We have not yet learned that a great civilization is all built upon the bodies of men and women enfeebled and distorted by overwork, filth, and disease." The present is regarded as a peculiarly favorable time for taking in hand seriously the organization and socialization of the elementary conditions of health, on account of the public and official attention that has been given to the matter in recent years. We also possess to-day, the author affirms, a closer grip of the conditions of health than has ever been possible before, and are better able to unravel their complexity and to show clearly what a man should do who would live a healthy life. "The key-word of our modern methods is not cure but prevention, and while this task is more complex it is also far easier. It is to a gigantic system of healthy living by a perpetual avoidance of the very beginnings of evil that our medical science is now leading us." The present condition of the new movement for the prevention of disease, here referred to, is sketched; then the present position of the more ancient system of the treatment of disease—by the medium of friendly societies, in private practice, in hospitals, and infirmaries, with respect to special classes of disease; the registration of disease; and industries as related to health are discussed; the evils of the *laissez-faire* system are exposed, as illustrated now in Russia; and the conclusion is reached that the maintenance of the conditions of health is not a merely national question, but calls for international co-operation and action. The recognition of this fact is already seen in the holding of International Congresses of Hygiene, which have done much to consolidate, unify, and stimulate the various movements connected with public health.

The Great Enigma. By William Samuel Lilly. New York: D. Appleton & Co. Pp. 334. Price, $4.

Mr. Lilly may always be trusted to present the broadest comprehension and ablest exposition of the Roman Catholic view of controverted questions. The present work, which is composed chiefly of articles already published in leading English reviews, where they have been read widely and appreciated, is an inquiry, supposed by the author to be from the point of view of a class of readers "practically outside the Christian pale," into the tenableness of the religion "which for more than a thousand years has supplied the foremost nations of the world with an answer to the great enigma of human existence." It presents, in aid of the solution of that question, certain considerations which have been helpful to Mr. Lilly, with special reference to the religious difficulties peculiar to these times. "Possibly they may be of use to some who find themselves unable to employ the old theological symbols." In the first article, or chapter, which is entitled The Twilight of the Gods, the present conditions of religious doubt are described; it is assumed, for the purpose of the argument, that the solution of the enigma presented by theistic belief, and especially by Christianity, is discredited; and the intention is announced to consider the other solutions offered in their theoretical and practical aspects, and to inquire whether Theism in general, and the Christian religion in particular, are so utterly untenable as is very generally contended. The two answers, besides Theism, to the great enigma are atheism and agnosticism. Atheism is described as teaching that the answer to the great enigma is not moral but material; that faith in the Divine must be put aside as a senseless and servile superstition; that the rule of right and wrong is to be found in self-interest; that ethics is only a regulation of police; that physical fatality must be acquiesced in; and as holding out the practice of a "brutal egoism." Of that kind of agnosticism which is merely critical and negative, and is content with professing nescience of God, M. Renan's career and writings are held up as a type. His criticism, after examination, is pronounced inadequate to support the vast edifice of doubt which he reared upon it. The other kind of agnosticism, scientific or affirmative, which asserts the existence of God but denies that he can be known, is considered best represented by the philosophy of Herbert Spencer—"Mr. Spencer's portentous generalities." This is examined in detail, criticised unsparingly, and is declared to leave the mystery of "the immeasurable world" precisely where it found it. The inquiry is next made whether Theism is, in fact, so hopelessly discredited as is frequently and confidently alleged. Mysticism, or the doctrine of the inner light, is then examined in the four chief systems—Hindu, Greek, Moslem, and Christian—in which it has been clothed, and the conclusion is reached that while, in the more vulgar manifestations of religion, it may assume most unlovely forms, it is still there, "potent in its divine virtue to slake the thirst of human nature for a great good transcending sense." Finally, the claims of the Christian synthesis are considered, with the conclusion that, "while no one pretends that Christianity offers us a complete explanation of the scheme of things, there is no more reason in the nineteenth century than there was in the first why its message should not be received by cultivated and intelligent men, who feel their need of it, and who will carefully and candidly examine its claims for themselves." We think Mr. Lilly has failed to appreciate the importance of the contributions which Mr. Spencer and the exponents of scientific inquiry into the questions he discusses have made to a clearer understanding of the subject. By enlarging the sources of knowledge and broadening the lines of thought, they have made it possible to regard the questions from different sides, and thereby to take more comprehensive views of them; by more plainly defining the essential points, they have enabled us to discern them unencumbered by minor features and the rubbish which tradition and superstition have heaped around them; and by presenting them distinct, in strong light, they have enabled us to apprehend them undisturbed by the perplexing excrescences which made conception of them difficult and embarrassed faith; and have thus augmented rather than diminished respect for the fundamental principles of Christianity and their hold upon candid minds.

Metal Coloring and Bronzing. By Arthur H. Hiorns. New York: Macmillan & Co. Pp. 336. Price, $1.

It is surprising to find that the Japanese still surpass us in artistic metal coloring, notwithstanding our chemical knowledge of alloys. This is acknowledged to be the case by the author of this volume, who asserts that even "the bloom of fruit is faithfully reproduced" by them, and inharmonious coloring is unknown in their work.

Some advance, however, may be expected among us now, as we begin to realize that metal is beautiful when finished as metal, and not when perverted to an imitation of wood or glass.

This book is the result of experiments in bronzing which have been most carefully conducted. Many old recipes have been tested, as well as methods now commonly used in France. The first part of the work is devoted to the chemical and general relations of the subject; the preliminary treatment of metals follows; and the three remaining sections contain chemical metal coloring, electro-chemical processes, and mechanical metal coloring. Some remedies to be used in case of accident and suggestions for preventing ill effects are given, and an index is appended. The text is concise and clear, and the book can not fail to be of use to those interested in the art of bronzing, or to students of metallurgy.

A History of Modern Philosophy, from the Renascence to the Present. By H. C. Burt. Chicago: A. C. McClurg & Co. Two volumes. Pp. 368 and 321. Price, $4.

This work aims to present in considerable fullness, yet with suitable brevity, the principal content of the leading systems and partial systems of philosophy in modern times, together with a reasonable amount of information regarding philosophical authors and works. It aims to show, in a general way at least, the historical connections of systems, or to exhibit the historical continuity of modern philosophical thought, and further, to furnish materials and stimulus to the student for the study of the higher genesis and final values of ideas and systems. Modern philosophy, according to the author's definition, as distinguished from mediæval philosophy, is occupied with the immanent and concrete rather than the transcendent and abstract; with the natural and the human rather than with the unnatural and the superhuman. As distinguished from ancient philosophy, it is occupied with the subject rather than with the object; with thought, rather than with being. It may be divided into three great periods, of which the first was one predominantly of reception and appropriation—though with considerable self-assertion as against mediævalism; the second, a period of original effort, very largely destructive or negative—toward previous philosophy as well as toward the object of thought generally; and the third as a period of equal originality and more constructive or synthetic effort. Psychologically speaking, those periods are periods of sense (receptive), understanding (analytic), and reason (synthetic); logically they are regarded as periods of thesis, antithesis, and synthesis. Their dates are from the middle of the fifteenth to the beginning of the seventeenth century, thence to the third quarter of the eighteenth century, and thence down to the present. An apparently disproportionate amount of space is given to certain recent systems, because they have not as yet become commonly known through other histories of philosophy. Closing with a brief glance at American philosophy, the author finds that the study of the science has been more seriously undertaken than ever before in our higher institutions—for its own sake and independently of theological influences; and that it seems safe to predict a vigorous future for it here.

