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NOVEMBER, 1894

THE GLACIERS OF GREENLAND.

By Prof. ANGELO HEILPRIN.

THE traveler who skirts the coast of Greenland, and sufficiently far from it to permit him to look over the rugged cliffs which almost everywhere dip abruptly into the dark blue ocean, sees above these a long, undulating white crest, beyond which are only sky and conjecture. The white crest glistens awhile in the bright sunlight, elsewhere it disappears in the hazy mist which silently crawls over the landscape and shrouds it in a more or less permanent veil of obscurity. Between the cliffs and bluffs, whose crests rise well into the plane of respectable mountain height, soaring to three, four, and six thousand feet elevation, broad valleys open out to the sea, which here show a carpet of beautiful and inviting green, and elsewhere lie immobile beneath vast sheets of ice which have invaded them and remained possessors of the soil. In some places the ice sheets quite touch the sea, in others they mark a white line across the valley, which is at once the termination of the ice and of the vegetation which crawls up to it. These are the Greenland glaciers, whose tongues the eye readily unites with the interior ice crest, the snow parent to which they owe their birth.

In its fundamental construction a Greenland glacier is much like every other glacier; it neither agrees absolutely with nor differs essentially from the glaciers of the Alpine type. It is only in the matter of size that it can lay claim to special distinction. If the snows of Switzerland and Norway build up glaciers of possibly two, three, or four miles' width, those of Greenland are compacted into ice rivers of from two to five times this width, and exceptionally into streams with perhaps ten or even fifteen times the expanse. For full two hours we steamed abreast of the great Frederickshaab glacier (latitude 62°) and along the northeast contours of Melville Bay the eye failed to detect a break in the continuity of the ice wall for seemingly thirty miles or more. Where the eye follows a line of coast for any distance it is almost

MELVILLE GLACIER.

sure to compass all the types of glaciers which belong to the land: the broad and lazy glacial plain, flattened out like a vast and continuous ice slide; the sharply pitched hanging glaciers, which, caterpillar-like, crawl down the steeper slopes at angles of twenty-five to thirty-five degrees; and the deeply fissured crevasse glaciers, whose forbidding aspect only too vividly recalls the wicked ice sheets of the Alps. These types are, however, but the expression of a common structure, modified by local conditions, and set into the particular mold which belongs to each particular region. To assume, as perhaps the greater number of geologists do, that the Greenland glaciers represent, both in their construction and workings, a distinct or individual type, is to do violence to truth.

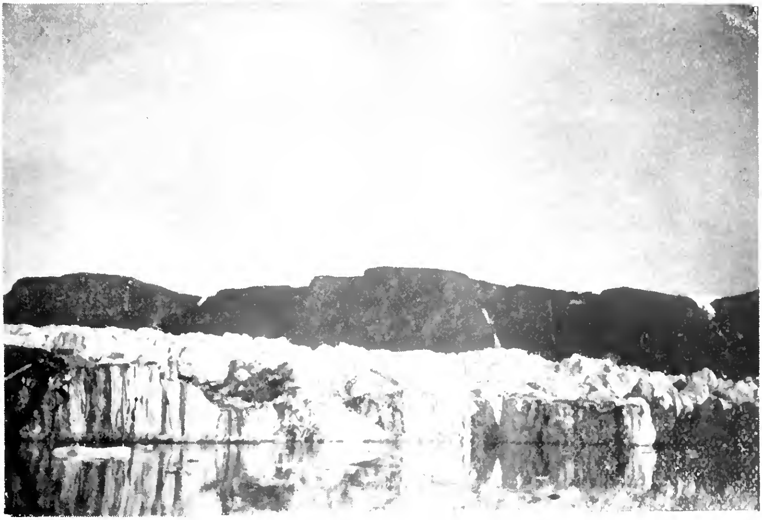
In the many hours of silent contemplation of these vast ice sheets I often pondered the question of the possible thickness of the ice which was involved in their making. Agassiz's measurement of some eight hundred to a thousand feet in one or more of the Swiss glaciers conjured up visions of vast possibilities in the Greenland giants, yet nowhere could I satisfy myself that even that thickness which was measured in the Alps was to be found here. Perhaps in the far interior the ice may have that thickness and more, but on the tongue sheets and in their terminal walls we found no indications of it. Two or three hundred feet the ice certainly has, but how much more, if anything, I could not determine. Yet the majestic bergs which, flotilla-like, sail out from these slow-moving rivers of ice, and scatter themselves in hundreds and thousands over the blue mirror of the sea, rise in themselves full two hundred feet out of the water, and perhaps not less than seven or eight hundred feet of subaqueous anchorage gives to them that wonderful aspect of immobility which all who have seen it so much admire. Is the exact relation of the fallen berg to its parent still to be determined? Seemingly so, for it is certain that in perhaps by far the greater number of cases the height of the berg bears no distinct relation to the thickness of the glacier of which it at one time formed a part. With my own eyes I saw but few bergs fall or being made, and these were all of insignificant dimensions. Like many of their larger sisters which undergo disruption, they lashed and foamed in the disturbed waters, rising serenely to no definite relation with the parent mass from which they parted.

SURFACE OF VERHOEFF GLACIER.

The older accounts of travelers have invested the Greenland ice with a wicked sublimity particularly its own, which may be said to be in part an expression of the real terrors of the arctic regions, and in other part a mere fiction of the imagination. What in Nature could be more terrorizing than those impending bergs, fang-armed like the jaws of some antediluvian monster, and rising hundreds of feet in height, which have been made to do service in the annals of nearly all arctic navigators for a full century or more! Yet how many are there who have in fact seen these fantastic symbols of the north? In our two cruises among thousands of bergs of all conditions and sizes we saw only monuments of quiet and impressive beauty—nothing suggestive of near or immediate catastrophe. A berg would tumble here and there, another would groan under the weight of its own dismemberment, and others would, perhaps, be licking up the parts that the sea had torn from them; but whatever it was, the work was accomplished in a peaceable manner, with a seeming consciousness that it had no regret for the results. Nor, indeed, were the results of any magnitude. Travelers have graphically described the commotion in the waters produced by the fall of one of these vast ice mountains, of the cannon-like detonations which were sent out by the snapping of the ice. I should compare the sound more with that of not very intense or even distant thunder, and the agitation of the waters to the churning of a heavily plowing steamship. There are, however, times when the bergs appear in an angry mood. When the after-storm sends them forth from their havens of rest, shooting billowy foam over and through them—it is then that they take on the mane of the lion. The surging waters open out in front of them like the parting in the path of a dolphin, and the bergs swing out triumphantly into the rocking sea. Vain and hopeless would then be the barring of the passage of the moving monster.

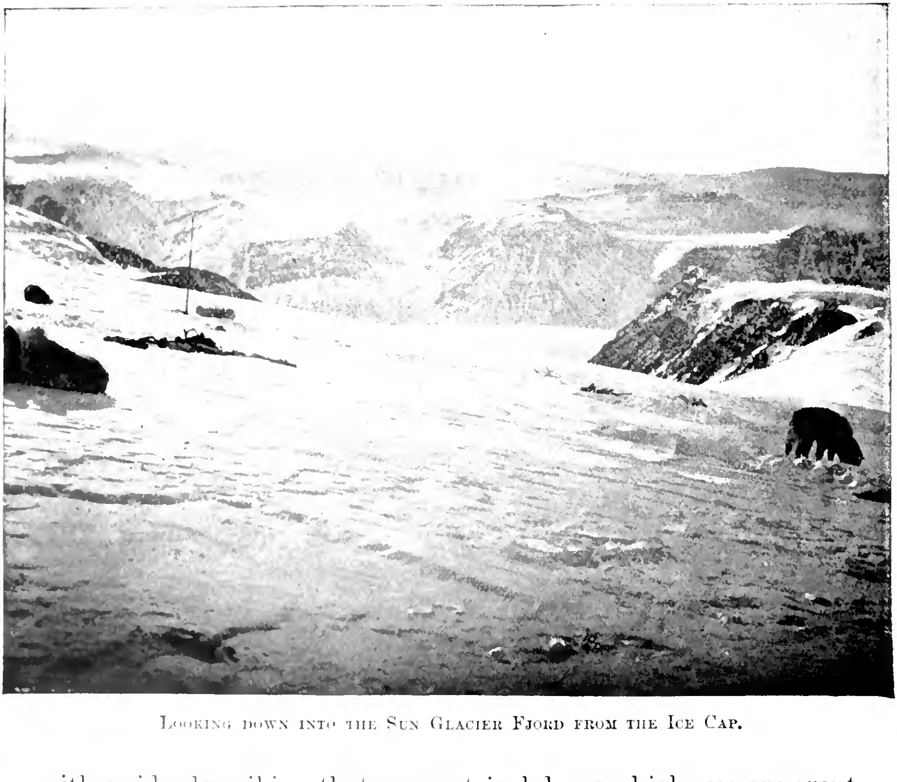
The glaciers of Greenland, like their children, have their quiet and angry moods. The flat ice sheets of the north, so firmly consolidated that for miles scarcely a trace of a crevasse is to be found, and whose inclination is such that over almost any part of them railroading could readily be made possible, typify the quiet phase of Nature—wholly different from that which is embodied in the structural form of the majority of the glaciers of the south and of those of Melville Bay, in which the crevasse character is so largely developed. The struggles of Janssen, Nordenskjöld, Whymper, Peary, and Nansen would hardly be intelligible to those whose first efforts in glacial climbing were realized among the solid ice sheets of the north, whose only difficult points, as a rule, are to be found not very far from the ocean front of the ice sheet. With seemingly few exceptions all the larger Greenland glaciers are rifted at their terminal falls, but the rifting, as in all other glaciers, depends upon the slope of the bed, the extent of the ice, and the general compression or extension that it has undergone. In but few instances did we find the rifting so complete as to debar easy circumvention through zigzagging, and rarely did the crevasses have a greater vertical plunge than from thirty to forty feet, or a width exceeding ten or fifteen feet; indeed, by far the greater number were of insignificant depth and breadth, offering little difficulty in their passage to the mountaineer provided with a glacial axe.

Our first attempt to scale a Greenland glacier was made on one of the minor ice sheets debouching on the northern face of Sonntag Bay, in latitude 78°. We had with us a steel-shod Hudson Bay toboggan, on which we loaded some two hundred or two hundred and fifty pounds of traveling impedimenta, and which



Terminal Wall of Verhoeff Glacier.

we had hoped to be able to drag with us. We had selected this glacier because from our anchorage it presented to the eye an attractively gentle slope, which was apparently interrupted by but few crevasses, and a terminal ice wall of but insignificant height. Approach to the ice border soon showed, however, how erroneous had been our perspective. The ice wall, instead of being fifteen to twenty feet in height, as we had assumed, in reality rose to the respectable proportions of some sixty feet, over which arched a dome of graceful and even curve. In a few minutes some of our party had cut their way to the top, but it was made manifest that any attempt to draw our sledge over would only result in disaster to it, and we accordingly abandoned the enterprise. We repeated our efforts still the same night on a larger but more auspicious-looking glacier, and without difficulty, by climbing over the scanty lateral moraine, reached the middle of the ice. The surface, as in nearly all the Greenland glaciers, was almost entirely destitute of rock *débris*, the sparsely scattered bowlders which in a broken, zigzag line tottered over the flanks of the ice sheet scarcely revealing the structure of a moraine. Two miles in advance of us the ice was solid, with only knife-edge cracks to indicate where it had parted and to mark the positions of possible past crevasses. It fell easily from the center to



Looking down into the Sun Glacier Fjord from the Ice Cap.

either side, describing that symmetrical dome which was apparent from the water front; seaward it descended with so gentle a slope that over long areas it appeared to the eye only horizontal, and elsewhere the gradient could not have exceeded five degrees. Over this surface the toboggan could be drawn without difficulty, and so few were the hummocks that guy-lines could readily be dispensed with. We were still in the cooler hours of night, or rather of the "day of night," and the sun had made but little impression upon the surface. Here and there the crisp, granular ice showed symptoms of early dissolution, and an occasional water pool marked progress to the gradually advancing hours of true day. A few foxes ventured near our tracks, and some crows winged their way landward, but these were all the signs of animal life that gave movement to the landscape. About two miles from the ice front a great pyramidal rock mountain or *nunatak* split the glacial stream, causing it to swell into gently rising waves and crests, which mounted terracelike one above the other, without, however, materially breaking the continuity of the surface. We found progression over this billowy surface slow and fatiguing; it was difficult to hold the toboggan in position, as the steel runners gained no purchase upon the adamant polish of the ice. It swayed from side to side, undulating like the fins of a fish, and keeping us in a constant state of adjustment. As the slope increased at an elevation of about fourteen hundred feet, crevasses gradually took the place of the fissure splits, and it was found advisable to make use of the rope. We tied ourselves together in single line, keeping about twelve feet apart. There were few crevasses of greater width than the length of our toboggan, and most of these were of insignificant depth, yet there was enough danger in them to warrant a sharp lookout. The snow bridges were particularly treacherous, and their presence was sometimes only made known through an unexpected plunge. Cautiously avoiding these so far as it was possible, and the numerous ugly holes which only too frequently interrupted our course, we finally reached the basin, eighteen hundred feet above the sea, out of which the glacier emerges. We had accomplished our mission; the great glacier lay all below us, and above were only the sky and the upper snow fields which tirelessly fade off to unite with the sky.

A pleasanter ice party than this one can hardly be conceived. With a temperature that was neither warm nor cold, and with just sufficient point in it to give to it that exhilarating quality which impels to work; with a lingering midnight sun sending its warm illumination through a seemingly endless rift of clouds and bergs; a mountain and ocean panorama of almost matchless grandeur around you; a solitude immeasurable and undefinable—these are the elements which united in an exercise to make it forever memorable.

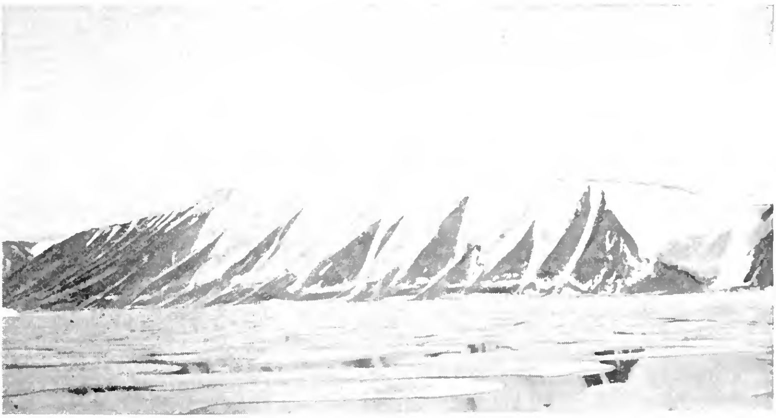
A few days after this first experience we were called upon to do a piece of glacial work the memory of which, unfortunately, associates itself with one of those sad incidents of travel which are seemingly destined, from time to time, to break upon the rugged path of exploration. When all but ready to leave the icebound northern shores for the more hospitable havens of the south, whither we had hoped to convey, unbroken by disaster, the untarnished record of a most successful exploration, intelligence was brought to our quarters that a member of our party was missing. Mr. Verhoeff, mineralogist of the North Greenland party, had made a final excursion after new rock specimens, and from this search he never returned to meet his associates. It was to ascertain his fate that we were again summoned to those icy fields and domes whose first acquaintance we had but

CROSSING A GREENLAND GLACIER.

recently made. We suspected that our poor friend had attempted a traverse of one of the many glacial sheets which tumbled out into the sea and that disaster had overtaken him in his lonely tour. Accordingly, we instituted a close search over mountain top and valley, and day and night peered among the ice pinnacles for possible traces of the missing man. Our first search was made on the great glacier, since named the Sun Glacier, which cuts the eastern extremity of McCormick Bay, and parts the dry land which in the summer season bounds both the northern and southern shores. It was early in the evening of the 19th of August, when the elevation of the sun still marked about twenty degrees above the horizon, that we again entered the shadows of the same granite cliffs over which, only a few days before, we had so joyfully passed after our meeting with Mr. Peary on his return from his memorable journey. The scene had changed. The deep cañon, along which the eye could follow the long, lazy line of glacier for a distance of twelve to fifteen miles to its mother ice cap, looked bleak and forbidding; there was no longer that charm of the unknown about it which attracts when all Nature smiles with success. A dark cloud had settled over the landscape and for a time closed out its joys.

We approached the front wall of the glacier with caution and almost in silence, fearing lest any percussion might too hastily precipitate some of the tottering masses which were "calving" their way to sea as bergs. Like the snowy avalanches of the Alps, which are at times called to life by the clapping of the hands, so must these ice masses of the north be left to their own peaceful slumbers. Once overturned, there can be no forecasting of the commotion that might follow. A turn or two may end the scene, or it can be that it has hardly begun before the water is churned into foam.

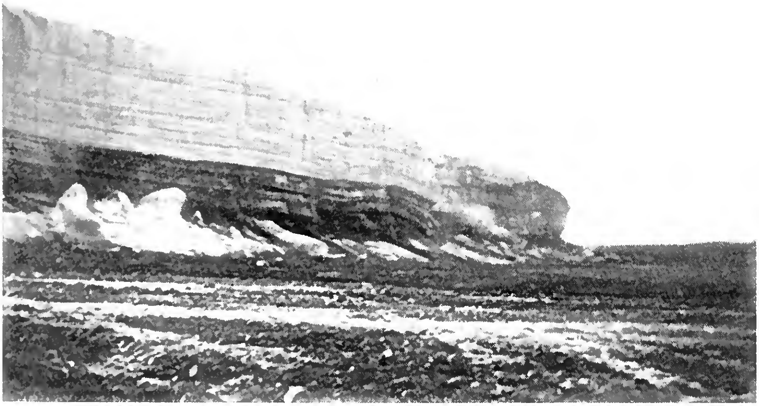
Cutting our steps into the dome-shaped lateral margin of the glacier, we soon gained the surface, upon which walking was fairly easy and comfortable. An effort to reach the opposite side was frustrated by the numerous crevasses which cut into the median portion of the ice, and about which we were obliged to wander in a tortuous, zigzag line. Generally, however, we managed to keep on a united body, or where the fissures were of but insignificant width. For some distance the surface of the ice kept disagreeably hummocky, but after passing a feeding glacier it



Hanging Glacier of Herschel's Island.

spread out in an almost horizontal glistening sheet, admirably adapted for sledging purposes and of necessity for pedestrianism. The crevasses became less and less numerous, and ultimately ceased altogether, so that a traverse could be made in any direction. A narrow, remarkably straight, and evenly defined medial moraine, more in the nature of a dirt band, with angular blocks scattered over it—so like the "archaic" illustrations which figure in the works of Forbes and Agassiz and in other old-fashioned books of geology—occupied the central axis, stretching off upward to the limit of vision. As in all the other Greenland glaciers which it was our pleasure to explore, there were no really large blocks in the moraines, and there was a complete or nearly complete absence of glacial tables and pyramids. Here and there low mounds of gravel and stones heaped themselves up in beehive-like masses, such as have also been found on the surfaces of the glaciers of Alaska and Spitzbergen, and occasional impacts had also thrown the ice into deformed caps and rafts. There were no ice rivers worthy of the name, and such channels as still marked the courses of surface waters were of but insignificant extent.

Had our mission been different from what it really was we might have said that this glacial traveling was truly delightful. With all the beauty of the ice fields of Switzerland, and that charm of pedestrianism which an unexpected and varying change of scene carries with it, we had here the advantage of the



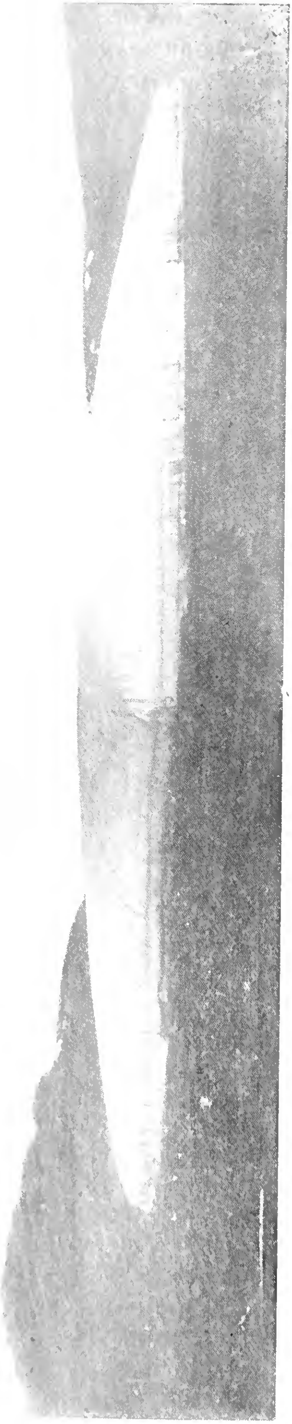
Glacier debouching on Plain.

many hours, the consciousness that a journey was not limited to any arbitrary separation of day from night. It was all day, albeit the sun shone for only a paltry few hours. For some time angry-looking clouds had been gathering about the blackened granite crests; the side cañons poured out their fleecy hosts, and before long the wild spirits of the mountains swept demonlike across the valley of the glaciers. The few lazily falling flakes which for a half hour or so had portended evil were before long replaced by blinding sheets of snow, and for a long time, save in its elements, Nature ceased to exist. The landscape was completely blotted out from view. We were not prepared for this change, and the cold wind stung mercilessly wherever it caught an exposed surface. We muffled ourselves as best we could in our not over-generous garments, but yet it was not all solid comfort. Fortunately, the storm was of only short duration, and in its wake the landscape rose resplendent in its new garb.

We had now penetrated up stream about five or six miles, and had ascended probably six hundred or seven hundred feet in that distance. At three o'clock in the morning we started upon our return. We had seen nothing, and no sound, save the echoes from the beetling cliffs of granite and trap, which here rose in impending masses two thousand five hundred or three thousand feet above us, responded to the oft-repeated shouts to which we gave utterance.

The general aspect and features of the Sun Glacier we found repeated in a still more gigantic ice sheet, the Verhoeff Glacier, which bore the final traces of our unfortunate associate and buried in its bosom the forlorn hope which carried our search for upward of seven days and nights over mountain, snow, and ice. This glacier measures two miles across its terminal wall, but in its middle course, where it is split by a giant *nunatak* rising hundreds of feet above the glistening sheet of ice, it expands to fully twice this width, and then recalls the broad *mers de glace* with which, as miniatures, we had become acquainted in the ice fields of Switzerland and Scandinavia. But here we have the flat united ice mass, with only a suggestion of crevasse to remind one that the ice is a moving body, tearing itself apart and then uniting; all appears firm and stationary, except small rills, which in serpentine courses cut shallow troughs into the surface and musically wend their way to lower levels, ultimately to join the sea. To the eye the main part of the glacier appeared almost absolutely horizontal, and probably it was the flattest of all the sheets that we examined. We were unable to determine the rate of motion, but doubtless it was exceedingly slow, perhaps averaging not more than twelve to fifteen inches in twenty-four hours. In the Sun Glacier we had determined a movement of some seven or eight inches in as many hours, but this was in a part of the glacier where the ice was badly cut by crevasses and in its more rapidly moving lower section. In some of the minor glaciers of the same region we could determine no motion at all, and possibly at that time they had come to an almost absolute standstill. While no detailed observations on the motion of the glaciers of northern Greenland have as yet been made, and therefore no safe deductions can be drawn from the fragmentary records that are now before us, it would appear, nevertheless, almost certain that the majority of the northern ice sheets are much slower in their motion than those of South and Central Greenland—a condition, indeed, that might have been inferred from the conditions of climate which govern the several regions.

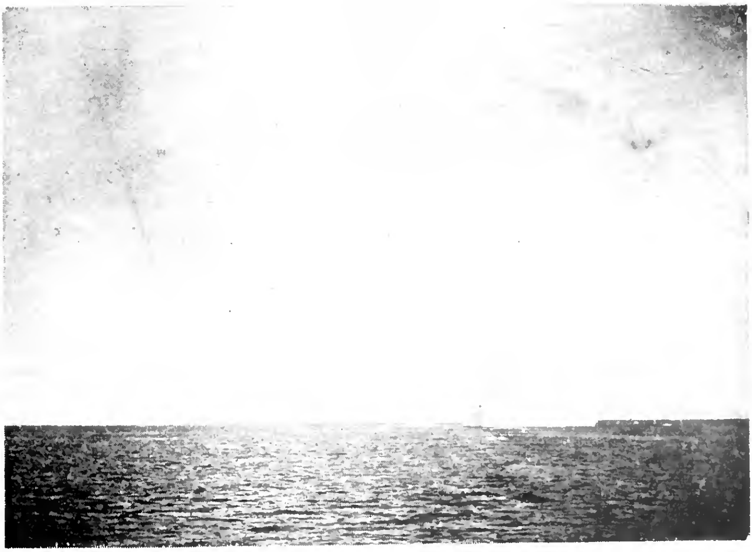
The Verhoeff Glacier presented one aspect in its existence



Remarkable Domed Glacier in Inglefield Gulf.

which was new in our experience. This was the wealth of vegetation upon which it trespassed and which in part took possession of the icy sea. The spot whence we mounted upon the ice, and where the lateral moraine was discharging its cargo of rock *débris*, was a true garden spot, luxuriant with its growth of grass, and smiling under its garniture of poppies, chickweed, potentillas, and gentians; butterflies flitted about in the bright sunshine, whose genial warmth recalled memories of a distant south. Where the great *nunatak*, rusty in its coat of lichen, threw off the main stream into two broadly diverging arms, the charms of glacial scenery were brought to their fullest height. There, in the midst of the ice, resplendent in the vigor of its own coloring, was a garden of grass, moss, and wild flowers—a veritable oasis in an ice wilderness. Fruitless would be the effort to depict the beauty of this scene, so wholly magical and weird did it present itself to the eye and mind. The long tufts of grass were twelve to sixteen inches in height, and all about were a wealth and profusion of flowers which would have done justice to the landscape of the full tropics.

Thus, in its quiet mood, does the Greenland glacier reveal itself in a form wholly different from that which the imagination paints it—so different, in fact, that one is tempted to ask, Does it conform to the conditions of existence which have made glaciers



DETACHED FRAGMENTS OF GREENLAND GLACIER. The Watch-Tower Berg.

elsewhere? It unmistakably does, and these conditions have shaped all the forms of glacier, from the tiniest to the largest, from the quietest to the most wicked, to which the region has given birth. Probably all the forms of glaciers that exist in the world are represented in Greenland, and none are found there which might be said to embody a type of structure that is unknown elsewhere. Such as they are, they are but the remains of far more extensive ice sheets which, at no very distant period back in time, plowed far into the ocean deep, shaped much of the contours of the existing land surface, and perhaps even carved a relief of mountain and valley. The traces of past glaciation are everywhere apparent on the barren or uncovered shores, and troughs or water channels, thousands of feet in depth, bight deep into the areas of continuous drift. How vast, manifestly, have been the changes which marked the landscape during and since the period of greatest ice! The period of recession seemingly still continues, but how far the results of this recession will extend can not be told.

The insignificant development of the ice cap, in its relation to the large glacial streams which radiate off from it, is so striking a peculiarity in some parts of Greenland as to have suggested the suspicion that many of the existing glaciers are merely relics of the great Ice age. Bessels, the accomplished scientist of the Polaris Expedition, indeed, gives voice to this feeling in explanation of the by no means insignificant glaciers of Herbert and Northumberland Islands, lying somewhat north of the seventy-seventh parallel of latitude, which descend from an ice cap of eighteen hundred to two thousand five hundred feet elevation. It did not appear to him probable, or even possible, that the comparatively feeble accumulation of snow which is found at this elevation could originate ice streams of the dimensions which are there found. The facts, however, show that there is no real basis for this interpretation. The snow covering of these islands belongs to themselves, and, feeble though it be, it is quite competent to explain the associated phenomena. Many of the "hanging glaciers" of Herbert Island, which descend over slopes of some thirty to thirty-five degrees, are so attenuated in their upper parts as to be almost extinguished before reaching the summer ice cap; yet basally they rapidly increase in dimensions, so that before they finally terminate they measure not less than forty to fifty feet in thickness. The slowly accumulating snows descend over the first-formed layers, whether by sliding or otherwise, and help to build up the base while they thin out the top. In all essential respects these hanging glaciers are identical in structure with the larger streams, and it is only in their narrow connection with the ice cap that they at all differ. I am indeed convinced that some of the minor glaciers have been formed without the assistance of any ice cap or of the accumulated snows of a *névé* basin; for such streams, which are seemingly not very numerous, the designation of ravine or *couloir* glaciers might, perhaps, be advantageously used.

Briefly recapitulated, the glacial phenomena of Greenland are the phenomena of all other glacial regions; they are not illustrative of new forces and involve no explanations that have not already been made familiar through the teachings of other countries.

PREPARATION FOR COLLEGE BY ENGLISH HIGH SCHOOLS.*

By JOHN F. CASEY,
MASTER IN ENGLISH HIGH SCHOOL, BOSTON, MASS.

THE times in which we live are in many respects unlike any which have preceded them. New professions have arisen, old ones have lost their prominence; we live more in the present and less in the past. Recent investigations and discoveries in pathology and bacteriology have done much to increase the respect for and confidence in the practitioners of modern medicine, and have made of modern surgery almost a new science. Quacks may be as numerous as ever, but they rely for patronage upon the ignorant and credulous. The legal profession has taken no backward steps. But with those who undertake the formation of opinions, both spiritual and temporal, the condition of affairs is in many respects different. All the great questions relating to the welfare of the modern intellectual, social, and political world are now being brought up for discussion, and the traditional answers to them are no longer convincing or satisfactory. In the lack of respect for authority, which is so marked a characteristic of the present time, no person's mere dictum is obeyed, or accepted as true, unless he has the power to enforce or the ability, through knowledge, to establish the truth of his statements.

Journalism to-day does much of what was wont to be done by the clergyman and the schoolmaster. While there is no diminution in the respect paid to the sacred office of the preacher, his teachings upon doctrinal points are received *cum grano*, and each one for himself modifies pulpit teachings according to his own views. The world has become more liberal and tolerant. Material of which martyrs were wont to be made is becoming less and less abundant. The parson is no longer the chief source of supply of ideas, social, moral, and political, and is no longer *ex officio* chief man of the parish.

So, while the teacher of secular learning holds as teacher a higher place than ever before, yet, when he undertakes to act as adviser and tries to lay out a course of studies, his dictum does not obtain that confidence which it used to obtain. There arise doubts as to the soundness of the advice given, and suspicions that time and labor may be wasted through misdirection.

In elementary schools, and in technical and professional schools, the ends to be attained and the methods of attainment

* An address delivered before the Massachusetts Association of High and Classical School Teachers.

are comparatively clear and well defined. But the higher institutions of learning, which claim to train youth to engage to advantage in the struggle of life, to compete with their associates, and not only to carry off the prizes, but also to be examples of intelligence and refinement—these institutions, which claim to give what is expressed by the terms culture or a liberal education, find to-day a by no means unanimous agreement as to the best method of producing these results. Many a graduate, while thoroughly loyal to his alma mater, in looking back upon his college studies and considering their effect upon himself, has doubts as to the efficacy of some of his courses there, and questions with himself whether, were he to begin life again, he would, could he *mold fate* to suit himself, go over the same courses again. The advanced student of to-day knows pretty well what kind of instruction he wants, and will go where he can get it. The old, well-worn, and somewhat narrow path trod by his fathers does not satisfy him, and his demand for a change has brought about discussions which, if they have not yet found any practical solution, have at least changed and enlarged the prevailing view of the meaning and aim of a liberal education.

In the attempts at readjustment of the traditional college curriculum the principal attacks have been made, and it seems to me wisely, against the position of Greek in that curriculum. Individually, I have no feeling against Greek in its proper place. I suppose I do not know very much about the language, having like most graduates dropped the study as soon as possible in the college course, and having had little to do with it since. But for that very reason probably I prize what little knowledge I may possess of the subject in inverse ratio to the amount I have. And yet I can not but feel that if one half of the time I spent in studying Greek had been devoted to the study of my own language and the other half to physical labor, sawing wood, for example, I should have been happier at the time, should have had a better physical development, and very probably should never myself have realized the deficiency in my mental equipment.

Greek and Latin were prominent studies in the early European universities because these universities were ecclesiastical corporations; and when Christianity was first established by law the services of the Church were conducted throughout the western part of Europe in the language of those countries at the time, which was a corrupted Latin. After the Roman Empire was overthrown and Latin had ceased to be the language of any part of Europe, the reverence of the people still preserved the established forms and ceremonies, and the church services were still conducted in Latin. This necessitated the study of that language by the priests, so that, from the beginning, Latin made an essential part of a university education. Both Greek and Hebrew were introduced later, when the Reformers found the original text more favorable to them than the Latin translations.

Greek and Latin thus introduced into the college course have maintained their prestige unshaken almost to the present time, and, having taken such high rank in the college course, the fitting schools have been compelled to arrange their courses to meet the demands of the colleges; so that till quite recently the curriculum of most secondary schools was composed mainly of three studies, Latin, Greek, and mathematics. An English teacher of classics of the present time, speaking of the head master of the school which he attended as a boy, says: "The doctor was a noble type of the old-fashioned English head master. He had a loathing for all scientific study, was utterly ignorant of modern languages, English literature of the day to him was non-existent, his lectures smacked of the last century with their long modulating periods and pauses Ciceronian. All information, historical, antiquarian, geographical, or philosophic, as connected with the classics, he regarded with contempt; any dunderhead, he considered, might cram that at his leisure; but it pained him to the quick if a senior pupil violated the Porsonian pause or trifled with a subjunctive. 'A word in your ear, doctor,' said an Oxford examiner once to him, 'your captain, yesterday, could not tell me where Elis was.' 'I looked horrified,' said the doctor in repeating the circumstance. 'I looked horrified, of course, but on my word I did not know it myself.' From his point of view a boy's chief aim in life was evidently to spend years in studying etymology, syntax, and prosody, and still other years in trying to write Latin verses, a thing which Cicero himself could not have done well."

The classical craze never obtained so strong a foothold in this country as in England, and it might be difficult to find, especially at the present time, any head master in America to whom the above description would apply, and yet I have known some, a composite photograph of whom would show many of the old doctor's prominent characteristics. Dr. Gardner, for many years the head master of the Boston Latin School, one of the largest and best fitting schools in this country, was not a mathematician, and whether or not well versed in modern languages, including English, he never wasted much time in teaching those subjects to the boys. But woe to the boy who did not know his Latin grammar from cover to cover; who could not write his Greek accents as readily as cross his *t's* in English; who had forgotten one of the irregular verbs; or who could not detect an Ionic or Doric form long before he knew why it was used, or whether or not anybody ever used it except on special occasions for special purposes!

As to science, our knowledge of that was only in its special application to the manly art of boxing, and we always supposed that, athlete as he was, he had enough of that to meet all the requirements of his position.

The author just quoted further says, "Be the condition of other branches what you please, the melancholy fact stands that the classics are taught in such a way as to benefit only those who by superior talents or inordinately long continuance at school eventually emerge from the darkness overhanging their elementary training." Of his own class he says: "Of one entire half of their long school probation the majority carried away no intellectual memento. Upon that half had been brought to bear the most expensive part of the educational machinery; masters of arts instead of ushers; clergymen instead of laymen; dictionaries and lexicons instead of copy books and slates. There had been no lack of sowing, but there had been no reaping; the ground had been well harrowed and the seed had been watered plentifully and with tears. Many of his associates who had no special calling for a sailor's life had entered the Naval School, with the mere view of escaping a life of Latin and Greek drudgery on land."