The Beauties of Nature. By Sir John Lubbock. New York: Macmillan & Co. Pp. 429. Price, $1.50.

Such lovers of Nature as Thoreau, Ruskin, and the poets give us exquisite pictures of her varied moods and phases; but men of science vie with them in their enthusiasm and even in charm of expression. Throughout this volume are found many fine descriptions of natural scenery culled from various sources, and most vivid and glowing of all are those of the naturalists. For the introduction, the author has prepared a calendar of the special charms of each month, and encourages us to closer observation by premising that the lover of Nature is always young and can never be dull! None can gainsay his claim that science has given us a greater possibility of enjoyment in revealing two new worlds of beauty—the infinitely great and the infinitely little.

Animal life offers many problems for our study—the extremes of temperature at which animals can exist, their metamorphoses, modifications of growth, mimetic coloring, and modes of communication. Not only do many animals possess in a more acute degree the senses known to us, but it is possible that they also have others of which we can form no conception. It has been proved that the ultra-violet rays which are invisible to us are perceived by some of the lower species, while others have organs richly endowed with nerves indicative of uses wholly unlike those of man. Curious questions arise in considering the development of gnats and the reproduction of zoöphytes and infusoria. We can no longer define individuality with them, and some species are theoretically immortal.

Among plants it is found that the reasons for their variation are more wonderful than the old myths invented to explain them. The woods and fields are full of mysteries. Trees, like human beings, may have chosen associates; the larch and arolla grow together in Siberia and in the Swiss valleys. Some species have their familiar parasites, others find food purveyors in certain fungi. The ruthless destruction of forests has occasionally involved that of nations, while the planting of pines has brought prosperity to barren lands. The subsidence and shriveling of the earth's crust result in mountain ridges; the lofty cones of volcanoes, however, are formed from accumulations of lava, and the causes of eruption are local. Rivers are older than mountains; to trace their origin involves a study of geological changes and the folding of the strata. When the slope is acute, they widen their valleys through the rocks; with a slight fall they may run upon an elevated bed of their own sediment. While the land undergoes constant change, the sea remains the same for us, and contains all manner of strange creatures—enormous cuttlefish, and medusæ which color leagues of ocean. The fauna of the depths differ entirely from those of the surface, and species which are found in both situations undergo modifications in the great abyss. Some possess luminous organs, in others the eyes are absent.

Science has given to us a fuller idea of the immensity and beauty of the starry heavens. Not only have our own planetary relations been unfolded to us, but innumerable systems have been made visible. The distant stars shine upon us through the telescope with multicolored light, and by their spectra we detect their movements and chemical constitution.

So, through this pleasant and instructive discourse on "the wonders of the world we live in," does Sir John Lubbock fully persuade us that science is a fairy godmother with untold treasures at her command.

Mr. *David T. Day's* Report on the *Mineral Resources of the United States* for 1889 and 1891, its contributors having been nearly all engaged in preparing the volume on the mineral industries for the eleventh census, contains substantially the statistics of the Census Office. A few minor exceptions consist of the cases in which the mineral report for the Census Office did not consider certain industries which are usually included in the reports of this series. The statistical tables of former years have been carried forward. The scope of the present volume has been lessened slightly in the effort to include more complete and accurate statistics from all producers in the subjects of coal, iron ores, and other important products. The total product indicated for 1890 was $654,604,698, an increase far beyond the total of any previous year.

Chemists and sanitarians will find in *The Coal-tar Colors, with Especial Reference to their Injurious Qualities*, by *Theodore Weyl* (Blakiston, $1.50), definite information as to how far these substances are poisonous. The book tells what colors have been found to injure the health of workmen employed in making them, what regulations concerning the use of poisonous colors have been made in Europe, what results have been obtained from experiments with various colors on animals, and other related facts. The essay was translated by Dr. Henry Leffmann.

Dr. *Franklin H. Martin* has prepared for medical students and practitioners a treatise on *Electricity in Diseases of Women and Obstetrics* (Keener). It embraces a statement of the general principles of electricity, fully illustrated descriptions of electrical apparatus designed for the physician's use, and accounts of the author's mode of using electricity in his specialty, with notes of cases. The volume contains seventy-nine illustrations and has an alphabetical index.

The treatise on *Rectal and Anal Surgery*, by *Edmund* and *Edward W. Andrews* (Keener), which has now reached its third edition, has the two objects of instructing physicians in its special subject, and of exposing the methods of a class of itinerant pile-curers that has flourished in the West. In the new edition nearly every part of the work has been rewritten and enlarged, a compact formulary has been added, and other additions have been made. The volume contains fifty-three illustrations.

In a well-written little volume entitled *Fermentation, Infection, and Immunity*, Dr. *J. W. McLaughlin*, of Austin, Texas, reviews the chief known facts concerning these subjects, and advances a new theory to account for them. His book is based upon partial statements of his theory in medical journals, which have received encouraging attention, and will doubtless prove of interest to biologists.

There is in Chicago an organization known as the Sunset Club, which holds meetings fortnightly for the discussion of social topics. Some of the addresses prepared for these discussions are printed in a volume with the title *Echoes of the Sunset Club*. The subjects treated are such as freedom of the press, subsidies and the tariff, the Sunday question, pensions, money and its functions, nationalism, anarchy, etc. Something of the customs and success of the club is told in a few preliminary pages. Those wishing to know if the book is on sale should address the secretary, at 154 Lake Street.

Under the title *Where is my Dog?* the Rev. *Charles J. Adams* presents a plea for belief in the immortality of the lower animals. His argument is briefly that because animals possess so much intelligence and morality as they frequently exhibit, they "ought" to be rewarded by immortality. Their masters, too, "ought" to be allowed to meet their lowly friends in another world. (Fowler & Wells Co., $1.)

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POPULAR MISCELLANY.