The original design of the colleges in America was the training of a learned clergy, and the ancient languages naturally and properly constituted a main feature of the college curriculum. The best secondary schools naturally were classical schools. The heads of these schools were chosen on account of their classical ability, and in these schools the ancient languages were taught by the ablest and best paid instructors, while the teaching of modern languages, mathematics, and science was generally intrusted to subordinates. From these conditions it is easy to see the evolution of the belief that a liberal education meant a classical education, a knowledge of ancient languages and literatures.

The college requirements for admission, the traditions or superstitions of the past, and the inclinations of those in charge of secondary schools have all tended to maintain and strengthen this view. At a time when the only opportunity for advanced study was offered by institutions which made the classics the principal feature of their instruction, it was natural to measure all learning by the classical standard. To do so to-day is pedantic if not foolish. And yet with the prestige of age and tradition, aided perhaps by the somewhat different class of pupils who attend the strictly classical schools, there pervades these schools a sentiment of superiority which possibly enhances the dignity and honor of the instructors therein.

Now, if there is any such thing as a pedagogical hierarchy, at the very head should be placed the successful teacher of English;

that teacher who, combined with the requisite knowledge, has the ability and inclination to endure hard work and drudgery; who has, in short, the many and rare qualities necessary to give to pupils a good knowledge of their own language, so that they can speak and write it readily, forcibly, and correctly.

One of the principal arguments in justification of the prominence given classical studies is their efficiency in inculcating correct theories of the general principles of language, with the ultimate object, of course, that the student be well versed in his own language, as he never expects to speak or write Greek or Latin. Now, if the study of Greek and Latin does give to the student ability to speak and write his own language readily and correctly, all honor to them. If as good results may be obtained by the direct teaching of English, or indirectly by means of the modern languages, then this chief argument in favor of Greek and Latin loses much of its force. I am inclined to the opinion that good results in English may be obtained by a capable instructor through the medium of almost any subject, and that more depends upon the teacher than upon the subject. Even mathematics, which is not generally taught with special reference to English, may be made to have much influence upon that branch. It is beyond question that where there is not clear, logical thinking, there can not be good speaking or writing, and I have found that apparent deficiency in mathematics is often due to the pupil's inability properly to express mathematical facts which his mind clearly comprehends.

Good teachers of English are not easily found, and as to the practical effect of classical studies upon the student's English, the Board of Examiners of Harvard College, who last year made a careful examination in English of one of the classes, say in their report that "the reflex influence on the student's English of translating Greek and Latin into the mother tongue seems, when subjected to a practical test, to amount to nothing."

Till very recently but little preparation in English was required to pass the college entrance examinations, and consequently preparatory schools neglected that subject; but of late, to meet special requirements in it, the fitting schools have been obliged to give more attention to English. And yet the board of visitors report that of the present Sophomore class of Harvard College, on the entrance examinations only two per cent passed with credit in English, forty-seven per cent were conditioned, and twenty per cent failed to pass the examination. The causes of this may be that the college examinations are not in harmony with the teaching in the preparatory schools, or that the teaching in the fitting schools is not good or is neglected for want of time. In the leading school in Boston for teaching shorthand writing the pupils are mostly graduates of high schools. The principal of that school tells me that the most serious obstacles which these pupils meet in their study of shorthand is their inability to spell correctly. The condition of affairs is well expressed by a parent who, having seen on his son's school report eighty per cent in French and forty per cent in English, wrote on the back of the report for the teacher's inspection, "This seems to indicate that, in addition to any blame to be attributed to the boy, there is something wrong elsewhere."

Is it well to fit boys for college so that they may pass the entrance examination with honors in Greek and Latin, and get conditions in English? Would these boys of their own free will, if competent to judge, desire to offer the maximum requirements in Greek and Latin and the minimum in English, modern languages, mathematics, and science? Have not pedagogues, as a class, exposed themselves to the just criticism of being pedantic, dogmatic, and influenced too much by the example and traditions of the past, and possibly also by their own personal tastes and abilities? Are they at present fully in sympathy with the demand of the American civilization of to-day?

It is foolish to deny that there is much that is instructive and ennobling in Greek literature, or that the study of the Greek language is beneficial to such as desire to study it. Greek grammar is the delight of grammarians, whatever it may be to others. Few or no valid objections can be raised against the study of Greek in itself, and all objections to it are made simply against its being an essential for admission to college. The following are some of these:

1. It is in a majority of cases studied merely in order to pass the entrance examinations, and it is therefore an artificial and for such cases almost useless barrier. Tom Brown of Rugby, who was a typical English boy of the upper middle class, says, "I went to school to get, among other things, enough Latin and Greek to take me through Oxford respectably"; and Tom's father says of him: "I do not send him to school mainly to make him a good scholar. Neither his mother nor I care a straw for the digamma or the Greek particles. If he will only turn out a brave, truth-telling Englishman and a gentleman, that's all I want." Mr. Taine says, "Remarkable words these, and well summarizing the ordinary sentiments of an English" (and he might have added of an American) "father and child."

2. There seems to be no necessity for both Greek and Latin where one will answer every purpose, except where extreme verbal subtlety is required. As a means of inculcating clear and exact views on the philosophy of language Latin is nearly the equal of Greek, and there seems to be no need of both except in

special cases for special purposes; and as between Latin and Greek the least deserving should be dropped. Latin is the mother tongue of so many modern European languages that it has its proper place antecedent to those languages.

3. Making Greek a *sine qua non* has debarred many from entering college who, through inaptitude or inability to procure good teaching, have been unable to pass their entrance examinations in that subject.

4. The time required for Greek has acted as a prohibition on many other studies.

5. Greek being a difficult language, not enough of it is learned to be of much practical service to the student. Huxley says: "It is only a very strong man who can appreciate the charms of a landscape as he is toiling up a very steep hill along a very bad road. The ordinary schoolboy is peculiarly in this case. He finds Parnassus uncommonly steep, and there is no chance of his having much time or inclination to look about him till he gets to the top, and nine times out of ten he never gets to the top." As to the disciplinary drill in Greek, it is by no means certain that it possesses any advantages over many other studies pursued with as much care and hard work.

Says Grant Allen: "Do you think that a man can not learn just as much about the Athens of Pericles from the Elgin marbles as from a classical dictionary or a dog-eared Thucydides? Do you suppose that to have worked up the first six Iliads with a Liddell and Scott brings you in the end very much nearer the heart and soul of the primitive Achæans than to have studied with loving care the vases in the British Museum, or even to have followed with a sculptor's eye the exquisite imaginings of divine John Flaxman? Do you really suppose there is no understanding the many-sided, essentially artistic Greek idiosyncrasy except through the medium of the twenty-four written signs from alpha to omega?"

The old-fashioned classical education is an excellent and possibly necessary preparation for the legal, clerical, and pedagogic professions. It furnishes a capital training in words; it does not reach the facts behind the words; it is only plowing over again the old ground; it leaves each generation just where its predecessor was. It does not furnish either the methods or the material for originality. In the whole domain of science the classics afford a convenient terminology. That they give any useful fundamental preparatory training can not be demonstrated, and their study with this end in view is time wasted.

Greek history, mythology, philosophy, and poetry all together have less influence upon the civilization of to-day, less effect upon the prosperity, happiness, and general welfare of mankind than the discoveries and inventions of a few modern scientific investigators. The world to-day is looking more to the future than to the past, and its great and successful men are those who know the laws which govern men and things and obey them. The direct loss to the silk industries of France in a few years was two hundred and fifty million dollars, and would have increased had not Pasteur studied the nature of the minute organism which caused the trouble, and found a means of relieving the silkworm of its presence. Had the antiseptic treatment of wounds been known thirty years ago, at least one hundred thousand lives might have been saved during the war of the rebellion. Nature punishes ignorance as sharply as willful disobedience. Incapacity and crime receive the same punishment. Certainly he who knows her laws and can add to our rapidly increasing amount of knowledge of the mysterious ways in which Nature works, is as liberally educated a person as the pedant who has had his memory trained by years of classical study.

In general, I object to that complete begging of the question which assumes that an education to be called liberal must be obtained by a course of studies comprised within any hard-and-fast lines. Recognizing the demand for a more extended and broader curriculum, the colleges have enlarged their courses, and some of them have recently changed their requirements for admission. This change must have come sooner or later. I wish to show that this change was a wise one, and also to make this suggestion, that other colleges, in addition to the privilege given the candidate of offering either Greek or a substitute, should follow the example of the few who have established an elementary course in Greek for undergraduates.

There is no substantial reason why the secondary schools should teach the elements of all the studies pursued in the colleges, and that has never been attempted or suggested for all the college courses. The colleges have always offered elementary courses in some subjects, and one course more or less would not materially affect the grade of the college. Why not offer an elementary course in Greek as well as in Hebrew or Sanskrit or modern languages? The colleges themselves complain that they are now forced to give elementary instruction in English and no instruction in several important European languages.

This would enable those who are uncertain as to their future to defer making their decision until later in life, when, if they chose to select Greek, they could bring to the study more mature judgment and the advantage of training in other subjects, and for such students Greek would no longer be a school study, but a learned study worthy of the college. Also, students who came from schools where Greek is not taught would be debarred neither from entering college nor from pursuing that study. Since the extension of the elective system at Harvard neither Greek nor Latin studies are pursued by so large a proportion of the students as formerly, and yet a greater proficiency in classics is obtained. By this plan the graduates of our best English high schools could postpone until after graduation the choice of a career. They would then be in a fair condition to make a proper estimate of their ability, their special capacities and leanings, and their probable fitness for a commercial or a professional life.

It has been said that the recent changes in the requirements for admission to college have operated only for the benefit of inferior scholars who would not otherwise have been able to enter college. If we admit for a moment the truth of this statement, the change has some merits even on these grounds. So-called dunces are often only so many visible evidences of an imperfect and too narrow educational system. They are the results of attempting to fill square holes with round pegs, to mold and develop the manifold and diverse characteristics of human nature of both sexes by the same method and with the same appliances, in conformity with a prearranged, harmonious, and symmetrical system, just as blocks of wood are run through a machine. Many dunces at school often become distinguished in social, business, and political life, and, even in school, show ability in subjects congenial to them. Conscious of their skill in art, in music, or of their ability to do many things outside the routine of school duties better than the ordinary not specially gifted pedagogue, they feel justified from their point of view in believing that, as between themselves and their instructor, if there really be a dunce, the question is certainly debatable as to who best answers the description.

But the youth who enters college without Greek is by no means inferior in mental equipment to him who enters under the old system. From what I have seen of both methods I should advise plodding mediocrity to stick to the old lines. Hard work and good teaching have always enabled this class of pupils to pass the entrance examinations, and even sometimes to distinguish themselves. But distinction in science and mathematics is only obtained by industry plus something very closely allied to genius. In fact, at Harvard it seems to me that the new method has been handicapped by requiring too much in mathematics. Boys in secondary schools can learn and assimilate their elementary algebra, their geometry, plane, solid, and analytic, and their trigonometry, but they are not mature enough to undertake the study of advanced algebra.

The present scheme of requirements for admission to Harvard College was adopted in 1886. Since that time one hundred and forty-eight persons have entered Harvard without Greek. Thirty-five of these have graduated, seventeen of them with honors, two receiving the A. B. and the A. M. degrees simultaneously. Of the ninety-one men who have not graduated, but have been in college long enough to make a record, a little more than half have a record above "C." President Eliot says in his annual report, "This record is a very creditable one, and shows conclusively that the persons who have thus far entered college without Greek are abundantly able to profit by their college life and to win a standing, which is, on the average, above that of those who entered with Greek."

At the time I made inquiries (one year ago) there were in Harvard University forty-eight graduates of the Boston English High School, divided as follows: undergraduates, thirty; graduate students, two; special students, six; scientific school, one; medical school, eigh ; law school, one. Seven graduates of the Boston English High School took their degrees at Harvard the preceding June (1891). Some idea of the rank of these seven may be obtained from the fact that they received the fourth, sixth, eleventh, thirteenth, fifteenth, and twenty-first scholarships. The seventh did not take a scholarship, as he did not need it, but he received honorable mention in natural history, and was assigned a commencement part. Of the other six, three graduated *magna cum laude* and two *cum laude*. Eight English High graduates received their diplomas at Harvard last June. Of these, one received the degree *summa cum laude*, three *magna cum laude*, two *cum laude*, and two without distinction. One of these, Lovett, led his class, was editor in chief of the Harvard Monthly, was the class-day poet, and was the best-known literary man in college. He is at present instructor in English at Harvard. Under date of September 26, 1892, President Eliot wrote me the following letter:

"Harvard University, Cambridge, *September 26, 1892*.

"My dear Sir: The standing in college of the young men who have entered Harvard College from the English High School of Boston without Greek has been remarkably high. Speaking from my general knowledge of the college standing of boys from different schools, I should say that the standing of these high-school graduates has been, on the average, higher than the average standing of the graduates of any other school in the country. I have not yet made an actual comparison with figures; but I propose to do so, and to state the result in my next annual report. I suppose, however, that it would be just to state that the boys who have come from the English High School to Harvard College are picked boys; they do not represent the average of the school. I had some conversation with Mr. Waterhouse on this subject last July at Saratoga, and I wrote him a note giving the standing of a certain number of graduates of the English High School at graduation at Harvard College. This was not a comparative statement; but any schoolmaster who is in the habit of sending pupils to Harvard College would know at sight that it was a very remarkable exhibit.

Very truly yours,

(Signed) "CHARLES W. ELIOT.

"MR. JOHN F. CASEY."

During the year immediately preceding the time when I made my inquiry, in the class of '92, two English High boys were the only ones who received "A" in all their examinations in their regular work of the year. During the same year, in the class of '93, an English High graduate and a young man from Chicago were the only ones to receive "A" in all their examinations in their regular work of the year, and at the same time two English High boys outranked all others in college in English composition. During that year, of seven honors in mathematics given to all the classes, three were taken by graduates of the English High School. Of three theses selected by President Eliot as especially meritorious, two were written by boys from our school.

As might be expected, the subjects in which English High School graduates receive distinction are different from those in which classical school graduates would seek honors. The subjects in which our boys have obtained distinction are English, French, history, political economy, mathematics, natural history, chemistry, botany, and meteorology. S. M. Ballou, in his special work in meteorology, wrote an article opposing the cold-wave theory held by the Weather Bureau at Washington. This essay was translated and published in Europe, and Ballou received quite flattering letters in regard to it from eminent scientists—one especially from Mr. Woeckoff, head of the Russian Meteorological Department, in which he said that Ballou's article completely disproved the theory held by the authorities in this country. Young Ballou afterward met Prof. Russell, head of the Meteorological Department at Washington, and, having previously sent in his card, when ushered into Prof. Russell's presence, was greeted with, "I suppose you are Mr. Ballou's son." He failed to recognize in the stripling a scientific opponent. In English "B" course, which all sophomores are obliged to take, in 1888 Parker was one of four to receive "A"; in 1889 Lovett was one of ten; and in 1890 Ballou was one of three.

Among the list of instructors I find in the catalogue of Harvard College the names of four graduates of the English High School. Two English High School graduates, while undergraduates in Harvard, have been one an assistant instructor in botany and one in the fine arts. That reminds me that drawing, once considered rather as an accomplishment than as having much practical use or educational value, is one of the studies which in many classical schools Greek has crowded to the wall.

I wish to add just a word in regard to the statement in President Eliot's letter that our boys were picked boys. In one sense they are and in another they are far from it. They have undoubtedly been above the average of the school; so are the boys from any secondary school, because at most schools the poor scholars are dropped and made to repeat and refused promotion till they have come up to a high standard. We have practically nothing of this. After graduation such boys as choose return for another year's study. During this year they are allowed within certain limits to choose their course of study, and at the end of the year they are prepared to enter the medical, law, or undergraduate department of Harvard University. One of our boys who went directly from this class to the Law School of Boston University graduated there last June *summa cum laude* at the head of his class. Most of our graduates go directly into business or to the Institute of Technology, so that we have to take the small percentage who return as they come and make the best of them. Thus they do not represent what is understood by picked boys—that is, a few of the best selected. Neither do they represent by any means in point of numbers or ability what might be sent to represent the school could the teachers exercise the right of selection from the graduating class.

I heard Mr. Bradbury, of the Cambridge Latin School, a year ago say that he had asked permission of Mr. Hill, of the Cambridge English High School, to talk to the pupils of the English High in the hope of inducing some of them to change their course and join the Latin School. It seemed to me that there was a principle involved behind this request. Boys ought to hear both sides of the question, and doubtless there are many boys in the High School who would be better off in the Latin School. And this carries with it the truth of the converse also, that there are boys in the Latin School who would be more in accord with their surroundings were they to change. Were Mr. Bradbury to obtain the required permission of Mr. Hill and also grant Mr. Hill the same privilege, some of the pupils and both schools would be benefited by the change. And were both head masters to hold out the same inducements to the pupils—viz., successful preparation for Harvard—I do not think the High School would in the end be the loser in point of numbers.

It seems to me the duty of a teacher to advise a change when he finds a pupil out of step with his class and manifestly unsuited for the course he is trying to pursue. It may be that the ideal preparatory school is one which under one head combines both courses; then, as occasion required, pupils could be readily transferred from one course to the other; and even the senior who found his Greek too much for him could drop it and take up the alternatives of science and mathematics, pursuing more than one branch of these at the same time and reciting with more than one class if necessary. The plan is perfectly feasible, just as at Harvard we find members of different classes taking the same courses together. In the English High School we have members of the advanced class studying several branches of mathematics at once, and reciting with different classes. There is no difficulty or trouble about it. The member of the advanced class who wishes to review a certain study simply finds a class which is reciting in that study at an hour when he is disengaged and puts in an appearance to recite with this class. The only objection that I see to this would arise from the conservatism of professional educators as being inconsistent with custom and tradition. The tendency has been to separate the courses rather than unite them, but the conditions have always been quite different.

I have made special reference to Harvard College rather than to any other, because the new scheme of requirements for admission has been tried there sufficiently long to observe how it works, and these results have been made public. Boys who have succeeded at Harvard under the new regulations would have been equally successful at any other college under the same conditions. I have also cited as special examples graduates of the Boston English High School, because this school has probably sent more boys to college under the new system than any other school, and also because I have had an opportunity, through acquaintance with these young men, of knowing how they have succeeded and what they themselves have thought about their ability to get the most possible benefit from their college course.

The English High School of Boston is not a fitting school; its original design was that it should be a finishing school, and this plan has never been changed. Its course of studies covers a period of three years, and is the usual high-school course. To this is added a post-graduate course of one year, during which the student has great freedom in his choice of studies. The three-years' course is well arranged to meet the requirements of those who have no definite intention of pursuing their studies further, and the fourth year meets the demand of those who desire to do special work. A very few of the graduates of this school from choice studied Greek under a tutor during their advanced year in school, and a few more from necessity did the same thing, as they found the alternatives for Greek too difficult for them. This Greek was in most of these cases "crammed" for the special purpose of passing the entrance examinations.

and was of little use and had but little effect upon their subsequent success.

If boys who learn just enough Greek to pass the entrance examinations do not pursue that study in college and are successful in the courses which they pursue, it would seem to imply that they were prepared to take up those studies without having been examined in Greek, and that Greek was for them an unnecessary requirement, which might have been dispensed with or for which any other study requiring as much time and training might well have been substituted. A slight reduction in the alternatives for Greek would benefit English high schools, and make them legitimate preparatory schools on an equal footing with the classical schools, when both kinds of schools would be benefited by friendly rivalry, and pupils would gain by having two good, equally easy roads open to the college gates. The modern requirements for admission to college seem to have been successful thus far, and as professional instructors we ought to give so promising a plan our encouragement and wait for time to disclose by the numbers who enter under this plan and by their success whether there is a real demand for anything better than the old method, and whether that demand is a reasonable one.

ALCOHOL AND HAPPINESS.*

By Dr. JUSTUS GAULE,
OF THE UNIVERSITY OF ZURICH.

NOT as an ascetic, Dr. Gaule assures his hearers, anxious to debar them from a pleasure, but from their own standpoint, as friend with friends, all interested in increasing the sum of happiness, he wishes to discuss the proposed question. First, where do all the life activities come from? They are, as it were, latent in the body substance, the expression in some form or other of impressions received from without. Every act, of course, destroys substance, which must be replaced. Material taken from outside does this work of rebuilding, and it is of two sorts—one, which is enough like body substance to be readily changed into it and express the same activities; the other, so unlike that if it once finds way into the body in such form as to express its own latent power, it injures or destroys—is poison.

Alcohol belongs to the second class. That it injures can be readily seen in the liver, kidneys, and stomach of a drunkard, and

* Synopsis of a lecture given in Berne, the second in a series for the advancement of temperance in Switzerland.

also in more delicate changes of the elements revealed by a microscope, where the quantity taken has been even a small one. A physiological examination proves always beyond doubt that, where any appreciable quantity of alcohol has been taken, there are changes in the body substance, not always indeed wholly proportionate to the quantity taken, because the living elements have always more or less power to resist and overcome.

But I am not to deal with dangers and consequences from the use of alcohol, but with the problem of possible pleasure in existence without it. Let us see what pleasure does come from its use. While the influence of alcohol on the elements of the body is so evident and important, it is yet only as that influence touches the nerves that we are conscious of it. This becomes real to us in two ways: first, through the senses of taste and smell, as it touches the outward body; and, secondly, when it has entered into the blood and begins its chemical working in the nerve centers. How far shall we count these influences pleasurable? We are wont to count them one, but in a physiological sense they are very different, resulting from the action of very different parts of the drink taken. Wine, for instance, is made up of six elements, five of which give the taste, the sixth the fragrance of the wine. One of the five is alcohol, the only one which can not be enjoyed alone, and is never taken alone except by the man whose sense of taste has been utterly destroyed. We are not now situated as were the ancients—"*der gute Noah*," for instance—nor even as the men of the last generation, who had discovered so little of the earth's power to produce pleasure-giving substances that they were naturally delighted with and disposed to make the most of the new discovery of wine. We can take the elements of wine which do please our taste and make a better drink without alcohol. It needs only that a sufficient number of men resolve upon such a course.

But the effect of wine upon the brain and other nerve centers is that of the alcohol alone. To understand it physiologically one must remember the ordinary action of the nerves. An impression from without meets us, the nerves carry it to the nerve center, and a movement or other expression results. The movement does not, however, always accompany the sensation directly. In reading, for instance, one may indefinitely postpone any expression of received impressions; and then a single action may express a number of stored-up impressions, or again one impression may call forth a number of movements. Man has learned to in some sense measure the relation of movement to sensation—as to rapidity of movement, and as to the relative strength of the two. It is found, first, that the sharpness and certainty of sensations are modified by even small doses of alcohol, completely deadened or destroyed by large quantities. Secondly, as to the expression of sensation in motion, small doses of alcohol increase the quickness of that expression; large doses make it slower and more slow, until at last there is no expression. Thirdly, as to the movements themselves, small doses make them more rapid, but less sure of attaining the end sought; large doses tend to make movements impossible. And popular experience bears witness to the truth of these three statements, only the masses can not understand how the rapidity with which action follows impression and rapidity of action itself are increased by small doses, but decreased by larger quantities; and the friends of alcohol have claimed that the difference between small and large doses is real, not of degree, and really distinguishes the moderation of the wise man from the madness of the foolish. But science has proved that this contradiction is only apparent. The same increased rapidity of expression of a sensation is noticed when the brain is stupefied, and the greatest rapidity results when the brain is entirely separated from the other centers. Reflex action is more sudden and more rapid than brain action. So the influence of alcohol is exactly as if the brain were cut away. The man no longer stops to consider the whole situation, to make use of impressions of former experiences stored away in his brain, or weigh present obligations, and the sly saloon-keeper well understands this. The man who would engage another in a brawl or cajole a secret from him knows well how alcohol dethrones reason and loosens the tongue. And as more and more is taken, the stupefying influence reaches lower and lower, until at last even reflex action is imperfect and slow.

If this then is the influence, where is the pleasure in it? It is not my object, however, to depict the dangers and consequences from such disturbance of brain functions, but to ask only in what then consists the pleasure which alcohol brings us? The fact that so many men seek this condition, even passionately seek and value and prefer it to others, must have deep psychological ground. I will only say in passing that men differ as to the particular time of richest delight, some choosing the very beginning, others the time when sleepiness and forgetfulness have come, still others the perfectly senseless condition; but the influence of alcohol is still the same, sometimes on a smaller, sometimes on a larger portion of the nervous system. How does it increase the feeling of happiness? The body uses its powers in resisting the outside forces which act upon it. Normally, there is a balance between body and environment. If environment prevails we are discouraged; if we are able to prevail, our spirits rise and our happiness grows. And it is not for the moment only, but we compare the accumulated impressions of the powers outside of us with the powers which our brains develop, and are happy or unhappy according as we feel our superiority or otherwise. Just how much does alcohol interfere in this balance of powers? It clearly can not lessen the power of outside influences which harm us; it can as clearly not increase our own powers in so far as they enter into this conflict with the outside world—it rather makes us less skillful and able. What can it do, then? It can deceive us. It dulls our appreciation of powers outside of us until they seem so much smaller that we are sure we can conquer them, and so we gain a feeling of satisfaction. Nine tenths of those who take strong drink seek this feeling in alcohol. This is their "refreshing" at eventide, their "rest from the day's cares," their forgetfulness of sorrows; but it rests upon a deceit, and at the least trial falls into ruin. He who to-day forgets is not any stronger to-morrow, and so is constantly tempted to a new appeal to his false friend until his senses are so dulled that every duty is forgotten. His holiest interests are but shadows and mist before his eyes, and he knows nothing more but thirst for the deceitful drink. Even the defenders of alcohol at last call a halt; but they have forgotten that the first steps are much more easily undone than the later ones, when the brain has in a measure lost its power to control. They do not forget through malice, but because they have not rightly understood the physiological effect of alcohol.

And the poor drinkers say: "There is so much misery in the world, and we must have now and then a care-free hour; therefore we drink. What will you give us in place of drink?" Is the argument true? Is the future of mankind really so hopeless, and does life offer nothing to the man who refuses alcohol instead of the forgetfulness which alcohol brings? I believe that in this respect the attitude of men toward this problem has very much changed. Has not the newly awakened appreciation of Nature in this century revealed a new source of joy which our forefathers did not know? Who ever could have known formerly that a glimpse of the Alps or the raging sea could give pleasure which really makes strong and furnishes recompense for trouble and trials? Our new insight into the secrets of Nature, the general dissemination of art so that even the masses may enjoy its works, these are worth more to alleviate care than anything known of old. But it comes so slowly, some say. It takes the masses so long to acquire the power to appreciate these things. But why? Because they spend their leisure hours in seeking the stupor and forgetfulness which alcohol brings, and so have no time to discover beauty anywhere; also because so many have dulled their senses until they have no power to appreciate, and because alcohol has really made the sum of misery larger. That this is true is conclusively proved in communities where alcohol is not used at all. In Massachusetts, for instance, the most enlightened State of North America, where the question has been discussed *pro* and *con*, and the friends of alcohol have been worsted, the condition of the working class proves my statement. On a visit there I went through one of the cloth factories and was surprised when the foreman told me a certain workman wished to talk with me because he had learned I knew about microscopes. He wished to know what microscope was most in favor in Germany. I described a good one of moderate price, twenty dollars; but he said he had one of that sort and wished now a better one. On questioning him I found he really had knowledge about bacteria, for the study of which he wished his instrument; that he was president of a club of workmen who spent their leisure hours in this study. When I then looked at the homes of these workmen, with their pretty, well-tended gardens and blooming, well-dressed children, I felt clearly the different atmosphere where the father spends his spare time and money not for alcohol, but for the beautifying of his home. And can this life be less enjoyable than ours?

In Mr. Bryce's American Commonwealth he has devoted one chapter to the consideration of the pleasant character of American life, in which he calls attention to the general air of hopefulness which prevails among American people and extends also to all foreigners who visit them, through which, moreover, difficulties are lightly overcome, losses and injuries good-naturedly endured. One misses this characteristic painfully among us when one has once experienced it; it is like a new melody in the great concert of life. . . . And what says this melody? I understood it first as I saw this hopeful spirit, and I said to myself, Must mankind then be always miserable? Must they be always helpless against Nature's forces? Can they not conquer these forces, make them subservient, if they use intelligence to understand them instead of stupefying themselves? Must they pine away for lack of pleasure in a world which is so beautiful that it charms us if we lift but the corner of the veil which hides its secrets? This it is which makes me consider life without alcohol more beautiful than the other, and that is the transformation in the feeling of mankind which I await with their development.

Nothing retards this development except that we are bound by the customs of the middle ages. The conditions of the middle ages have vanished, but the habit of stupor still remains, as if, in place of the serfs and lords of old, a new man had not come who can use his manly powers. See what this inheritance of inactivity costs us. Statistics of last year show that in Switzerland every tenth man who died, died directly or indirectly from drink; that of men between forty and fifty-nine years old every sixth was killed by alcohol. You have learned how our hospitals for the insane are filled and how men are led to violence from Dr. Speyr's lecture, and you recall scenes of coarseness you have yourselves seen as the result of alcohol. You will see that a chain of coarseness is drawn about our whole life, which binds us fast on a plane of barbarity and wretchedness. Follow this chain even to yourselves. It is wound about you. . . . That here one dies of delirium tremens, there one loses his senses through alcohol, there a deed of violence is done, here a brutality perpetrated—these are all manifestations of a single great phenomenon, the bondage of mankind to a plane of rudeness in which they deaden and make useless the most precious instrument which is given them for their development; and you are sharers in the guilt so long as you do not break this chain, so long as you do not have courage to adjust your life-compass with reference to the future instead of the past.

This is the joy of the one who does not drink—the feeling of freedom from responsibility for misery, the joy of hope for the future of mankind, the increased sensitiveness to the beauty of the world; and on us, the chosen people, rest the hopes of the world for the future. We must be leaders.

UNSOLVED PROBLEMS OF SCIENCE.*

By the Most Hon. the MARQUIS OF SALISBURY, K. G., D. C. L., F. R. S.,
CHANCELLOR OF THE UNIVERSITY OF OXFORD.

MY functions are of a more complicated character than usually is assigned to the occupants of this chair. As Chancellor of the University it is my duty to tender to the British Association a hearty welcome, which it is my duty as President of the Association to accept. As President of the Association I convey, most unworthily, the voice of English science, as many worthy and illustrious presidents have done before me; but in representing the university I represent far more fittingly the learners who are longing to hear the lessons which the first teachers of English science have come as visitors to teach. I am bound to express on behalf of the university our sense of the good feeling toward that body which is the motive of this unusual arrangement; but, as far as I am personally concerned, it is attended with some embarrassing results. In presence of the high priests of science I am only a layman, and all the skill of

* Inaugural Address of the President of the British Association for the Advancement of Science.

all the chemists the association contains will not transmute a layman into any more precious kind of metal. Yet it is my hard destiny to have to address on scientific matters probably the most competent scientific audience in the world. If a country gentleman, who was also a colonel of volunteers, were by any mental aberration on the part of the commander-in-chief to be appointed to review an army corps at Aldershot, all military men would doubtless feel a deep compassion for his inevitable fate. I bespeak some spark of that divine emotion when I am attempting to discharge under similar conditions a scarcely less hopeless duty. At least, however, I have the consolation of feeling that I am free from some of the anxieties which have fallen to those who have preceded me as presidents in this city. The relations of the association and the university are those of entire sympathy and good will, as becomes common workers in the sacred cause of diffusing enlightenment and knowledge. But we must admit that it was not always so. A curious record of a very different state of feeling came to light last year in the interesting biography of Dr. Pusey, which is the posthumous work of Canon Liddon. In it is related the first visit of the association to Oxford in 1832. Mr. Keble, at that time a leader of university thought, writes indignantly to his friend to complain that the honorary degree of D. C. L. had been bestowed upon some of the most distinguished members of the association. "The Oxford doctors," he says, "have truckled sadly to the spirit of the times in receiving the hodge-podge of philosophers as they did." It is amusing, at this distance of time, to note the names of the hodge-podge of philosophers whose academical distinction so sorely vexed Mr. Keble's gentle spirit. They were Brown, Brewster, Faraday, and Dalton. When we recollect the lovable and serene character of Keble's nature, and that he was at that particular date probably the man in the university who had the greatest power over other men's minds, we can measure the distance we have traversed since that time, and the rapidity with which the converging paths of these two intellectual luminaries, the university and the association, have approximated to each other. This sally of Mr. Keble's was no passing or accidental caprice. It represented a deep-seated sentiment in this place of learning, which had its origin in historic causes, and which has only died out in our time. One potent cause of it was that both bodies were teachers of science, but did not then in any degree attach the same meaning to that word. Science with the university for many generations bore a signification different from that which belongs to it in this assembly. It represented the knowledge which alone in the middle ages was thought worthy of the name of science. It was the knowledge gained not by external observation, but by mere reflection. The student's microscope was turned inward upon the recesses of his own brain; and when the supply of facts and realities failed, as it very speedily did, the scientific imagination was not wanting to furnish to successive generations an interminable series of conflicting speculations. *That* science—science in our academical sense—had its day of rapid growth, of boundless aspiration, of enthusiastic votaries. It fascinated the rising intellect of the time, and it is said—people were not particular about figures in those days—that its attractions were at one time potent enough to gather round the university thirty thousand students, who for the sake of learning its teaching were willing to endure a life of the severest hardship. Such a state of feeling is now an archæological curiosity. The revolt against Aristotle is now some three centuries old. But the mental sciences which were supposed to rest upon his writings have retained some of their ascendency even till this day, and have only slowly and jealously admitted the rivalry of the growing sciences of observation. The subject is interesting to us, as this undecided state of feeling colored the experiences of this association at its last Oxford visit, nearly a generation later, in 1860. The warmth of the encounters which then took place have left a vivid impression on the minds of those who are old enough to have witnessed them. That much energy was on that occasion converted into heat may, I think, be inferred from the mutual distance which the two bodies have since maintained. Whereas the visit of 1832 was succeeded by another visit in fifteen years, and the visit of 1847 was succeeded by another visit in thirteen years, the year 1860 was followed by a long and dreary interval of separation, which has only now, after four-and-thirty years, been terminated. It has required the lapse of a generation to draw the curtain of oblivion over those animated scenes. It was popularly supposed that deep divergences upon questions of religion were the motive force of those high controversies. To some extent that impression was correct. But men do not always discern the motives which are really urging them, and I suspect that in many cases religious apprehensions only masked the resentment of the older learning at the appearance and claims of its younger rival. In any case, there is something worthy of note, and something that conveys encouragement, in the difference of the feeling which prevails now and the feeling that was indicated then. Few men are now influenced by the strange idea that questions of religious belief depend on the issues of physical research. Few men, whatever their creed, would now seek their geology in the books of their religion, or, on the other hand, would fancy that the laboratory or the microscope could help them to penetrate the mysteries which hang over the nature and the destiny of the soul of man. And the old learning no longer contests the share in education which is claimed by the new, or is blind to the supreme influence which natural knowledge is exercising in molding the human mind.