Meeting of the American Psychological Association.—The first regular meeting of the American Psychological Association was held in Philadelphia, at the University of Pennsylvania, on December 27th and 28th. President G. Stanley Hall, of Clark University, presided at the meetings, and the papers presented gave good evidence of the variety and value of the work in experimental psychology which the laboratories of the various colleges are producing. Among the general papers presented, that of President Hall, giving a synopsis of the history and prospects of experimental psychology in America, was perhaps of widest interest. The important steps in the development of this movement within recent years were carefully traced, and various measures of credit judiciously assigned. The effect of the entire presentation was an extremely satisfactory one, showing that in America perhaps more prominently than elsewhere the laboratory method of instruction in psychology was becoming widely adopted, and that the general outlook for the steady development of psychological study was particularly hopeful.—Another very interesting presentation was that of Prof. Muensterberg, who has recently been called to take charge of the graduate work in psychology at Harvard University, and, upon request of the president, addressed the association in German. While the object of his remarks was to outline the problems upon which his students at Cambridge were at present working, the introduction of this description dwelt upon the general point of view that directs the choice of subjects and the method of investigation. Dr. Muensterberg laid stress upon the necessity, not only of accurate answers to problems already stated, but particularly on the discovery of new problems. The difficulty here is more that of asking significant questions than of answering them. The question of the investigations themselves shows what a wide field was being touched upon in various points by the Harvard men—investigations of the methods of localizing sounds in space, a new method of determining when differences of sensation are to be regarded as equal, an elaborate series of experiments on the nature of the association of ideas, of the daily change in mental condition, of complex forms of reaction in which various subjects take part at the same time, and others.—Prof. Jastrow, of the University of Wisconsin, gave some account of what was to be attempted in the laboratory of experimental psychology which has been founded in connection with the World's Fair. The general plan of this exhibit includes a collection of the various types of apparatus that are employed in psychological research; also those that are used in connection with laboratory courses in psychology. A great variety of apparatus gathered from all portions of Europe and America will here be collected, and will cover such branches of the subject as the tests of the senses, the powers of judgment, the times of mental processes, the nature of the association of ideas, the limits and varieties of memory, the effects of fatigue, the relation of mind and body, and so on. A second important part of the exhibit will consist of a working laboratory, in which tests will be made upon all who choose to subject themselves to them. The tests are necessarily simple in character, and have for their object the determination of normal averages in respect to various forms of vision, of tactile sensation, of times and accuracy of judgment, association and reaction, of the nature of association, and the like. And, thirdly, a department in which results will be exhibited, will attempt to show the practical importance of these investigations and their various applications in the study of child growth, the study of abnormal forms of mental phenomena, and the like.—Dr. Sanford, of Clark University, gave an account of some of the studies in progress there. One of these related to the fluctuation in mental power at different portions of the day, as determined by the capacity to remember a series of arbitrary impressions. Another research gave an account of the frequency and character of the dreams of subjects who at once record their dreams upon awakening from them. The frequency of dreams and their concentration in the early hours of the morning, the large factors that recent events contribute to them, appeared as some of the results of this investigation.—Another interesting paper, presented by Dr. Witmer, of the University of Pennsylvania, gave an account of the research upon the æsthetics of visual form and attempting to answer the question, What are the most pleasing forms and proportions in the great variety of figures and conditions?—A paper by Prof. Bryan, of the University of Indiana, giving an account of the development of motor power in children at different ages, and bringing out many significant and important results, was presented; also papers by Dr. Nichols, of Harvard University, presenting some novel experiments upon illusions of rotation and upon the sense of pain; by Prof. Pace, of the Catholic University of Washington, on the power of judging the thickness of surfaces held between the thumb and forefinger; and papers by Dr. Chamberlain, on the Relation of Psychology and Anthropology, and by Dr. Aikens, on An Analysis of Cause.—The meeting adjourned to next December at Columbia College, New York, the officers of the association being: President, G. Stanley Hall, of Clark University; vice-president, George T. Ladd, of Yale University; and secretary, Joseph Jastrow, of the University of Wisconsin.

Arbitration with English Trades Unions.—The English Labor Commission has completed its examination of the conditions, etc., of every branch of labor, except agriculture, in the kingdom. Its results, embodying the testimony of more than four hundred and thirty witnesses, as summarized by Mr. John Rae, in the Contemporary Review, make it clear that there has been during the last twenty years a remarkable growth in all parts of the kingdom of the institutions that make for industrial peace—the Board of Arbitration, the Joint Committee of Conciliation, and the sliding scale. The Board of Conciliation, the essential feature of which was a full interchange of views between the representatives of the parties—employers and hands—face to face, was started in 1866. The original board, formed by Mr. Mundella for the hosiery trade, was short-lived, but the principle was adopted, and still prevails. The first Board of Arbitration, which provides for binding reference to an umpire in case the conference fails, started in the iron trade by Sir Rupert Kettle in 1869, is still efficient; and a second board, started in 1872, has likewise proved its usefulness and its right to live. Since the establishment of these boards in the northern and midland counties of England, respectively, there has been no strike in the northern district, and only one insignificant strike in the middle district. In fact, "strikes, and even the very disposition to strike, seem to be thoroughly stamped out in this [the iron and steel] industry." In many trades there is a great belief in conciliation, but a great dislike to arbitration. Many think the "long jaw" (as the Conciliation Conference is called) "sufficient to remove all difficulties, and make both parties in the end see eye to eye; but the members of the manufactured iron trade are most decided in counting conciliation incomplete and of very uncertain efficacy without the reference to arbitration in case of disagreement. Employers and employed were equally emphatic on this point. They thought the knowledge of an appeal to arbitration being in reserve was absolutely essential to a successful negotiation at the Conciliation Board. The right of appeal might seldom be used, but in their opinion it must always be there, otherwise, though things might not go so far as a strike, there would be constant worrying and keeping up of a contention." Two rules contribute greatly to the smooth working of the system: one, forbidding any suspension of work at any place under the jurisdiction of the board before the cause of dispute has been submitted to the consideration of the board; and the other, making the board's decision retrospective, so as to take effect from the date of the raising of the point. Both these rules have been observed by both sides in good faith. These boards have further exercised a salutary influence in promoting a more reasonable spirit among employers and employed. "There is very much more reason than there used to be formerly; so much so, indeed, that more disputes are now settled at home without going to the board at all than were settled at home before its establishment, and all in consequence of the growth of habits of reasonable consideration and mutual forbearance, which have been bred through the board."