A study of the addresses of my learned predecessors in this office shows me that the main duty which it falls to a president to perform in his introductory address is to remind you of the salient points in the annals of science since last the association visited the town in which he is speaking. Most of them have been able to lay before you in all its interesting detail the history of the particular science of which each one of them was the eminent representative. If I were to make any such attempt I should only be telling you with very inadequate knowledge a story which is from time to time told you, as well as it can be told, by men who are competent to deal with it. It will be more suitable to my capacity if I devote the few observations I have to make to a survey not of our science but of our ignorance. We live in a small, bright oasis of knowledge, surrounded on all sides by a vast unexplored region of impenetrable mystery. From age to age the strenuous labor of successive generations wins a small strip from the desert and pushes forward the boundary of knowledge. Of such triumphs we are justly proud. It is a less attractive task—but yet it has its fascination as well as its uses—to turn our eyes to the undiscovered country which still remains to be won, to some of the stupendous problems of natural study which still defy our investigation. Instead, therefore, of recounting to you what has been done, or trying to forecast the discoveries of the future, I would rather draw your attention to the condition in which we stand toward three or four of the most important physical questions which it has been the effort of the last century to solve.

Of the scientific enigmas which still, at the end of the nineteenth century, defy solution, the nature and origin of what are called the elements is the most notable. It is not, perhaps, easy to give a precise logical reason for the feeling that the existence of our sixty-five elements is a strange anomaly and conceals some much simpler state of facts; but the conviction is irresistible. We can not conceive, on any possible doctrine of cosmogony, how these sixty-five elements came into existence. A third of them form the substance of this planet. Another third are useful, but somewhat rare. The remaining third are curiosities scattered haphazard, but very scantily, over the globe, with no other apparent function but to provide occupation for the collector and the chemist. Some of them are so like each other that only a chemist can tell them apart; others differ immeasurably from each other in every conceivable particular. In cohesion, in weight, in conductivity, in melting point, in chemical proclivities they vary in every degree. They seem to have as much relation to each other as the pebbles on a sea beach or the contents of an ancient lumber room. Whether you believe that Creation was the work of design or of inconscient law, it is equally difficult to imagine how this random collection of dissimilar materials came together. Many have been the attempts to solve this enigma, but up till now they have left it more impenetrable than before. A conviction that here was something to discover lay beneath the persistent belief in the possibility of the transmutation of other metals into gold, which brought the alchemy of the middle ages into being. When the immortal discovery of Dalton established that the atoms of each of these elements have a special weight of their own, and that consequently they combine in fixed ponderable proportions from which they never depart, it renewed the hope that some common origin of the elements was in sight. The theory was advanced that all these weights were multiples of the weight of hydrogen—in other words, that each elementary atom was only a greater or a smaller number of hydrogen atoms compacted by some strange machinery into one. The most elaborate analyses, conducted by chemists of the highest eminence—conspicuously by the illustrious Stas—were directed to the question whether there was any trace in fact of the theoretic idea that the atoms of each element consist of so many atoms or even of so many half-atoms of hydrogen. But the reply of the laboratories has always been clear and certain—that there is not in the facts the faintest foundation for such a theory.

Then came the discovery of the spectrum analysis, and men thought that with an instrument of such inconceivable delicacy we should at last find out something as to the nature of the atom. The result has been wholly disappointing. Spectrum analysis in the hands of Dr. Huggins and Mr. Lockyer and others has taught us things of which the world little expected to be told. We have been enabled to measure the speed with which clouds of blazing hydrogen course across the surface of the sun; we have learned the pace—the fabulous pace—at which the most familiar stars have been for ages approaching to or receding from our planet, without apparently affecting the proportions of the patterns which, as far as historical record goes back, they have always delineated on the evening sky. We have received some information about the elementary atoms themselves. We have learned that each sort of atom, when heated, strikes upon the ether a vibration, or set of vibrations, whose rate is all its own; and that no one atom or combination of atoms, in producing its own spectrum, encroaches even to the extent of a single line upon the spectrum that is peculiar to its neighbor. We have learned that the elements which exist in the stars, and especially in the sun, are mainly those with which we are familiar upon earth. There are a few lines in excess to which we can give no terrestrial name; and there are some still more puzzling gaps in our list. It is a great aggravation of the mystery which besets the question of the elements that, among the lines which are absent from the spectrum of the sun, those of nitrogen and oxygen stand first. Oxygen constitutes the largest portion of the solid and liquid substance of our planet, so far as we know it; and nitrogen is very far the predominant constituent of our atmosphere. If the earth is a detached bit whirled off the mass of the sun, as cosmogonists love to tell us, how comes it that in leaving the sun we cleaned him out so completely of his nitrogen and oxygen that not a trace of these gases remains behind to be discovered even by the sensitive vision of the spectroscope?

All these things the discovery of the spectrum analysis has added to our knowledge; but it has left us as ignorant as ever as to the nature of the capricious differences which separate the atoms from each other, or the cause to which those differences are due.

In the last few years the same enigma has been approached from another point of view by Prof. Mendeléeff. The periodic law which he has discovered reflects on him all the honor that can be earned by ingenious, laborious, and successful research. He has shown that this perplexing list of elements can be divided into families of about seven, speaking very roughly; that those families all resemble each other in this, that as to weight, volume, heat, and laws of combination, the members of each family are ranked among themselves in obedience to the same rule. Each family differs from the others, but each internally is constructed upon the same plan. It was a strange discovery—strangest of all in its manifest defects; for in the plan of his families there were blanks left—places not filled up because the properly constituted elements required according to his theory had not been found to fill them. For a moment their absence seemed a weakness in the professor's idea, and gave an arbitrary aspect to his scheme. But the weakness was turned into strength when, to the astonishment of the scientific world, three of the elements which were missing made their appearance in answer to his call. He had described beforehand the qualities they ought to have; and gallium, germanium, and scandium, when they were discovered shortly after the publication of his theory, were found to be duly clothed with the qualities he required in each. This remarkable confirmation has left Mendeléeff's periodic law in an unassailable position. But it has rather thickened than dissipated the mystery which hangs over the elements. The discovery of these co-ordinate families dimly points to some identical origin, without suggesting the method of their genesis or the nature of their common parentage. If they were organic beings, all our difficulties would be solved by muttering the comfortable word "evolution"—one of those indefinite words from time to time vouchsafed to humanity, which have the gift of alleviating so many perplexities and masking so many gaps in our knowledge. But the families of elementary atoms do not breed; and we can not therefore ascribe their ordered difference to accidental variations perpetuated by heredity under the influence of natural selection. The rarity of iodine, and the abundance of its sister chlorine, can not be attributed to the survival of the fittest in the struggle for existence. We can not account for the minute difference which persistently distinguishes nickel from cobalt, by ascribing it to the recent inheritance by one of them of an advantageous variation from the parent stock.

The upshot is that all these successive triumphs of research, Dalton's, Kirchhoff's, Mendeléeff's, greatly as they have added to our store of knowledge, have gone but little way to solve the problem which the elementary atoms have for centuries presented to mankind. What the atom of each element is, whether it is a movement, or a thing, or a vortex, or a point having inertia, whether there is any limit to its divisibility, and, if so, how that limit is imposed, whether the long list of elements is final, or whether any of them have any common origin, all these questions remain surrounded by a darkness as profound as ever. The dream which lured the alchemists to their tedious labors, and which may be said to have called chemistry into being, has assuredly not been realized, but it has not yet been refuted. The boundary of our knowledge in this direction remains where it was many centuries ago.

The next discussion to which I should look in order to find unsolved riddles which have hitherto defied the scrutiny of science, would be the question of what is called the ether. The ether occupies a highly anomalous position in the world of science. It may be described as a half-discovered entity. I dare not use any less pedantic word than entity to designate it, for it would be a great exaggeration of our knowledge if I were to speak of it as a body or even as a substance. When, nearly a century ago, Young and Fresnel discovered that the motions of an incandescent particle were conveyed to our eyes by undulation, it followed that between our eyes and the particle there must be something to undulate. In order to furnish that something, the notion of the ether was conceived, and for more than two generations the main, if not the only, function of the word ether has been to furnish a nominative case to the verb "to undulate." Lately, our conception of this entity has received a notable extension. One of the most brilliant of the services which Prof. Maxwell has rendered to science has been the discovery that the figure which expressed the velocity of light, also expressed the multiplier required to change the measure of static or passive electricity into that of dynamic or active electricity. The interpretation reasonably affixed to this discovery is that, as light and the electric impulse move approximately at the same rate through space, it is probable that the undulations which convey them are undulations of the same medium. And as induced electricity penetrates through everything, or nearly everything, it follows that the ether through which its undulations are propagated must pervade all space, whether empty or full, whether occupied by opaque matter or transparent matter, or by no matter at all. The attractive experiments by which the late Prof. Hertz illustrated the electric vibrations of the ether will only be alluded to by me, in order that I may express the regret deeply and generally felt that death should have terminated prematurely the scientific career which had begun with such brilliant promise and such fruitful achievements. But the mystery of the ether, though it has been made more fascinating by these discoveries, remains even more inscrutable than before. Of this all-pervading entity we know absolutely nothing except this one fact, that it can be made to undulate. Whether, outside the influence of matter on the motion of its waves, ether has any effect on matter or matter upon it, is absolutely unknown. And even its solitary function of undulating ether performs in an abnormal fashion which has caused infinite perplexity. All fluids that we know transmit any blow they have received by waves which undulate backward and forward in the path of their own advance. The ether undulates athwart the path of the wave's advance. The genius of Lord Kelvin has recently discovered what he terms a labile state of equilibrium, in which a fluid that is infinite in its extent may exist, and may undulate in this eccentric fashion without outraging the laws of mathematics. I am no mathematician, and I can not judge whether this reconciliation of the action of the ether with mechanical law is to be looked upon as a permanent solution of the question, or is only what diplomatists call a *modus vivendi*. In any case it leaves our knowledge of the ether in a very rudimentary condition. It has no known qualities except one, and that quality is in the highest degree anomalous and inscrutable. The extended conception which enables us to recognize ethereal waves in the vibrations of electricity has added infinite attraction to the study of those waves, but it carries its own difficulties with it. It is not easy to fit in the theory of electrical ether waves with the phenomena of positive and negative electricity; and as to the true significance and cause of those counteracting and complementary forces, to which we give the provisional names of negative and positive, we know about as much now as Franklin knew a century and a half ago.

I have selected the elementary atoms and the ether as two instances of the obscurity that still hangs over problems which the highest scientific intellects have been investigating for several generations. A more striking but more obvious instance still is life—animal and vegetable life—the action of an unknown force on ordinary matter. What is the mysterious impulse which is able to strike across the ordinary laws of matter, and twist them for a moment from their path? Some people demur to the use of the term "vital force" to designate this impulse. In their view the existence of such a force is negatived by the fact that chemists have been able by cunning substitutions to produce artificially the peculiar compounds which in Nature are only found in organisms that are or have been living. These compounds are produced by some living organism in the performance of the ordered series of functions proper to its brief career. To counterfeit them—as has been done in numerous cases—does not enable us to do what the vital force alone can effect—to bring the organism itself into existence, and to cause it to run its appointed course of change. This is the unknown force which continues to defy not only our imitation but our scrutiny. Biology has been exceptionally active and successful during the last half century. Its triumphs have been brilliant, and they have been rich enough not only in immediate result but in the promise of future advance. Yet they give at present no hope of penetrating the great central mystery. The progress which has been made in the study of microscopic life has been very striking, whether or not the results which are at present inferred from it can be taken as conclusive. Infinitesimal bodies found upon the roots of plants have the proud office of capturing and taming for us the free nitrogen of the air, which, if we are to live at all, we must consume and assimilate, and yet which, without the help of our microscopic ally, we could not draw for any useful purpose from the ocean of nitrogen in which we live. Microscopic bodies are convicted of causing many of the worst diseases to which flesh is heir, and the guilt of many more will probably be brought home to them in due time; and they exercise a scarcely less sinister or less potent influence on our race by the plagues with which they destroy some of the most valuable fruits of husbandry, such as the potato, the mulberry, and the vine. Almost all their power resides in the capacity of propagating their kind with infinite rapidity, and up to this time science has been more skillful in describing their ravages than in devising means to hinder them. It would be ungrateful not to mention two brilliant exceptions to this criticism. The antiseptic surgery which we owe chiefly to Lister, and the inoculation against anthrax, hydrophobia, and perhaps some other diseases, which we owe to Pasteur, must be recorded as splendid victories over the countless legions of our infinitesimal foes. Results like these are the great glory of the scientific workers of the past century. Men may, perhaps, have overrated the progress of nineteenth-century research in opening the secrets of Nature; but it is difficult to overrate the brilliant service it has rendered in ministering to the comforts and diminishing the sufferings of mankind.

If we are not able to see far into the causes and origin of life in our own day, it is not probable that we shall deal more successfully with the problem as it arose many million years ago. Yet certainly the most conspicuous event in the scientific annals of the last half century has been the publication of Mr. Darwin's work on the Origin of Species, which appeared in 1859. In some respects, in the depth of the impression which it made on scientific thought, and even on the general opinion of the world, its momentous effect can hardly be overstated. But at this distance of time it is possible to see that some of its success has been due to adventitious circumstances. It has had the chance of enlisting among its champions some of the most powerful intellects of our time, and perhaps the still happier fortune of appearing at a moment when it furnished an armory of weapons to men, who were not scientific, for use in the bitter but transitory polemics of the day. But far the largest part of its accidental advantages was to be found in the remarkable character and qualifications of its author. The equity of judgment, the simple-minded love of truth and the patient devotion to the pursuit of it through years of toil and of other conditions the most unpropitious—these things endeared to numbers of men everything that came from Charles Darwin, apart from its scientific merit or literary charm. And whatever final value may be assigned to his doctrine, nothing can ever detract from the luster shed upon it by the wealth of his knowledge and the infinite ingenuity of his resource. The intrinsic power of his theory is shown at least in this one respect, that in the department of knowledge with which it is concerned it has effected an entire revolution in the methods of research. Before his time the study of living Nature had a tendency to be merely statistical; since his time it has become predominantly historical. The consideration how any organic body came to be what it is occupies a far larger area in any inquiry now than the mere description of its actual condition; but this question was not predominant—it may almost be said to have been ignored—in the botanical and zoölogical study of sixty years ago.

Another lasting and unquestioned effect has resulted from Darwin's work. He has, as a matter of fact, disposed of the doctrine of the immutability of species. It has been mainly associated in recent days with the honored name of Agassiz, but with him has disappeared the last defender of it who could claim the attention of the world. Few now are found to doubt that animals separated by differences far exceeding those that distinguished what we know as species have yet descended from common ancestors. But there is much less agreement as to the extent to which this common descent can be assumed, or the process by which it has come about. Darwin himself believed that all animals were descended from "at most four or five progenitors"—adding that "there was grandeur in the view that life had been originally breathed by the Creator into a few forms or one." Some of his more devoted followers, like Prof. Haeckel, were prepared to go a step further and to contemplate a crystal as the probable ancestor of the whole fauna and flora of this planet.

To this extent the Darwinian theory has not effected the conquest of scientific opinion; and still less is there any unanimity in the acceptance of natural selection as the sole or even the main agent of whatever modifications may have led up to the existing forms of life. The deepest obscurity still hangs over the origin of the infinite variety of life. Two of the strongest objections to the Darwinian explanation appear still to retain all their force.

I think Lord Kelvin was the first to point out that the amount of time required by the advocates of the theory for working out the process they had imagined could not be conceded without assuming the existence of a totally different set of natural laws from those with which we are acquainted. His view was not only based on profound mechanical reasoning, but it was so plain that any layman could comprehend it. Setting aside arguments deduced from the resistance of the tides, which may be taken to transcend the lay understanding, his argument from the refrigeration of the earth requires little science to apprehend it. Everybody knows that hot things cool, and that according to their substance they take more or less time in cooling. It is evident from the increase of heat as we descend into the earth that the earth is cooling, and we know by experiment, within certain wide limits, the rate at which its substances, the matters of which it is constituted, are found to cool. It follows that we can approximately calculate how hot it was so many million years ago. But if at any time it was hotter at the surface by 50° Fahr. than it is now, life would then have been impossible upon the planet, and therefore we can without much difficulty fix a date before which organic life on earth can not have existed. Basing himself on these considerations, Lord Kelvin limited the period of organic life upon the earth to a hundred million years, and Prof. Tait in a still more penurious spirit cut that hundred down to ten. But on the other side of the account stand the claims of the geologists and biologists. They have reveled in the prodigality of the ciphers which they put at the end of the earth's hypothetical life. Long cribbed and cabined within the narrow bounds of the popular chronology, they have exulted wantonly in their new freedom. They have lavished their millions of years with the open hand of a prodigal heir indemnifying himself by present extravagance for the enforced self-denial of his youth. But it can not be gainsaid that their theories require at least all this elbow-room. If we think of that vast distance over which Darwin conducts us from the jellyfish lying on the primeval beach to man as we know him now; if we reflect that the prodigious change requisite to transform one into the other is made up of a chain of generations, each advancing by a minute variation from the form of its predecessor; and if we further reflect that these successive changes are so minute that in the course of our historical period—say three thousand years—this progressive variation has not advanced by a single step perceptible to our eyes, in respect to man or the animals and plants with which man is familiar, we shall admit that for a chain of change so vast, of which the smallest link is longer than our recorded history, the biologists are making no extravagant claim when they demand at least many hundred million years for the accomplishment of the stupendous process. Of course, if the mathematicians are right, the biologists can not have what they demand. If, for the purposes of their theory, organic life must have existed on the globe more than a hundred million years ago, it must, under the temperature then prevailing, have existed in a state of vapor. The jellyfish would have been dissipated in steam long before he had had a chance of displaying the advantageous variation which was to make him the ancestor of the human race. I see, in the eloquent discourse of one of my most recent and most distinguished predecessors in this chair, Sir Archibald Geikie, that the controversy is still alive. The mathematicians sturdily adhere to their figures, and the biologists are quite sure the mathematicians must have made a mistake. I will not get myself into the line of fire by intervening in such a controversy. But until it is adjusted the laity may be excused for returning a verdict of "not proven" upon the wider issues the Darwinian school has raised.

The other objection is best stated in the words of an illustrious disciple of Darwin, who has recently honored this city by his presence—I refer to Prof. Weismann. But in referring to him, I can not but give, in passing, a feeble expression to the universal sorrow with which in this place the news was received that Weismann's distinguished antagonist, Prof. Romanes, had been taken from us in the outset and full promise of a splendid scientific career.

The gravest objection to the doctrine of natural selection was expressed by Weismann in a paper published a few months ago, not as agreeing to the objection, but as resisting it; and therefore his language may be taken as an impartial statement of the difficulty. "We accept natural selection," he says, "not because we are able to demonstrate the process in detail, not even because we can with more or less ease imagine it, but simply because we must —because it is the only possible explanation that we can conceive. We must assume natural selection to be the principle of the explanation of the metamorphoses, because all other apparent principles of explanation fail us, and it is inconceivable that there could yet be another capable of explaining the adaptation of organisms without assuming the help of a principle of design."

There is the difficulty. We can not demonstrate the process of natural selection in detail; we can not even, with more or less ease, imagine it. It is purely hypothetical. No man, so far as we know, has ever seen it at work. An accidental variation may have been perpetuated by inheritance, and in the struggle for existence the bearer of it may have replaced, by virtue of the survival of the fittest, his less improved competitors; but, as far as we know, no man or succession of men have ever observed the whole process in any single case, and certainly no man has recorded the observation. Variation by *artificial* selection, of course, we know very well; but the intervention of the cattle breeder and the pigeon fancier is the essence of artificial selection. It is effected by their action in crossing, by their skill in bringing the right mates together to produce the progeniture they want. But in natural selection who is to supply the breeder's place? Unless the crossing is properly arranged, the new breed will never come into being. What is to secure that the two individuals of opposite sexes in the primeval forest, who had been both accidentally blessed with the same advantageous variation, shall meet, and transmit by inheritance that variation to their successors? Unless this step is made good, the modification will never get a start; and yet there is nothing to insure that step, except pure chance. The law of chances takes the place of the cattle breeder and the pigeon fancier. The biologists do well to ask for an immeasurable expanse of time, if the occasional meetings of advantageously varied couples from age to age are to provide the pedigree of modifications which unite us to our ancestor the jellyfish. Of course the struggle for existence, and the survival of the fittest, would in the long run secure the predominance of the stronger breed over the weaker. But it would be of no use in setting the improved breed going. There would not be time. No possible variation which is known to our experience, in the short time that elapses in a single life between the moment of maturity and the age of reproduction, could enable the varied individual to clear the field of all competitors, either by slaughtering or starving them out. But unless the struggle for existence took this summary and internecine character, there would be nothing but mere chance to secure that the advantageously varied bridegroom at one end of the wood should meet the bride who by a happy contingency had been advantageously varied in the same direction at the same time at the other end of the wood. It would be a mere chance if they ever knew of each other's existence—a still more unlikely chance that they should resist on both sides all temptations to a less advantageous alliance. But unless they did so, the new breed would never even begin, let alone the question of its perpetuation after it had begun. I think Prof. Weismann is justified in saying that we can not, either with more or less ease, imagine the process of natural selection.

It seems strange that a philosopher of Prof. Weismann's penetration should accept as established a hypothetical process the truth of which he admits that he can not demonstrate in detail, and the operation of which he can not even imagine. The reason that he gives seems to me instructive of the great danger scientific research is running at the present time—the acceptance of mere conjecture in the name and place of knowledge, in preference to making frankly the admission that no certain knowledge can be attained. "We accept natural selection," he says, "because we must—because it is the only possible explanation that we can conceive." As a politician, I know that argument very well. In political controversy it is sometimes said of a disputed proposal that it "holds the field," that it must be accepted because no possible alternative has been suggested. In politics there is occasionally a certain validity in the argument, for it sometimes happens that some definite course must be taken, even though no course is free from objection. But such a line of reasoning is utterly out of place in science. We are under no obligation to find a theory, if the facts will not provide a sound one. To the riddles which Nature propounds to us the profession of ignorance must constantly be our only reasonable answer. The cloud of impenetrable mystery hangs over the development and still more over the origin of life. If we strain our eyes to pierce it, with the foregone conclusion that some solution is and must be attainable, we shall only mistake for discoveries the figments of our own imagination. Prof. Weismann adds another reason for his belief in natural selection, which is certainly characteristic of the time in which we live. "It is inconceivable," he says, "that there should be another principle capable of explaining the adaptation of organisms without assuming the help of a principle of design." The whirligig of time assuredly brings its revenges.

Time was, not very long ago, when the belief in creative design was supreme. Even those who were sapping its authority were wont to pay it a formal homage, fearing to shock the public conscience by denying it. Now the revolution is so complete that a great philosopher uses it as a *reductio ad absurdum*, and prefers to believe that which can neither be demonstrated in detail nor imagined, rather than run the slightest risk of such a heresy.

I quite accept the professor's dictum that if natural selection is rejected we have no resource but to fall back on the mediate or immediate agency of a principle of design. In Oxford, at least, he will not find that argument is conclusive, nor, I believe, among scientific men in this country generally, however imposing the names of some whom he may claim for that belief. I would rather lean to the conviction that the multiplying difficulties of the mechanical theory are weakening the influence it once had acquired. I prefer to shelter myself in this matter behind the judgment of the greatest living master of natural science among us, Lord Kelvin, and to quote as my own concluding words the striking language with which he closed his address from this chair more than twenty years ago. "I have always felt," he said, "that the hypothesis of natural selection does not contain the true theory of evolution, if evolution there has been in biology. . . . I feel profoundly convinced that the argument of design has been greatly too much lost sight of in recent zoölogical speculations. Overpoweringly strong proofs of intelligent and benevolent design lie around us, and if ever perplexities, whether metaphysical or scientific, turn us away from them for a time, they come back upon us with irresistible force, showing to us through Nature the influence of a free will, and teaching us that all living things depend on one everlasting Creator and Ruler."

Last year, Garden and Forest says, the Genesee Valley Forestry Association of Rochester, N. Y., offered prizes to the children of the public schools for gathering the cocoons of caterpillars, and had encouraging success. This year, in addition to the other prizes, a special prize of ten dollars was offered to all who would bring a larger number than was brought in 1893 by any one pupil (44,900). Sixty-five pupils gained and received this prize, and five dollars each were given to the two boys who had the largest count. Eight million, eight hundred thousand and two hundred cocoons were gathered, and the city was relieved of that number of destroyers of vegetation and nuisances.

Prizes are offered by the *Revue Suisse de Photographie*, Geneva, for the best photograph of a falling drop of water. The drops are to be of distilled water, issuing from a tube, the internal and external diameters of which are measured, with no special conditions as to the size of the picture, but with preferences for something near the natural size. Three prizes of medals will be given and three honorable mentions.

MANUAL TRAINING.

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I.

THE editor of The Popular Science Monthly has always taken a warm interest in the question of manual training. On two occasions he has been kind enough to allow me to speak to his readers in the columns of the magazine. I have much valued these opportunities. The first article appeared in August, 1889, and was entitled The Spirit of Manual Training. It dealt with the general aspect of the subject, and more especially emphasized the ethical significance of well-performed action. The second article appeared in May, 1894, under the title of Cause and Effect in Education. It contained no direct reference to manual training. It was intended, however, to serve as an introduction to the two articles which the editor now asks me to write. It did this by illustrating the main proposition upon which manual training rests its educational claim, the very simple and undeniable proposition that we can only attain a rational education by setting in operation adequate causes. I am referring to these previous articles in order to avoid repetition. In the present paper it is my purpose to speak of the outward aspect of manual training, and in the succeeding paper, of its inner content.

It must be borne in mind at the very outset that manual training is not a complete and separate system of education, excluding other branches of human culture, and only administered during a definite period of boyhood. On the contrary, it is but one branch out of the many which make up the sum of education, and as such is applicable in every grade of school life. One must dismiss the idea that a manual training school is a "peculiar" institution which has parted company with the older avenues of culture, and has struck out in a new and somewhat erratic path of its own. It is quite possible that its early advocates held some such conception of its mission, but the view is certainly not shared by those who are trying to give manual training daily expression in the schools. A more modest conception prevails. Manual training is held to be a part of culture, not culture itself.

Curiously, manual training effected its entrance into the curriculum at both ends of the educational sequence—in the kindergarten and in the scientific departments of the universities. From the bottom and from the top it has been steadily pushing its way toward the center, until now the two frontiers are within plain sight of each other. The manual activities of the kindergarten, the weaving, modeling, and building, are succeeded by the sloyd of the primary school, while the technical work of the universities and scientific schools is now being preceded by the systematic wood and metal work of the manual-training high schools. The unoccupied territory lies between, in the elementary schools. It is, however, not entirely unoccupied. Already the simpler forms of wood work and clay modeling are being introduced into many of these schools, and the frontiers are disappearing.

This dual start is responsible for what would otherwise be a curious conflict of *motif* in the development of the manual training idea. The kindergarten has always in view the thought of the child. Its activities have but one purpose, and that is development. The things produced have in themselves no value whatever. The whole operation is a process. Its importance is subjective. One might, I think, sum up the ideal of the kindergarten in saying that its end is the cultivation of perception, and its method is the self-activity of the child.

It is far otherwise in the technical schools of the universities. Seldom have processes called educational been so oblivious of the material upon which they work. Men are taught to analyze iron and copper ores, because these analyses are needed in the industrial world; to survey fields and farms, because of the social necessity of emphasizing the difference between *meum* and *tuum;* to file and fit and turn, because only by such operations can machines be built; and to do a hundred other things whose end is objective. The work has regard only to itself. It is needed in the great outer world of enterprise and action. The worker is a part of the productive mechanism, and is now a means. Observe the contrast. In the kindergarten, the work was the means and the worker the end.

We thus find, at the two extremes of the educational line, parallel activities but opposite motives. So long as the frontier of the intermediate schools remained between the two, there was little conflict of ideals. Different sets of people were interested in each, and, as the interests were in both cases large, they prevented a too critical examination of the distant activity to which they were opposed. Thus became possible the spectacle of a father sacrificing himself to some industrial end, working beyond the point of fatigue, exceeding the bounds of sanity, while his children in the kindergarten were engaged in activities which were purely, though unconsciously, self-regarding; and no one appears to have found the spectacle so inconsistent as to be distressing.

But when manual training moved from its extreme positions and progressed along the line toward the center, it carried its motives with it—the educational motive upward, the technical motive downward. In the secondary schools the two have met and are in daily conflict. Sometimes this conflict of ideals is between different schools of presumably the same grade and intent. In one, manual training is followed as an educational process, and in the other as an industrial end. The outer world—if it be discriminating enough to really get at what the schools are about—sees two institutions of similar name and curriculum, and interprets the school according to the one it happens to visit. Very frequently the conflict is a civil war, having its seat in one and the same school, a part of the faculty working in one spirit and a part in the other. But most perplexing of all, one sees the conflict going on even in the same individual, the educational idea uppermost at one moment, and the love of technical perfection dominant at another. There are few teachers of manual training who do not at some time find themselves dangling between these two poles of thought.

Now I am restating these opposing motives in the development of the manual training idea at so much length and with so much emphasis because this is to-day the vital issue in the whole movement. And the restatement is the more necessary because the direct work of teaching manual training must rest for some time to come in the hands of men drawn from the artisan class rather than from the cultured classes, and is, therefore, in the greater danger of being regarded merely as the work of teaching a handicraft.

Moreover, this is only another aspect of the same issue which is now at stake in the universities. One can not move in the inner circles of collegiate life and thought without being constantly aware of the fact that the old breach between the classical party, the upholders of the humanities, and the newer faction representing the scientific and technical training, has never been closed. However pronounced the amenities of daily intercourse, the antagonism, at best, is only latent. When the wisdom and graciousness of humanity were all stored up in Latin and Greek, it was a prerequisite of culture to know these languages. It was early discovered that the act of acquisition was itself a most helpful intellectual gymnastic. The study thus came to have a dual value, as an end in itself, and as of high disciplinary power. This is undeniable. It is quite as true to-day as it was a hundred years ago when the classics were synonymous with culture. But the problem is now complicated by the necessary introduction of other considerations. The humane spirit of Greece is reflected more or less perfectly in the renascent spirit of modern times. The best of Greece and Rome is a heritage already ours. Further, those who would drink at the direct literary fountains can do so on the average far more perfectly in the admirable translations now available than in any translations they could make for themselves.

So far as the content of this literature is concerned, the human spirit may be as wise and as gracious without the study of the dead languages, as with it. The issue really hangs, then, upon the value of the discipline. This, too, is as great as ever, but it must be remembered that a discipline may be good—may, indeed, be the best at any one time—and yet with the progress of events become relatively poor. This, it seems to me, is the case with the classics. We are working for intellectual power. There was a time when the classics offered the best means of attaining this end. But such studies appeal only to a limited set of faculties. The best discipline is undeniably one which appeals to the fullest set of faculties, for this will mean the largest amount of brain development, and consequently the greatest intellectual power.

The objection which the classicists hold against our modern science culture as a substitute for the ancient languages is, I take it, that we have made this culture an end in itself, and have valued the facts above their effect upon the human spirit. So far as this objection is true it is a valid one. But the same spirit which once made the study of Latin and Greek the acknowledged means of culture is even more applicable in science. Like the content of Latin and Greek in the middle ages, the content of science at the present time is something greatly to be desired in and for itself as adding immeasurably to the wisdom and graciousness of life; while the process of gaining this content—a process which employs every sense and every faculty, and from its necessities evolves new senses and new faculties—represents a discipline of the highest possible value.

The classicists have preserved the spirit of true culture—a profound appreciation of the subjective value of learning.

The scientists have reached the right method—the employment and development of all the senses and faculties.

The proper reconciliation between these contending friends of culture is very simple. It consists in cherishing the spirit of the one and adopting the method of the other.

Now I believe that a similar reconciliation is possible as regards manual training. The great thing is the human spirit, the sum of human faculty. The end of education is the unfolding and perfecting of the spirit. All other ends are secondary to this. It is the great thing in the kindergarten, in the elementary schools, in the high schools, in the universities. It is also the great thing, and we are much too apt to forget this, in the conduct of mature life. We are working for power. We are after a certain quality in organized matter, a complexity of structure and a sensitiveness in the gray and white of the brain. We can accomplish this purpose, we can gain this power, we can evolve this quality of complexity and sensitiveness only by very definite reactions upon the organism. The self-activity of the child offers such a set of reactions. It is valuable because it means development. This should be the spirit of the work in manual training. It is the educational idea of the kindergarten. But this development is at its best the result of the most careful and accurate work, the sort of work that gives products of a high degree of perfection. This should be the method of manual training. It embodies the technical idea of the universities. With the blending of these two ideas, the *motif* of the kindergarten and the method of the technical school, we shall have the manual training school *par excellence.*

It is in this spirit that I wish to present manual training, and, though I may not myself have the requisite skill, I shall still believe it possible to show that such a training for such a purpose possesses the highest possible educational value. The *motif* belongs essentially to the inner content of manual training, but it must needs be stated in the beginning, since, like the anatomy of an animal, it determines very definitely its outer form.

In speaking of manual training, then, we speak of a branch of instruction capable in precisely the same way as English or mathematics of being represented throughout the entire course of formal education. It has so happened, however, that the fullest development of manual training has been reached in the secondary schools. So much is this the case, that when one speaks without modification of a manual training school, it is understood that a high school is meant—that is to say, a secondary school—one standing between the elementary schools on the one hand, and the higher education represented by the colleges and universities on the other.

In their organization these schools resemble the typical high school. They draw their material from the same sources and require the same entrance examinations. In the majority of them the unit course is three years. There is observable, however, a decided tendency to extend the time to four years, and to make the curriculum as complete as in the best four-year classical high schools. It is encouraging to believe that this tendency results from a growing recognition of the educational *motif* underlying manual training. In several of the larger manual training schools, and notably in the two schools in Philadelphia, a very complete fourth year of post-graduate study has already been formulated. It is probably only a question of a short time before this additional year will be included in the regular course, thus making the unit four years. Such a tendency must be regarded as highly desirable, for the work which the manual-training high schools are attempting to accomplish can scarcely be realized in less time.

The course in these high schools is a very full one. A copy of the official curriculum of the Philadelphia schools will serve as a type. It presents the outward aspect of manual training more fully and more concisely than several pages of text could possibly do. Read vertically, the curriculum shows the sequence of studies in any one department. Read horizontally, it shows the current work of any one term. (See pages 54 and 55.)

Perhaps the most notable thing about the curriculum is the amount of work which is not manual training. There are five departments in the school—the humanities, mathematics, science, drawing, and manual training. We have been proclaiming for some years past, and proclaiming from the house-tops, too, I am afraid, that these are essentially high schools, and not in even a remote sense, industrial or trade schools. Yet the discovery that such is in truth the case seems to be made independently by every visitor. The curriculum is a constant source of surprise. What are we doing with German and analytics and chemistry and political economy in a manual training school? it is asked. We are doing with them precisely what other high schools are doing with them—we are trying to make them the instruments of culture. This misapprehension is doubtless our own fault. One would expect that in new schools the nomenclature at least would be accurate. But ours is singularly inaccurate. The name of one department out of five has been chosen to designate the whole, and a branch capable of representation in all grades of school work has been made to arbitrarily stand for a given grade. In this the movement is guilty of a double inaccuracy, and it is scarcely to be wondered at that the outside world has misunderstood both the content and grade of the schools.

To be very explicit, the school day begins at nine and ends at half after two. The interval, exclusive of an intermission of half an hour, is divided into six periods, or "hours," of about fifty minutes each. As there is no school on Saturday or Sunday, this gives a total of thirty hours a week. The curriculum must be realized within these limits. During the junior and intermediate years half the time, or fifteen hours, is devoted to manual work and drawing, and the other half to the academic studies. In the senior year practically the same division holds. It hardly appears so from the curriculum, since the regular manual work, the mechanical construction, covers only six hours; but then it must be remembered that much of the science work, in chemistry and electrical engineering, is done in the laboratory, and should therefore be classed as manual work, while the surveying, being practical field work, properly comes under the same head.