Symbolical Communication.—Writing of the language of signs or the symbolism in ceremonial and current use among the lower tribes of Farther India, General A. R. MacMahon says: "The chief's special messenger, carrying his carved and ornamented spear as an emblem of authority—potent as a magistrate's seal in other countries—dumb though he be in presence of people to whom his dialect is a foreign tongue, metaphorically speaks in accents that can not be mistaken when he flings down the gauntlet in the shape of the *war-dah* with strip of crimson cloth in token of defiance, or produces the cross or dagger-shaped *plurvi* or wand, made of strips of bamboo, which, simple as it may appear to the uninitiated, under some conditions furnishes the materials for a lengthy dispatch, if reduced to a written medium. If the tips of its cross-pieces be broken, for instance, it signifies a money demand for each fracture. If one cross-piece be charred, it means an urgent summons, directing people to come by torchlight if it arrives at night. A capsicum fixed on the *plurvi* signifies that disobedience to the order will 'make it hot' for the recipient. If the *plurvi* be made of cane instead of bamboo, it betokens that this punishment will take the form of flogging. The smooth, round stone which was all that Lieutenant Wilcox received from the Abora, in reply to interminable verbal negotiations suggesting the advisability of their submission to British authority, was utterly meaningless to that very intelligent officer till interpreted by a rude native of the jungle who happened to be present when the mission arrived. The translation ran thus: 'Until this stone crumbles in the dust shall our friendship last, and firm as is its texture, so firm is our present resolution.' . . . Captain Lervin's policeman, when required to explain why he . . . desired a week's leave, said, 'A young maiden has sent me flowers and birnee rice twice as a token, and if I wait any longer they will say I am no man.'"

Animals and Music.—A curious account of the effects of various kinds of music on different animals is given by a writer in the Spectator. The general order of the experiments, based upon the supposition that animal nerves are not unlike our own, was so arranged that the attention of the animals should be first arrested by a low and gradually increasing volume of sound, in those melodious minor keys which experience showed them to prefer. The piccolo was then to follow in shrill and high-pitched contrast; after which the flute was to be played to soothe the feelings ruffled by that instrument. Pleasure and dislike were often most strongly shown where least expected; and the last experiment indicated stronger dislikes, if not stronger preferences, in the musical scale, in the tiger than in the most intelligent anthropoid apes. With "Jack," a six-months-old red orang-outang, "As the sounds of the violin began, he suspended himself against the bars, and then, with one hand above his head, dropped the other to his side, and listened with grave attention. He then crept away on all fours, looking back over his shoulder, like a frightened baby," and covered himself with his piece of carpet. Then his fear gave place to pleasure, and he sat down, with smoothed hair, and listened to the music. The piccolo at first frightened him, but he soon held out his hand for the instrument and was allowed to examine it. "The flute did not interest him, but the bagpipes—reproduced on the violin—achieved a triumph." The capuchins were busy eating their breakfast; "but the violin soon attracted an audience. The capuchins dropped their food and clung to the bars, listening, with their heads on one side, with great attention. The keeper drew our notice to the next cage. There, clinging in rows to the front wires, was a silent assembly of a dozen macaques, all listening attentively to the concert which their neighbors were enjoying. At the first sounds of the flute most of these ran away; and the piccolo excited loud and angry screams from all sides. Clearly, in this case, the violin was the favorite." When the flute was played to the elephant, he stood listening with deep attention, one foot raised from the ground, and its whole body still. "But the change to the piccolo was resented. After the first bar, the elephant twisted round, and stood with its back to the performer, whistling and snorting and stamping its feet. The violin was less disliked, but the signs of disapproval were unmistakable." The deer were strongly attracted by the violin, and showed equal pleasure at the tones of the flute. The ostrich seemed to enjoy the violin and flute, though it showed marked dislike at the piccolo. "The ibexes were startled at the piccolo, first rushing forward to listen, and then taking refuge on a pile of rock, from which, however, the softer music of the flute brought them down to listen at the railing. The wild asses and zebras left the hay with which their racks had just been filled; and even the tapir, which lives next door, got up to listen to the violin; while the flute set the Indian wild ass kicking with excitement. But the piccolo had no charms for any of them, and they all returned to their interrupted breakfasts." A sleeping tiger was awakened by the soft playing of the violin near its cage; listened to the music for a time "in a very fine attitude," then "purred," lay down again, and dozed. At the first notes of the piccolo, it "sprang to its feet and rushed up and down the cage, shaking its head and ears, and lashing its tail from side to side. As the notes became still louder and more piercing, the tiger bounded across the den, reared on its hind feet, and exhibited the most ludicrous contrast to the calm dignity and repose with which it had listened to the violin. With the flute, which followed, the tiger became quiet, the leaps subsided to a gentle walk, and coming to the bars and [illegible] and quiet once more, the animal listened with pleasure to the music."

The Observatory at Arequipa, Peru.—Prof. Pickering, of Harvard Observatory, [illegible] well satisfied with the advantages of [illegible] South American branch observatory [illegible] Arequipa, Peru, eight thousand feet above the sea. During a large part of the year, [illegible] says, the sky is nearly cloudless. A telescope having an aperture of thirteen inches has been erected there, and has shown a remarkable degree of steadiness in the atmosphere. Night after night atmospheric conditions prevail which occur only at rare intervals, if ever, in Cambridge. Several [illegible] the diffraction rings surrounding the bright stars are visible, close doubles in which the components are much less than a second apart are readily separated, and powers can be constantly employed which are so high as to be almost useless in Cambridge. In many researches the gain is as great as if the aperture of the instrument was doubled. The observatory is also favorably situated with reference to the southern stars, most [illegible] which can not be seen at all from the United States.

Ashamed, yet Faithful.—We have received from Dr. John S. Flagg, of Boston, [illegible] curious incident illustrating the operation [illegible] something like a moral sense in a dog. One rainy morning in October, [illegible], Dr. [illegible] observed a setter dog in front of [illegible] slinking along with his tail and head [illegible]pressed, and his whole gait one of dejection. He proved to be following a seedy-looking man in a state of reeling intoxication. [illegible]ing impressed that the dog's trouble [illegible] caused by shame at the intoxication of [illegible] master and the attention he was [illegible]

Dr. Flagg followed the case up. "On reaching the crossing at the head of Hanover Street," he says, "where the traffic is large, the dog lost a little of his dejected air and occupied himself chiefly in getting the man safely across. When his charge was finally over, and meandering down the left-hand side of Hanover Street, then the dog slunk to the opposite side and resumed the shamefaced air I had at first noticed, keeping constant watch with furtive glances on the staggerer opposite. Where Hanover Street crosses New Washington Street, the dog again piloted the man with anxious care. This done, he again declined to be seen on the same sidewalk with him, but slunk along in the shadow of the building opposite. The master turned into Prince Street, when the sense of degradation seeming to be somewhat lessened by familiar surroundings, the faithful animal trotted ahead as pilot to the door. I could not perceive in the dog's attitude any sign of fear of his master, or any evidence of wrong-doing on his own part; everything seemed to show that the one explanation of the dog's behavior lay in his appreciation of the common disgrace caused by the man's condition."