Before considering the manual work in detail, it will be worth while to see what is being done in the other departments. A

CURRICULUM.

PHILADELPHIA MANUAL TRAINING SCHOOLS.

Class.	Term.	Literature, History, etc.	Hours per week.	Mathematics.	Hours per week.	Science.	Hours per week.	Drawing.	Hours per week.	Manual Training.	Hours per week.
Junior (C). First Year.	1. Fall.	Literature and composition.	5	Algebra.	5	Natural history. (Geology.)	5	Constructive. Free-hand and perspective.	3 2	Joinery. Vise work. (Chipping and filing.)	5 5
	2. Winter.	Literature and composition.	5	Algebra.	5	Natural history. (Biology.)	5	Constructive. Free-hand and design.	3 2	Joinery. Pattern-making. Vise work. (Chipping and filing.) Smithing.	3 2 3 2
	3. Spring.	Literature and composition.	5	Geometry.	5	Natural history. (Biology.)	5	Constructive. Free-hand and design.	3 2	Joinery. Pattern-making. Vise work. (Chipping, filing, fitting.) Smithing.	3 2 3 2
Intermediate (B). Second Year.	1. Fall.	Ancient history. Literature. German. Composition.	3 2 2	Geometry.	3	Physics. (Mechanics.)	5	Constructive. Free-hand and perspective.	3 2	Pattern-making. Smithing and molding.	5 5
	2. Winter.	Mediæval history. Literature. German. Composition.	3 2 2	Geometry.	3	Physics. (Heat.)	5	Constructive. Clay modeling.	3 2	Pattern-making. Joinery. Smithing. Vise work.	3 2 3 2
	3. Spring.	Mod. European hist. Literature. German. Composition.	3 2 2	Geometry.	4	Physics. (Light and sound.)	4	Constructive. Design.	3 2	Wood-carving. Parquetry. Ornamental iron work. Vise work.	3 2 3 2
Senior (A). Third Year.	1. Fall.	U. S. history. Literature. German. Composition.	3 2 3	Plane trigonometry. Algebra.	4 2	Chemistry. Electricity.	3 3	Constructive. Free-hand.	2 2	Constructive work. (Machine-tool practice.)	6
	2. Winter.	Civil government. Literature. German. Composition.	3 2 3	Analytical geometry. Trigonometry.	4 2	Chemistry. Electricity.	3 3	Constructive. Architectural.	2 2	Constructive work. (Machine-tool practice.)	6
	3. Spring.	Political economy. Literature. German. Composition.	3 2 3	Surveying. Bookkeeping.	4 2	Chemistry. Electric ty and steam engineering.	3 3	Constructive. Architectural and perspective.	2 2	Constructive work. (Machine tool practice.)	6

Curriculum. Philadelphia Manual Training Schools.—(*Continued.*)

Class.	Language and Civics.	Hours.	Mental Science.	Hours.	Manual Training.	Hours.
Fourth Year. Post-Graduate Course.	1. English.	2	1. Psychology.	2	History and principles of art.	1
	2. German.	2	2. Ethics.		*a.*—Art course: 1. Drawing. 2. Modeling. 3. Wood-carving.	11
	3. French.	2	3. Logic.		*b.*—Engineering course: 1. Mechanical drawing. 2. Mechanical construction. 3. Electrical and steam engineering.	11
	4. Politics.	2			*c.*—Course in applied chemistry: 1. Laboratory work. 2. Inorganic chemistry. 3. Organic chemistry.	11
	Mathematics.		Business Preparation.			
	1. Calculus.	2	1. Stenography.	2		
	Natural Science.		2. Bookkeeping.	1		
	1. Biology.	2	3. Telegraphy.	1		

manual training school is essentially a modern-language school. In addition to the mother tongue only one other language is studied, and that is German. The humanities include, besides these, history, literature, and economics. The juniors have a lesson in English every day. The work is very elementary. It is a practical drill in the use of language. It is as difficult as it is elementary. And the difficulty lies chiefly in the fact that the home forces do not co-operate. If the same number of people who now have a blind faith in the talismanic virtue of foreign languages as a means of culture could be made to appreciate the importance of an accurate use of our own beautiful mother tongue, we might reasonably hope for much better things. As it is, the daily lesson in English is a little oasis of how to use the tongue in a dreary desert of how not to use it. I have a friend, a shrewd man, who maintains that the national habit of lying is a direct outgrowth of our inaccurate use of English. The observation is worth considering.

The intermediates devote seven hours to the humanities. Two hours are given to German, an introduction to the grammar with easy reading and conversation, and five hours to history and literature. The two latter studies go hand in hand. For example, during the first term, while ancient history is being studied, the literature consists in a reading of Plutarch's Lives, Stories from the Iliad, and other books of ancient content. The same parallelism is followed in the succeeding terms during the study of mediæval and modern European history. The plan was adopted experimentally, but its success has now made it a settled policy. The seniors add one hour to the German and now study literature, if one may so express it, in and for its own beauty. Civics are well represented under the triple head of American history, government, and economics.

The mathematical sequence is always an open problem. A contemporary philosopher who has written much that is wise and helpful as regards education contends that modern schools make entirely too much of mathematics. He holds that there are promising minds quite disqualified for such studies, and that it is unwise to force them along these lines as well as unfair to judge of their ability by reference to so alien a standard. His heresy seems likely to spread. I should agree with him were mathematics an isolated subject; but when one comes to think about it, we are dealing here not with a separate branch of study, but with an element common to all branches of exact study—the quantitative element. It is the expression of an acknowledged master that we have only so much science as we have mathematics. To omit or curtail such a study would be to omit or curtail exactitude of thought, and at the present juncture in human affairs we can ill afford such a result. The manual training school, therefore, as an exponent of modern education does well, I think, to lay full stress on mathematics, and I am only sorry that its work in this direction can not be more thorough and more extensive than it is. The present sequence begins with algebra and runs through geometry, plane trigonometry, and higher algebra to analytics. Up to the senior year the work is restricted to pure mathematics, but at this point two practical applications are introduced—surveying and bookkeeping. The sequence is much the same at all of the larger manual training schools. An inversion of the earlier part is now contemplated at the Northeast School. We propose to start with geometry. The motive for this somewhat unusual sequence is a serious one. Of the several branches of lower mathematics geometry makes the most direct appeal to the imagination of a child, and it does this by reason of its graphic method of presentation. Its concreteness makes it easier than either algebra or arithmetic. Algebra is nearly always difficult, and can best be introduced, it seems to me, after a boy has gained a somewhat more lively conception of quantity and relation than that given by the study of arithmetic. Such a sequence holds, I am told, in a number of English schools.

As it is essentially a modern-language and mathematical school, so also is the manual training school essentially a scientific school. The daily curriculum always includes a science lesson. The work begins with natural history (geology, botany, and zoölogy), progresses through physics, and ends with chemistry and electrical engineering. The two latter branches have long been conducted on the laboratory method, and the best schools count electrical and chemical laboratories a necessary part of their equipment. It is only very recently, however, that physics and natural history have been made laboratory courses, and the usage is still far from general. It has long been desired, but in most schools practical and financial difficulties have stood in the way. These are being gradually overcome and the science work is being put upon a sound foundation. It requires some little executive ability and considerable in the way of material resources to provide laboratory facilities for several hundred boys in so many different branches, and the schools which fail in this respect must not be criticised too severely. In our own school, for example, with a capacity for about three hundred and fifty boys, we have for the manual work of all sorts, seven laboratories or work rooms in addition to two large drawing rooms and the dynamo and engine rooms, and we find the accommodation quite insufficient. The character of the science work is in all cases elementary. So little is done in this line in the lower schools that the high schools have to begin practically at the very foundation. The time devoted to science does, however, permit some material progress to be made. It will be noticed that the work proceeds with marked singleness of purpose. Except in the senior year only one branch is taken up in a term, and this concentration of effort leads to results. Even in the senior year, but two branches are taken up during the entire year, and these are too closely related to lead to a dissipation of thought.

Half the day is gone. The occupations are classed as academic, but they have all involved some form of manual work—writing, drawing, measuring, adjusting instruments, handling chemical apparatus, dissecting. The manual part has been apparently incidental, but its exercise of the senses and its reactions upon the brain have been no less certain. Let us keep this in mind, for no gulf is crossed in passing to the other half of the day, to the more obvious manual occupations of the drawing room and workshop.

A school of three hundred boys requires two teachers of drawing—one for the constructive drawing and one for the art work. They are kept very busy, too, for the classes must be as small as practicable and the lesson comes every day. The work in constructive drawing is continuous, and is kept in close touch with the workshops. It begins with the simplest sort of mechanical drawing, such as a right-lined exercise for the wood shop done in pencil on manilla paper, and passes by easy stages to the more difficult and complicated mechanical drawings of the senior year —gear wheels, bridge trusses, valve movements, and the like. The work in constructive drawing is held to be a very important part of the manual training course. Its value is both for its direct bearing upon all mechanical problems and for the discipline it involves in intelligence and accuracy. It may properly be made a branch of applied mathematics, and as such has a very large thought content in addition to its manual requirements. The art work is more varied. It includes free-hand and perspective drawing, design, clay modeling, and the simpler forms of architectural draughting, as the drawing of floor plans, cross-sections, and front and side elevations. A manual training school can not be made an art school, or indeed the school of any specialty, for this would be fatal to its broader purpose of giving the faculties such general training that an intelligent choice of occupation may afterward be made. Nevertheless, the introduction to such work as it is possible to give has led in a number of cases to successful careers in architecture and kindred arts.

We have now arrived, by a somewhat circuitous path it is true, at the department which differentiates the manual training school from other high schools—at the manual training itself. This slow approach has been justified, I hope, by its success in placing the manual training work in proper relation to the rest of the curriculum, and this residue in proper relation to it. A manual training school is a unit, and as such every part of its curriculum is integral.

The boy just entering the school—he is commonly about fourteen or a little over—begins at once to work in wood and metal. He has five hours a week of each. It is found better to work in double periods, to save loss of time in putting on and off the aprons, washing hands, and so on, so that in reality he has six hours one week and four hours the next. It is a pleasant sight to see twenty-five bright little fellows at work in the wood shop. There is an air of serious earnestness about them and a sense of being all alive that promises a great deal for the future. Each has a workbench of his own and a full set of carpenter's tools at his hand. He begins by learning the use of the tools and the simpler operations of sawing and planing. When this is accomplished the first exercise is taken up. It is a simple parallelopipedon; but each face must be smooth and true, each angle exactly a right angle, and each dimension accurate. There is more in the work than appears at first glance, and few of the little workmen escape spoiling one or two pieces before they fashion an exercise that will bear the rigid examination of the teacher. The next exercise involves chiseling and is a little more difficult. Then come joints of various sorts, framing and nailing exercises, boxes and drawers. About a dozen exercises are finished in the joinery department during the first year. The rest of the wood work is in pattern-making and starts with the opening of the second term at New Year. This requires greater nicety of touch, and involves lathe work in turning as well as the use of the simple hand tools. Four or five patterns are made during the first year. As far as possible each one brings out some new principle and is made a trifle more difficult than its predecessor. The work requires not a little patience and perseverance, for no pieces are accepted which show either inaccurate dimensions or careless workmanship. These two departments comprise the wood work of the year.

Meanwhile the metal work has also been progressing. Each boy has his bench with its vise and accompanying tools, chisels and files, calipers, and rules. The work of the first term consists entirely of chipping and filing. The rough blanks of cast iron have approximately the form of the finished exercise, but they are larger in all their dimensions and their faces are just as they come from the molding sand. To dress them down to the right dimensions, to make the faces smooth and true, the angles right, and later to fit the pieces together so that no line of light shall be visible when they are held up in front of a window or no jamming or friction noticeable when they are taken apart—all this requires nice workmanship, the sort that comes only when we put a great deal of effort into it. It is exacting work and must not be carried too far, or the little workers grow discouraged. Smithing is also begun during the first year. With the opening of the second term the vise work is reduced to three hours a week, and the two hours thus gained are given to smithing. The first exercises are very simple, mere bars of given dimensions, and are done in lead before they are attempted in iron. The use of the tools and the proper way of handling the pieces may thus be learned more leisurely than is possible with red-hot metal. The anvil chorus is here given every day, the little Vulcans half masters and half mastered in the new set of conditions attendant upon the glowing forges. They are taught to draw the metal, to upset, to weld, to forge, and in general to go through all the typical smithing operations. The work is decidedly picturesque. It introduces a new element, that of time, for the metal must be fashioned while it is hot, and makes therefore a new demand upon the worker—he must needs be alert as well as painstaking.

The majority of schools do not follow quite this sequence in their manual work. It is customary to make the joinery and vise work of the first term extend uninterruptedly throughout the rest of the junior year. The plan of making the joinery alternate with pattern-making and the vise work with smithing has been introduced at the Northeast School for a double reason. The vise work, by its very nature, is slow and rather monotonous. It seems to us unwise to dull the boy's interest in his work at the very outset, by setting him tasks which weary him out of proportion to their advantage. Moreover, there is a distinct technical loss in completing the vise work during the first year. It must be taken up again in the constructive work of the seniors, and the year's interval without practice means that some time must be devoted to regaining the lost skill. By extending the vise work over the junior and intermediate years no such gap occurs, and we hope for increased efficiency in the senior shop work. The alternation in the wood work is not so necessary, but even here there is a certain gain in the variety of occupation, and no loss in the way of dissipation of energy.

This plan has only been in operation for the one year, so that its full effects are not yet open to study. Such results as are before us favor its continuance.

Let us pass now to the second or intermediate year. The work begins, as in the junior year, with but two subjects. In wood it is pattern-making, and in metal smithing and molding. Each has five hours a week. The pattern-making is a continuation of the work already started, and includes problems of increasing difficulty. The metal work opens with molding. Lead is used for making the castings on account of its low fusing point. It would not be practicable in schools of this grade to operate a cupola furnace and cast in iron. The same principles are illustrated in the use of lead. When this part of the course is completed the work in smithing is resumed. In the latter terms there is the same bifurcation in the wood and metal work as in the junior year. The pattern-making now occupies but three hours a week, and in the last term gives place to wood-carving. Each boy makes either a complete panel himself or executes a part of the carving on some larger project, such as a chair or chest. The thirty-six hours given to the subject do not permit any very elaborate undertakings. The remaining two hours in wood work are devoted to the construction of some finished project in joinery, such as a shutter or door or staircase, and to the putting together of a panel in parquetry. Smithing and vise work alternate during the second term of this year, and in the third term the smithing gives place to ornamental iron work. No formal exercises are introduced, for the previous work in smithing has served the purpose. The ornamental work is entirely in the shape of finished projects, such as grills, electroliers, lamps, andirons, brackets, and the like. Some of these are of considerable beauty. As with the wood-carving, the limited time does not permit very elaborate accomplishment. I place a high value, however, on both of these lines of work. They are technically admirable. They have a large subjective value, and they do not a little toward the cultivation of the æsthetic sense.

In the senior year the manual work shows entire singleness of purpose. It is somewhat technical in character. The machine shop devoted to it is equipped with machine lathes, drill, planer, shaper, and vises. It has quite the appearance of being ready for serious work. The early part of the year is given to a series of formal exercises—turning straight and tapering cylinders, cutting right and left screw threads, shaping irregular parts of mechanisms, drilling, fitting, and going through the manifold operations required in machine construction. In the latter part of the year a series of mechanical projects is undertaken. These vary from year to year, and are simple or elaborate according to the capacity of the group of boys constructing them. They include such mechanisms as steam engines, centrifugal pumps, force pumps, overhead carriers, screw propellers, dynamos, and motors. The finished projects have the advantage over simple exercises of requiring a nice interchangeability, and giving splendid practice in the assemblage of parts. At the end of the year the total amount of work done is not very large. It looks, indeed, almost insignificant in comparison with the elaborate mechanism needed for its production. It will bear examination, however, and it has involved many operations and many principles.

The output of work in the manual department represents two classes—formal exercises and finished projects. The first are almost as abstract as a problem in geometry. They are numbered, labeled, and graded. They have the flavor of the schoolroom about them. The second are more concrete. They represent intrinsic worth in addition to the lesson they have taught. They have, however, no industrial value. They are never sold. They remain the property of the school, lending their beauty to the furnishing of the building, and also serving as an example and incentive to succeeding classes. They have as high an educational value as the more formal exercises, for they are carefully chosen and embody principles which are quite as general. In the early days—that is to say, some eight years ago—when manual training was less secure in its educational position than now, I used to be much afraid of anything which betokened a value apart from the little workmen themselves. The production of finished articles seemed to indicate the shop rather than the school. This was the cause of my distrust. But now my feeling is different. I begin to set a higher value upon these completed projects. I see that it is possible to make an object of beauty, and even of utility, and get quite as deep a lesson out of the operation as if the object were ugly and useless. One may require the same careful workmanship, the same strict regard for dimensions, and may bring into play the same set of muscles in the one as in the other. In addition, there is the advantage of a keener interest. More work is done, and it is done, I believe, in a livelier and happier spirit. It is quite possible that the boy himself places a higher value upon the project than upon the process, but no harm is done. It does not change their relative values. I am disposed to believe, too, that the more unconscious the spirit in which a boy works the finer will be his results. It is not necessary to be forever suggesting to him that he is being educated. It is quite enough if we older people keep that in mind. The boy himself had much better be engaged with the activities through which we propose to educate him. When one has been teaching for some years—let us say for seven, so that I may speak from experience—one comes to value increasingly the quality of unconsciousness. The machinery of education ought to be kept strictly out of sight. The child nature is at its best when it is spontaneous. The post-graduate course is still tentative. The chief feature in the present plan is the elective character of the manual work. Three courses are offered—in art, engineering, and chemistry. It is possible that, with the incorporation of the fourth year into the undergraduate curriculum, groups of parallel studies will be made elective.