The Use of Lightning Rods.—A discussion, by Alexander McAdie, of the question, Shall we erect Lightning Rods? (Ginn & Co., Boston), in which the arguments on both sides are presented, leads the author to an affirmative answer; and he suggests, to those contemplating the erection of a rod, that they get a good iron or copper conductor, weighing six ounces to the foot of copper, or thirty-five ounces if of iron, preferably of tape form. The nature of the locality will determine in a great degree the need of a rod, as some places are more liable to be struck than others. The very best ground that can be got is after all but a very poor one for some flashes, so that the ground can not be too good. If a conductor at any part of its course goes near water or gas mains it is best to connect it with them, but small-bore fusible pipes should be avoided. The tip of the rod should be protected from corrosion or rust. Independent grounds are preferable to water and gas mains. Clusters of points or groups of two or three along the ridge rod are recommended. Chain or link conductors are of very little use. Slight faith is to be placed in what is called the area of protection. Lightning is much more indifferent than has been supposed to the "path of least resistance." Any part of a building, if the flash is of a certain character, may be struck, whether there is a rod or not; but such accidents are rare with the comparatively mild flashes of our latitudes. The widespread notion that lightning never strikes the same place twice is erroneous, and plenty of cases are recorded to show the contrary of it.

Irrigation in Australia.—Australia, great as is its extent, has but one river system carrying any really important volume of water to the sea. This is the Murray and its large tributaries, which water portions of the three colonies of New South Wales, Victoria, and South Australia, in the southeastern corner of the island-continent. Want of rain and the absence of perennial streams constitute one of the greatest difficulties that settlers on the land, whether pastoralists or agriculturists, have to contend with. Subterranean supplies are, indeed, being found in the form of running rivers from sixty to a hundred feet below the surface, but not hitherto in sufficient quantities to compensate the lack of rainfall and surface water for ordinary purposes in years of drought. Still less is there enough such water to be found to irrigate the arid plains. The only supply at all adequate for purposes of irrigation on any extensive scale is afforded by the surplus water of the Murray system, now carried to the sea, and this surplus is obviously a limited quantity. An attempt to fertilize by irrigation some portion of the land lying within reach of this supply of water has been made in the last four years at what are known as the irrigation colonies or settlements of Renmark in South Australia and Meldrum in Victoria. The scheme was started in 1887 by two brothers, the Messrs. Chaffey, who had had experience of fruit-raising in California, who have obtained the grants and means necessary to enable them to carry out their plans. The properties are subdivided with a view to settlement by individuals on small sections, each cultivator enjoying, upon a co-operative system, the use of the fixed plant of the settlements, not only for irrigation, but for rendering the fruits of the soil marketable, by processes of drying, canning, wine-making, etc.

The Love of Nature in America.—The London Spectator has learned from the evidence of books on the subject that there now exists in New England a counterpart to the great and growing appreciation of wild Nature which has left such a mark on recent English literature. Even Fenimore Cooper, it admits, "painted the wild life of the woods with a minuteness of detail and depth of feeling that suggests that the readers for whom he wrote were not less in sympathy with the subject than himself. The works of Thoreau and John Burroughs are now American classics; and to judge by the number of recent works similar in kind and object, the appetite of New England grows by what it feeds on. The coincidence by which people of the same race, and living in the same latitude, but on different sides of the globe, are now eagerly expressing in a common language their pleasure and interest in exactly the same kind of subjects and scenes, though the actual birds and beasts, trees and plants, are often as distinct as the two continents in which they are found, is probably unique. There is no such analogy in taste between England and any of her colonies as this common love of Nature which finds almost identical expression in the prose idylls of Jefferies and of Burroughs, and the engravings of Wolf and of Mr. Hamilton Gibson." The Spectator goes on to cite from the books of two or three of our Nature-loving authors, without giving anything like an adequate exemplification of the list. It might also have extended its studies and brought in other sections than New England. Where, for instance, can we find more faithful portraitures of hill and ravine, forest and field, and the moods of Nature in sunshine and storm, frost and flood, than Charles Egbert Craddock has drawn of her loved Tennessee mountains?

The Brooklyn Institute Biological Laboratory.—The last, its third, was the most successful season of the work of the Biological Laboratory of the Brooklyn Institute, at Cold Spring Harbor, N. Y. During its three years of existence more than sixty persons have made use of the advantages afforded by the laboratory, either in study or investigation; and among these have been college professors, public-school teachers, physicians, and students of various grades of schools. Of the three classes of students using the marine laboratories—those seeking a general knowledge of zoölogy and botany, including medical students; college students desiring to do miscellaneous work of a higher character than that of their college, or to study embryology from the practical side; and those who desire to undertake original research—the course of this school has been especially planned for the first two classes. An elementary course in zoölogy is arranged, lasting six weeks; courses of scientific lectures are given by well-known experts; a special line of work in bacteriology methods is offered; and at a certain point students who have taken the elementary course or its equivalent are allowed to plan their work each for himself.

Home Landscape.—An editorial article in Garden and Forest aims to show how beauty in landscape and in our home surroundings grows out of our honest attempts to adapt the conditions of Nature to our wants. In our clearings, orchard and garden planting, and building, so long as we are honest and straightforward in our work, Mother Nature "stands ready to adopt it as her own, and to make of it landscape rich in meaning and pathos, such as no primitive wilderness can show." Look for a moment upon a typical valley of the interior of New England. "We are standing upon the eastern wall of upland. The village, with a mill or two and a church or two, lies below us at the mouth of a gap in the northern hills. Southward the valley broadens to contain a fresh green intervale. Opposite us the western wall of the valley is an irregular steep slope of rising woods, with numerous upland farms scattered along the more level heights above. The central intervale, the flanking woods, the village gathered at the valley's head—the whole scene before us possesses unity and beauty to a degree which interests us at once. And how was this delightful general effect produced? Simply by intelligent obedience to the requirements of human life in this valley. The village grew what it is for the sake of nearness to the great water power which rushes from the gap in the hills. The intervale was cleared and smoothed for raising perfect hay. The steep side hills have been maintained in woods because they are too steep for agriculture, and because, if they were cleared of trees, their sands and gravels would wash down upon the fertile land of the intervale. Similarly upon the upland farms the greenery along even the tiniest brooks has been preserved in order to obviate that wasteful washing away of soil which results from carrying plowing to the edges of the water-courses. Throughout the landscape before us it is most interesting to note how beauty has resulted from the exercise of common sense and intelligence. The every-day forces of convenience, use, and true economy have here conspired with Nature to produce beauty, and this beauty is of a very different and much more satisfying kind than that which tries to found itself on mere new caprice or fashion."

Perversity conquered.—The story of successful dealing with two cases of idiocy manifesting itself in violence is related by Margaret Bancroft, of Haddonfield, N. J. The first case was a deaf-mute, twenty years of age, "a sickly, wild, destructive, disgusting specimen of humanity," who had to be taken charge of day and night. He would tear or destroy three or four suits a week. An attendant, having noticed that he was fastidious about the color of the things he wore, suggested having fine clothing for him. He was fitted with a suit, and "the success was wonderful. He was perfectly delighted, blew and puffed on his clothes, and from that time, unless some very serious trouble arose with his care-taker, he never destroyed anything unless it was ugly. He was gradually led on from one step in good behavior to another—sitting to witness a play, being photographed, sitting in school during the opening exercises, drawing lines, and mat-weaving, in which, when he threaded his needle and put in one row without help, the whole school set up a hurrah. "There were many ups and downs, but from that time improvement was constant" till boy and teacher were separated in consequence of the burning of the school building. The success is a subject of wonder to all who know of the case. "It has taken unbounded patience, hopefulness, and trust, but the great secret has been love, our love for him and his love for us and trust in us." The other case was a boy who had been hurt mentally by a fall, a destructive, murderous savage, with whom, "for some time after his arrival, we felt that we had a young tiger in our peaceful home.... The first attempt to have him in the school-room was a tempest." He was tied in a chair and had to be held by two persons; then he had only to be tied; but, "after six months of this work, we could have him in the school-room untied for a short time. It was so in everything we attempted to do with him; in teaching him we were obliged to have one person hold him while another directed his hands. So on until we gradually got him to like his work. In marching, calisthenics, games, kindergarten work, chart work, board work, slate work, there were the same battles week after week; but now he leads the marching. . . . He is trying in all his work to use his right hand, but it is a great effort, and requires the exercise of patience on his part. He is loving and neat, takes great pride in his clothes, says his prayers, and tries to please. . . . We are proud of his table manners."

Plains in Cold Countries.—In his book on Ancient and Modern Steppes and Tundras, Prof. A. Nehring undertakes to show that such formations are marks of the post-glacial transition period, the analogues of which can be found in the central regions of Europe and North America, and even in the South. The heaths of central Europe, the *puszten* of Hungary, the African deserts, North American prairies and savannas, and the pampas and llanos of South America, are, according to his view, all of one class with them. Their common characteristic is not the desolation we usually conceive when the steppe or the tundra is mentioned, which is only a topographical incident, but the limitation of vegetation to herbaceous plants with scarcity of trees, and a general flatness or moderately undulating character of the surface. Sometimes island elevations occur in them, which are covered with trees, and whence streams flow. They are not depressions, but often constitute table-lands or cap the tops of mountains or high hills. As described by Prejevalski, some of the Siberian steppes in spring appear like immense flower beds of various colors, with wood-clad hills of dark pines or dwarf birches rising from among them. Our prairies present this floral exuberance through most of the summer, but on the thinner soil of the steppes it usually dies out under the intense heat, while in winter the region is subject to the other extreme of excessive cold. Rain is more abundant in the steppes than in the northern tundras. It falls chiefly in summer, in violent showers, which do little permanent good to vegetation. In the north, the water, prevented by the perpetual ice in the subsoil from percolating through it, forms the marshes characteristic of the tundras. Another feature common to steppes and tundras is that of raging snow-storms or *buranes* (blizzards ?), or high winds with or without snow. These winds, charged with sand, dust, and snow, sweep away or destroy everything they meet, and deposit in curious formations alternate strata of sand and snow. The animal life of the tundras includes animals that live in them constantly, and those that visit them from other regions. Of the former class are the lemming, the arctic fox, and the snow hare in the tundras, while the characteristic animals of the steppes are the arctomys, the jerboa, and the spermophilus. It was the discovery of numerous remains of these animals in central Europe that suggested to Nehring that all the prairie formations may have had a similar origin. The objections which have been brought against this theory, which are not without weight, are ingeniously answered by Prof. Nehring in his book.

A River's Work.—Regarding the varying phases of a river's work in its passage from the form of a mountain torrent to that of a broad estuary, Mr. Albert F. Brigham remarks that transportation begins at the head waters, and continues, always important, to the ocean. Corrasion (wearing away) is active in the torrential stage, and passes practically down to zero in the lower course of the stream. Deposition begins at the end of the torrential section, and prevails strongly to the ocean. In the middle or terrace section the forces approximate an equilibrium. The river lays up its waste in its banks, only to load it up again after months or years, and carry it a stage farther toward its destination. Somewhere in descending our stream we pass the critical point between land destruction and land building. Above this point materials are gathered up; below they are strewn down."

Surviving Superstitions.—The more sober and matter-of-fact the people, says an essayist in the London Spectator, the more curious are the superstitions that survive among them, in spite of their common sense. It is not only the ignorant sailor before the mast who regards Friday with superstitious dread. His captain and several other well-educated men share in the feeling. The superstition concerning thirteen at the table is perhaps more widespread than any other. A hostess who deliberately made up a party of thirteen would be a bold woman indeed, for two or three of her company would object to dining at her table. Many people will positively assert that they have actually known cases in which one of a party of thirteen at dinner has died in the course of the year—and with perfect truth, probably; for, taking the average age of the assembled guests to be thirty-five or over, the mathematical chances of death occurring among them within a year are rather more than one in thirteen. The chance of a death would be even greater if there were twenty, and would amount to almost a certainty in the case of a hundred—an excellent reason for abstaining from public dinners! The same writer gives as the origin of the superstition against passing under a ladder the circumstance that in the old days the man to be hanged had to pass under the ladder which stood against the gallows for the convenience of the executioner; "and he passed under that ladder with the fair certainty of being immediately hanged." The superstition concerning the spilling of salt dates from the most distant antiquity. "Salt, the incorruptible and the preserver from corruption, the holy substance that was used in sacrifice, could not be rudely spilt or wasted without incurring the anger of all good spirits and giving an opportunity to the evil ones. Now, the evil spirit lurks, as a rule, somewhere behind a man upon the left side, so that it is desirable, if one wishes to avoid the consequence of carelessness, to throw the salt over the left shoulder three mystic times and discomfit the wicked one exceedingly. It is interesting to view the grave solemnity with which the intelligent and well-educated woman of to-day will perform that ceremony."

Rock Striation by River Ice.—A study of the striation of rocks by river ice has been made by Mr. J. E. Todd in the Mississippi and other Western rivers. While not much attention has been paid to this agency, the author finds that planation and striation are sometimes the work of river ice armed with erratics; that the situations most favorable for the phenomenon seem to be on the outside of a bend, or near a strong current, near low-water mark, and below a point where siliceous erratics lie near the water-level. The dynamical conditions necessary are probably a sudden breaking up of the ice before it is rotted by thawing and a flood to wield it. The proper conditions do not often occur in our present Western streams. Usually the striæ are parallel, as much so as in glacial action, and commonly on surfaces dipping up stream, but occasionally upon limited areas dipping down stream. While these facts, the author observes, may have no direct significance of practical value, they indirectly throw much light upon the possible origin of the extra-morainic drift and of some ancient striated surfaces outside of the moraines.

Animals not Afraid of Man.—Mr. W. H. Hudson's observations of birds in La Plata lead him to different conclusions from those which Darwin and Herbert Spencer have reached respecting their supposed instinctive fear of man or birds of prey antecedent to experience or parental teaching. The one thing that is instinctive, says Mr. Alfred R. Wallace, in his review of the book, "is the alarm caused by the warning note of the parent. This produces an effect even before the chick is hatched, for in three different species belonging to widely separated orders Mr. Hudson has watched the nest while the young bird was chipping its way out of the egg and uttering its feeble *peep*, when, on hearing the warning cry of the mother-bird, both sounds instantly ceased, and the chick remained quiescent in the shell for a long time, or till the parent's changed note showed that the danger was over. Young nestling birds take their food as readily from man as from their parents till they hear the warning cry, when they immediately close their mouths and crouch down frightened in the nest. Parasitical birds, which do not recognize the warning cries of their foster-parents, show no fear. The young parasitical cow-bird takes food from man, and exhibits no fear, although the foster-parents are hovering close by, screaming their alarm notes, So a young wild dove, reared from the egg by domestic pigeons, which, never being fed, were half wild in their habits, never acquired the wildness of his foster-parents, but became perfectly tame and showed no more fear of a man than of a horse. He had none of his own kind to learn from, and did not understand either the voices or the actions of the dove-pigeons. Mr. Hudson has also reared plovers, tinamous, coots, and many other wild birds from eggs hatched by fowls, and found them all quite incapable of distinguishing friend from foe, while some, such as the rhea and the crested screamer, are much tamer when young than domestic chickens and ducklings. Mr. Hudson concludes that birds learn to distinguish their enemies, first, from parental warnings, and later by personal experience.

The Truffle.—In a book on that vegetable, lately published in France, M. Ad. Chatin defines the truffle as a mushroom, which is not a parasite, though it grows by preference in the immediate vicinity of certain kinds of trees; and like its congeners, the tuberaceous mushrooms, instead of living in the air it is hypogeous. The truffle is first mentioned by Theophrastus, who calls it *mizy* and *mison*, and regards it as a rootless plant engendered by the thundershowers of autumn, but capable, according to many observers, of reproducing itself from seeds brought by storms from Tiaris, on the shores of Mitylene. This truffle, that of Lesbos, was an inferior variety to the truffle of Périgord, which is so highly prized by epicures. The truffles of Algeria, called *terfas*, and those of western Asia, called *kamès*, although not equal to those of France, are of considerable importance as food to the Arabs. M. Chatin has added several species, previously unknown, to the truffle of all these countries, and a new genus, the *Tirmania*, to those of Africa. The history of the truffle, as old as that of civilization, begins with the most brilliant days of Greece and Rome, was lost in the darkness of the middle ages, and revived with the Renascence; and at a later period the delicacy spread from the court to the tables of the rich, and is now known in all ranks. Scientific acquaintance with the plant has enjoyed a growth parallel with that of its alimentary use, and with methods of cultivation, which are wholly of modern origin, having been established as the result of the scientific investigations of the present century. According to the latest statistical report of the truffle crop, the total production was valued, for the year 1889, at $500,000.

Superstitions about Saturn.—The somewhat dull and heavy appearance of the light of Saturn as compared with that of the other planets and of the stars of the first magnitude may, according to Paul Stroobant, of the Royal Observatory of Belgium, help to account for the baleful influence which the ancients attributed to it. Recognizing it as the most remote of the planets with which they were acquainted, they paid it a special regard. The Assyrians included the sun, the moon, and the five planets known to them among the superior divinities, calling them the interpreting gods; and of these Saturn was the chief interpreter or revealer. They called it Nisroch or Asshur, the god of time or the year. Similar ideas prevailed in ancient Egypt. Julius Firminius, speaking of astral influences over the dispositions of men, says, "if one is born under the influence of Mercury, he will be addicted to astronomy; if under Mars, he will embrace the profession of arms; if under Saturn, he will devote himself to alchemy." This planet was regarded by the Egyptians as a foreign divinity, for its altars were built outside of the cities, among those of the adopted gods. Probably this usage came from the North, for Plutarch, who locates the island of Ogygia in the North, says that its people, every thirty years, when Saturn went into the sign of Taurus, sailed away to sacrifice in another country. The Greeks regarded Saturn as the god of time. Latin texts represent Saturn as a planet dangerous to human life, and say that it brings rains and four-day fevers. This planet likewise played an important part in the astrology of the middle ages. It was certainly known to the Chinese 2500 years B. C., for they then had ephemerides of the five older planets. Egyptian monuments of the fifth and sixth dynasties mention it. The most ancient precise observation of Saturn known was made by the Chaldeans in the year 579 of the era of Nabonassar. Ptolemy fixes this on March 1, B. C. 228. Ptolemy observed an opposition of Saturn A. D. 127, which was the basis for his determination of the elements of its orbit. The sign ♄, employed to designate Saturn, was not known to the ancients. Laland derives it from the sickle of time. Some persons believe that it stands for the figure 5, answering to the place of the planet in the order of the system, as the sign ♃ of Jupiter may stand for 4. Alexander von Humboldt says that the signs for the planets are no older than the tenth century. Different opinions prevail as to whether or not the ancients had any knowledge of Saturn's ring. It is hardly probable.

Jokes by Animals.—Among the incidents of jokes played by animals upon one another cited by a writer on The Animal Sense of Humor, in the London Spectator, is that of a jackdaw which, whenever it found its setter-dog companions asleep, would steal up to them and pull at the little fluffy tassels of hair between their toes—where the animal was more sensitive than in other hairy parts of its body—unpleasantly waking them up. At a certain house, a tame magpie was kept in the stable yard with two kestrels. The kestrels were in the habit of sitting on the sides of the water pails that stood outside of the stable doors. At one time the magpie approached a kestrel from behind, seized its long tail in its beak, jerked it violently, and pushed it over into the pail; but the kestrel afterward caught the magpie and punished it well. A cat expressed its dislike of a peacock by jumping through its spread-out tail when the bird was displaying its beauty and exhibiting its own vanity, to the great discomfiture of the fowl. The writer's dog, which was accustomed to hunting rabbits, showed its displeasure when its master had sho a bullfinch by going into the hedge, finding a rabbit, and bringing it to him. Another dog, which knew tame ducks and that they were not hunted, but had no acquaintance with wild ones, was much disgusted when its master shot a teal, believing he had made a mistake, and would have nothing to do with the game. "He behaved in exactly the same way when we shot a black rabbit; nothing would persuade him that it was not a cat; and he would do no serious work for the rest of the day." The writer tells also of dogs that thought it beneath their dignity to chase rats, except when their masters were engaged in the sport; and he speaks of the very obvious dislike of dogs to be laughed at.

Suicidal Ingenuity.—A curious list and description of ingenious methods which insane patients with suicidal tendencies have adopted for disposing of themselves is given by Dr. H. Sutherland in a paper on the prevention of suicide in the insane. Patients with suicidal tendencies should be put under surveillance and constant attendance at once. Care must be taken against all imaginable and even some unimagined things with which they might contrive to kill themselves—medicines, pills, lotions, and plasters, and the patients' taking the prescribed doses, should be looked after, lest they by some craft accumulate a quantity sufficient to kill and take it all at once; keys, razors, knives and forks, fire-irons, even brooms, broken glass, and crockery, should be kept out of their hands; and nails, wires, ropes, sash-lines, bell-pulls, tapes, and string, lest they hang themselves. Even a piece of slate pencil or an old spoon may be used for the purpose of strangulation, by being attached to a string and then pushed through a keyhole and pulled taut. Patients working at their trades require constant watching and daily examination, for their tools and materials may be made to afford facilities for killing themselves. In fact, the ingenuity of these people can be matched only by ingenious vigilance and alertness.

Camphor.—The camphor tree, according to the United States consular report from Osaka, Japan, is a tree of the laurel family growing in southern Japan, the wood of which is valuable in ship-building. It grows in mountainous regions far from the sea. It is a well-proportioned, handsome evergreen, its elliptical, slightly dentate leaf turning a lighter color for one or two months in the spring. The berries grow in bunches. The tree is cut down for the collection of the camphor, but the law requires that it be replaced by another. It is then cut up into chips and steamed. The camphor and oil extracted by the steaming are passed through a connecting tube into a second receiver, and thence into a third, which is divided into two compartments, one above the other. These compartments are separated by a perforated partition, which gives passage to the water and the oil, while the camphor is deposited on a layer of straw provided for it. It is then separated from the straw and prepared for sale. The oil which is drawn out from the lower compartment is used for illumination.

NOTES.

The ethnographic exhibit at the Chicago Fair will be partly within the main building and partly outdoors—the collections being within and other features without. The American department will include specimens of native tribes living their usual life and engaged in their usual occupations; relief maps of the most famous earthworks of the Mississippi Valley; models of the mysterious structures of Yucatan and Central America, with casts of the hieroglyphics; Peruvian mummies; palæolithic implements and relics of the mound-builders; photographs of mounds and ruins from Alaska to Tierra del Fuego; illustrations of primitive religions, games, and folk lore; and numismatic, zoological, geographical, and natural history collections in general. Arrangements are being made to have the State historical exhibits placed in this department.

Since noticing Mr. Edward Atkinson's book on The Science of Nutrition, we have received a good many letters asking where the work can be obtained, information that we were unable to give when the notice was printed. We can now state that Messrs. Damrell & Upham, 283 Washington Street, Boston, are the publishers, and the price of the book is fifty cents.

An address on The Railroad in Education, delivered by Prof. Alexander Hogg, of Fort Worth, at the Texas Teachers' Association, in 1883, attracted attention at once by the breadth of its views and the novel suggestions it embodied. It was delivered again—rewritten—by request of the Commissioner of Education before the Congress of Educators at the New Orleans Fair in 1885, and has been published in various editions since. The author is now preparing a new edition for the Chicago World's Fair, in which several of the chapters will be rewritten and other chapters added on Fast Running and The World's Fair itself.

The Eleventh International Congress of Medicine will meet in Rome, September 24 to October 1, 1893, and will be divided into nineteen sections. The price of membership for physicians and men of other professions interested in the labors of the Congress will be five dollars. The official languages of the Congress will be Italian, French, English, and German, and official bulletins of proceedings will be published daily in those languages. Papers and communications for the Congress must be announced by June 30th, and abstracts must be sent to the committee by July 31st. Dr. A. Jacobi, 110 West Thirty-fourth Street, New York, is chairman of the American Committee of the Congress.

A paper read before the Society of Arts by F. Seymour Haden, in a temper decidedly not judicial, is devoted to the vindication of earth burial as the best method of disposing of the dead, and to the condemnation of cremation as involving the possibility of criminal poisoning passing often undetected by the destruction of all the evidences of it; while they would be preserved and accessible for a substantially unlimited time under any method of burial. Much of the paper is devoted to showing that burial in destructible casings instead of practically indestructible ones, as under the present system, insures the speedy, harmless restoration of all the elements of the body to their normal condition, and is free from all the objections that may be urged against the present system or against cremation.

An incident related recently in the Trinidad Field Naturalists' club goes to indicate that the bite of the tarantula is not especially poisonous. A laborer was badly bitten in the foot, and was much frightened. He was taken to the infirmary, hopping all the way on the other foot; a fomentation of water and spirits of ammonia was applied, and he was given a dose of ether mixture. He ate his dinner heartily about two hours later, and slept well at night. In the morning he complained of no pain, and went to work as usual. No local swelling or inflammation was observed, and but little pain at any time. Fright was the only ill effect.

Prof. Cahn, of Breslau, claims to have found the immediate cause of the spontaneous combustion of hay in the heat-producing action of a parasitic fungus called *Aspergillus fumigatus*, a plant already known to be destructive to the germination of barley by the heat it produces. A heat of 95° Fahr. having been already induced by the natural chemical changes, the aspergillus steps in and raises the temperature to 140° Fahr., after which combustion is almost inevitable.

A theory, founded on the earlier analyses, that peach yellows was caused by a deficiency of phosphorus and potash, prevailed several years ago, and a treatment with bone phosphate, muriate of potash, and kieserite, based upon it, was in vogue for several years. Analyses made during the last four years, under the direction of the Department of Agriculture, while they agree among themselves, are contradictory of this theory. Experimental evidence, derived from opposite modes of treatment of peach trees, presented by Dr. Erwin F. Smith, in a paper on The Chemistry of Peach Yellows, is likewise contradictory of and depreciatory of the value of the treatment based upon it; and the conclusion is declared by Dr. Smith that we are to look for the cause of peach yellows and the means of prevention in a different direction.

Yawning, which is regarded by most persons as merely a sign of weariness or sleepiness, is considered by M. Naegeli as a therapeutic agency. He believes that a series of yawns, with the stretching that accompanies them, would make an excellent morning and evening exercise. The lungs can not fail to be benefited by the inflation they get.

According to Mr. George A. Allen, the Mohaves believe that the spirits of their dead go up in smoke to the "White Mountain" when their bodies are cremated, and that property which is thrown into the flames goes up with them. They also have a belief that all the Mohaves who die and are not cremated turn into owls, and when they hear an owl hooting at night they think it is the spirit of some dead Mohave returned.

The Smithsonian Institution has printed a paper by Dr. J. F. Snyder describing an urn containing incinerated human bones, which was dug out of an ancient mound in Georgia. The urn or vase is nearly conical, eleven inches and a half high, and was covered by an inverted bell-shaped vessel fifteen inches and three quarters in height. The ashes nearly half filled the vase, and mingled with them were calcined human teeth and fragments of bones. Lying on the surface of these remains were a quantity of wampum and several small pearls that had been pierced for stringing.

Many farmers in cutting potatoes for planting take care to follow some rule in regard to the number of eyes to a piece. Experiments made last summer at Purdue University Experiment Station show that the number of eyes is immaterial, even eyes that are cut in two sending up plenty of good stalks, but that the weight of the pieces is the important matter.

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