I have been trying to tell, in a very plain and unvarnished way, just what we do at a manual training school. In the next paper I hope to tell why we do it, and, having done it, what it leads to.

THE SWISS WATCH SCHOOLS.

By THEODORE B. WILLSON.

ONE need not be specially interested in watchmaking in order to be fascinated with what he will see of watches and watch work in Switzerland.

The great number of jewelers' shops in the cities, displaying watches in every conceivable form and setting—as eight-day watches, watches in pencils, studs, cane-heads, bracelets, rings, etc.—will be sure to make him loiter fascinated in front of each window he passes. For minute and ingenious work the Swiss outdo the world. Indeed, to what an extent the Swiss are furnishing the world with its pocket time may be guessed from the estimated exports in that line, which are now said to exceed twenty million dollars annually, and this figure can hardly include that unknown amount of such wares bought to some extent by almost every tourist as a present or a souvenir. In almost every European country the watches offered for sale are in large part Swiss. The only rival of the Swiss watch is the American, and even here, despite our development of the industry and high tariffs, the smaller patterns are chiefly Swiss.

The writer was greatly interested in this nation of watchmakers, and gave some attention, during a recent visit to that country, to the Swiss methods of making watchmakers, as well as of making and marketing watches.

The Écoles d'Horlogerie—schools of watchmaking—are under the municipal management in Switzerland precisely as are our common schools. Special permission must be obtained by any one desiring to visit either the watch or the common schools. There are watchmaking schools at Geneva, Neufchâtel, Chaux-de-Fond, Locle, Bienne, Ste. Imier, and Porentruy.

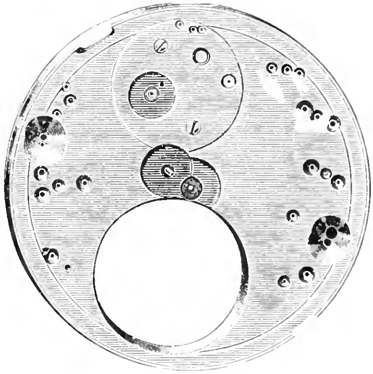


Fig. 1.—Plate.

The idea of going to school to learn to make watches would strike an American schoolboy as queer enough. Doubtless many of them who find the arithmetic and geography and grammar to go rather heavily, but who are fond nevertheless of seeing "the wheels go round," would think it a blessed existence to study nothing at school except these wheels, how to make them, and make them go round. But the reality loses the novelty and charm with which the American schoolboy might invest it long before the slow, thorough, exacting work is done which entitles the Swiss boy to graduate an accredited watchmaker.

The school the writer visited is the extensive one at Geneva. Being provided with the requisite permission, and escorted by an "alumnus" of the institution, he was shown every courtesy and afforded every opportunity to observe.

One is first ushered into the beginners' room. To enter, a boy must be at least fourteen. He will first be introduced to a wood-turning lathe and set at turning tool handles. He will be kept at this from eight days to several weeks, according to aptitude. Then he will be advanced to the work of filing and shaping screw-drivers and similar tools. These, and all other tools which he may afterward make, will be his own. Being in course of time to some extent provided with tools, he will undertake making a large wooden pattern of a watch frame perhaps as large as a dining plate. After he has learned just how this frame is to be shaped, he is given a ready-cut one of brass of the ordinary size, and he begins drilling the holes for the wheels and screws (Fig. 1). All along the masters stand over him and instruct him. The circular pieces of brass which are put into his hands here he will go on with, and when the watch is completed that, too, will be his own.

He is then taught to make other fine tools, and to finish the frame, ready to receive the wheels.

Then he will leave the first room, and pass up into one where he is taught to fit the stem-winding parts, and to do other fine cutting and filing by hand, to make watches that will strike the hour, minute, etc., for which class of work the Swiss are so famous. One can readily conceive how exceedingly minute and exact such workmanship must be, particularly on the minute snail—that is, the guide which permits and arrests the striking, so that, in addition to the hour and the quarter, the very minute shall be sounded.

The master in this room had been thirty-eight years in that office, directing, inspecting, criticising, and it was interesting to

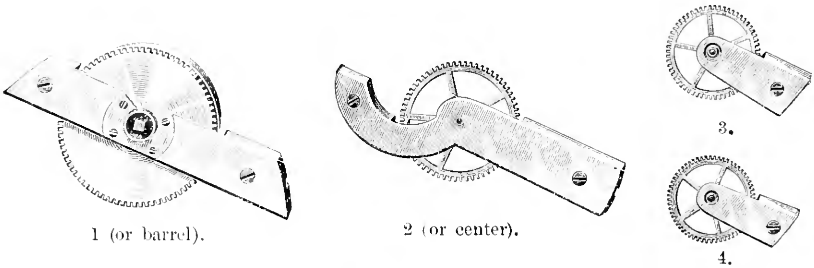

1 (or barrel). 2 (or center). 3. 4.

Fig. 2.—Wheels of Train.

observe that his eyesight was still perfect, a fact which tends to confirm the statement sometimes made that it is rare to find a working jeweler an inmate of an eye infirmary.

When the student has mastered the work on these fine file-dressed parts, he is ready to pass on into the train room—i. e., the room in which the wheels are cut. Here he will be taught how to handle the beautiful little machines which cut the cogs. Some of them are so fine that they can be adjusted to cut twenty-four hundred cogs on one small wheel.

In this room are to be seen large working models of watch movements, perfect watches in every respect though large as a saucer, which enable the student to study very important matters of the angles of cogs, the bearing and adjustment of the matched parts, etc. Many of the numerous jewelry shops over the city have these mammoth watch movements running in the windows as a means of engaging the attention of the passer-by of mechanical tastes.

The next step upward is into the escapement room, where those steel parts that constitute the escapement—the scape-wheel, lever, and balance—are cut (see Figs. 4, 5, 6).

The essential difference between the American manner of making a watch and the Swiss is brought to mind in the course of your stay in this room. Take the lever in illustration. The American manufacturer cares little how a lever looks, provided only it serves its purpose properly. The Swiss workman, however, must needs dress down the lever until it shall have a delicacy and comeliness all its own. The difference between a Swiss and an ordinary American lever has been likened to that between an antelope and a bear (compare Figs. 3 and 5).

Fig. 3.—An American Lever.

Having remained in the escapement room long enough to master the principles and the practice required for making those delicate and critical parts the boy, or rather young man—for he has added several years to his age by this time—is ready to enter the last or timing room. Here he learns to do the very fine work which makes a watch a fine timekeeper. Without this work a watch may run a little faster when wound up tight than when partly run down. It will often run a little faster in the cold than in the warm pocket. It may not keep quite the same time when hung up that it does when lying down.

To get rid of all these imperfections requires very careful, patient, and skillful work. It will suffice for the ordinary reader if we give but a few suggestions as to the manner of procedure.

The tendency of a watch to vary by reason of the varying pressure of the mainspring is overcome by means of the hairspring. Experimentation has proved that if certain peculiar

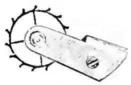


Fig. 4.—Scape-wheel.

Fig. 5.—Swiss Lever.

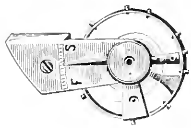


Fig. 6.—Balance.

curves and inclinations are given to portions of the hairspring it will compel the balance to beat equal time for a longer or shorter swing. What these curves are the student learns from drawings which he follows as closely as he can, and then proceeds on the "cut and try" principle. Timing for heat and cold is a simpler matter, and is accomplished by adjusting the screws on the balance. Every respectable balance is made, by means of a combination of brass and steel hoops, to adjust itself more or less accurately in changes of temperature. But to bring about great accuracy in this respect requires much patience and experimentation. Then comes the adjustment for changing positions. If a watch runs a little faster lying down, the bearing affected by that position must be made a little coarser. Here the "cut and try" method must again be patiently applied.

At length, when the young man can get his watches so that they will not vary more than two and a half seconds a day, whether cold or warm, and no matter how many times they are changed in position, he is entitled to a certificate from the astronomical observatory where the watches are tested, that he is a competent watchmaker.

In the United States men or women or boys learn to run, perhaps, one little machine in a large factory, which cuts or polishes one small part, and do not try or need to understand the whole trade of watchmaking. But in Switzerland the man who makes a watch or any part of it is a watchmaker always, although he will sooner or later decide what part of watchmaking he prefers, and manufacturers will then bring him just that work to do. One man may make a business of merely polishing screw-heads, another does nothing but time watches, etc. There are no large watch factories in Switzerland, such as we have, but all their myriads of watches have been passed round through the little shops of these watchmakers before they have got all their parts and are ready for the pocket.

One of the consequences of the Swiss mode of making a watch is, that its every part is made for that particular watch. This is true not only of the movement but the case. Cases are not interchangeable as with us. Each case is made to fit a given movement, and will not, unless by sheer accident, fit another. A dealer requiring watches must give his order—say for a dozen—to the watchmaker who is making a specialty of the earlier parts of the work, and then the dealer must follow his order on until it is completed and cased.

After observing the thoroughness of the training of which the Swiss workman has the advantage, one hardly wonders that the Swiss are able to produce at once the quantity and quality of watch work for which they are justly famed.

Concerning famines in India, which were formerly often terrible, Mr. C. E. D. Black, in his third decennial report of progress, does not deny the existence of "habitually starving millions," but maintains that, taking the country as a whole, it can always furnish food enough for all its inhabitants. The difficulty has hitherto been in moving the surplus of one or other locality to the spots where deficiency exists. This has now been mainly overcome, and the days when grain was selling at famine prices in one district and rotting on the ground in another are gone. Registered meteorological observations indicate that, as a rule, two thirds of India are affected each year, either favorably or prejudicially, differently from the other third. There is no record of a universal failure of crops, any more than of a general harvest above the average.

THE COBRA AND OTHER SERPENTS.

By G. R. O'REILLY,
CORRESPONDING MEMBER OF THE ROYAL ZOÖLOGICAL SOCIETY OF IRELAND.

DURING a three years' residence in southern Africa cobras and other snakes were my pets and most intimate companions. They occupied my bedroom; they sunned themselves in my windows; they coiled themselves in my armchair and on my study table, and made themselves quite at home among my book shelves and bric-a-brac. Baby cobras were born into my hands, and adult cobras accompanied me coiled in my pocket whenever I went out to take sly observations, through a binocular glass, of the movements of their brothers and sisters still free among the rocks and bushes of plain or hillside.

Above all his peers in the ophidian kingdom, the royal cobra claimed my chief attention. His beauty, the web of Oriental romance in which his name is intertwined, and the dreadful destruction of human life with which he is credited, make him to all of us an exceedingly interesting animal. As man alone stands up and walks erect, the acknowledged king among living things, so it is only the cobra of all the reptile kind that raises himself perpendicularly from the ground and expands his neck as if in fancied pride of his power to dispute with humanity the supremacy over animal life. Year after year, over the whole of southern Asia, but especially in the Indian Peninsula, a vast multitude of men, women, and children fall victims to his deadly fangs. If each year, within the bounds of British India alone, a town of ten thousand inhabitants were to be utterly depopulated by a painful form of death, and if this calamity had been constantly recurring, as far back through the centuries as history has record of, who would not be filled with commiseration for a people so afflicted? And yet in that same country this number of human beings is annually carried off by the bite of poisonous serpents, and the world looks for it as a matter of course. Thus the dreaded cholera itself is not a greater destroyer of human life, as it is but an occasional visitant. As the cobra is blamed for nearly all this appalling mortality, we need not seek out further reason for giving him the title of "king of deadly serpents."

Sir Joseph Fayrer, in his magnificent Thanatophidia of India, gives us copious information regarding his poison, its terrible work among the Indian peoples, and the various methods of counteracting its effects; and more recently our own able inquirer, Dr. Weir Mitchell, has given us its analysis. But as regards the story of cobra life itself, cobra capabilities, and cobra idiosyncrasies, we are still at the mercy of Pliny and his successors. From book to book the old yarns of his fondness for milk and his susceptibility to music are handed down as heirlooms, and will continue to find believers until writing naturalists keep living cobras at their elbows.

Under the general name "cobra" are included several species, differing little in general appearance. They are found all over southern Asia and throughout the entire continent of Africa. In India, *Naja tripudians* is common; in North Africa, *Naja haja;* and in South Africa, *Sepedon hæmachates.* In the other continents no true cobra exists. They are all hooded snakes, and

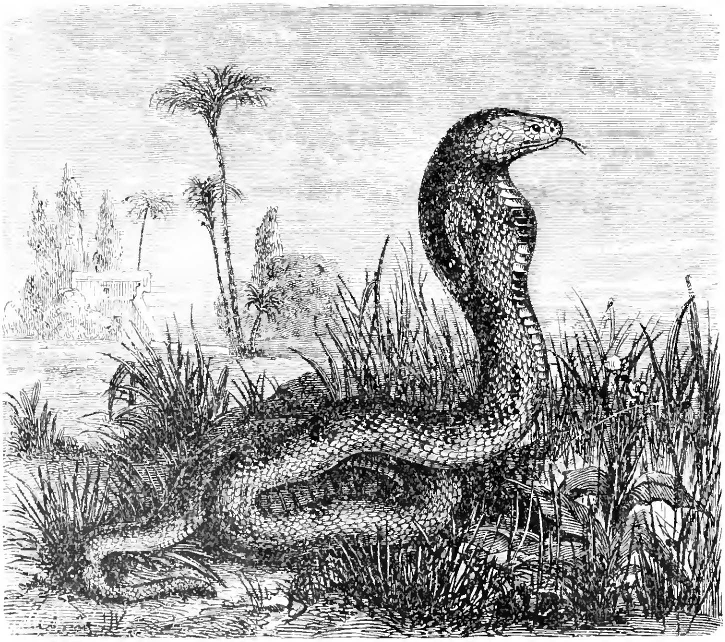


Fig. 1.—Cobra di Capello (*Naja tripudians*).

all exceedingly venomous. In color they vary much; some are yellow, some are brown, others black—while in general all are banded more or less distinctly with regular light and dark rings. They are usually about four feet in length and two inches in diameter, but can attain to six feet.

All terrestrial deadly serpents may be divided into two groups —the *Viperidæ*, which have the head covered with small, irregular scales; and the *Elapidæ*, which have it covered with large, regularly disposed plates. Taking the rattlesnake as the representative of the *Viperidæ* and the cobra of the *Elapidæ*, it will be instructive to note some of the differences between these two famous poisoners. The head in the rattler is broad and flat and the neck very thin; its body increases in diameter toward the middle and gradually tapers off to the tail. In the cobra the head, neck, and body are of the same thickness until the tail commences. In the rattlesnake the eyes have a vertical pupil, like a cat's; in the cobra the pupil is round. In the rattlesnake the fangs are long, well curved, very movable, thin, and with the end of the poison duct coming out almost in the same line with the point of the fang; in the cobra the fang is very short, slightly curved, scarcely movable, strong, and with the end of the poison duct coming out at a large angle with the point. In disposition the rattler is much more sluggish and not nearly so timorous as the cobra. To meet an assailant, the rattlesnake will arrange himself coiled carefully, like a spring, in a horizontal position; while the cobra prepares no coil, but raises himself up on high perpendicular from the ground. As to the manner of securing their prey, the rattlesnake is like a cat: he lies in wait for it in a suitable locality, and then springs on it unawares, generally waiting till its death struggles have ceased before swallowing it. The cobra, on the contrary, hunts up his victims, pursues them like a dog, and swallows them alive when caught. There is also, as Dr. Weir Mitchell has shown, a marked chemical variance between their poisons.

All these differences are, as a rule, applicable to their respective classes; and it is worthy of mention that in the several points enumerated, excepting as regards the poison arrangements, the *Viperidæ* agree with the true boas and the *Elapidæ* with the colubrine or common harmless snakes. So it will be understood that the cobra is rather a cousin to the black snake than to the rattler.

In searching for his prey, he glides about without anything remarkable in his appearance to denote that he is a cobra; but, when excited by fear or anger, he raises his head and from one third to one half of his body perpendicularly from the ground, while the remainder is gathered beneath into a coil of support. At the same time the upper ribs, from the head downward for five or six inches or more, spread themselves out laterally, carrying the skin with them, thus making of his neck part a thin, flattened oval disk four or five inches broad. This wide flatness of the neck is called the "hood," and above it the head appears pointing horizontally to the front. His disposition is so extremely nervous and timid that he will strike at a moving adversary long before he comes near enough to reach him with effect. If you stand before a cobra thus erect and alarmed, and move alternately your left and right hands up and down, he will strike repeatedly to the left and right, following your motions, bringing his head and neck flat on the ground each time, and at every stroke drawing closer to you. In striking thus he hisses audibly and instantly reassumes his erect position, and thus he continues to act as long as danger menaces or a safe avenue of escape does not present itself. This turning to the left and right after one's movements and striking downward is the so-called "dancing," which superficial observers have attributed to the power of music. Even after a slight acquaintance with snake dancing I began to suspect that music had nothing to do with it. Before long I was convinced on the subject.

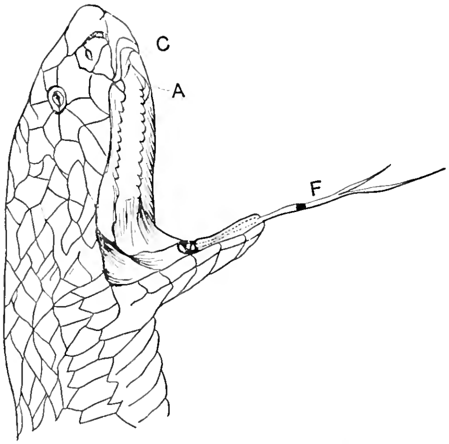


Fig. 2.—Head of the Cobra, showing Gape of the Mouth.

It happened, I believe, in 1877, that Sir Bartle Frere, Governor of the British dominions in South Africa, when on his way eastward to settle some troubles preceding the outbreak of the war with the southern Kafirs, paid a visit to my collection at Grahamstown. He arrived unexpectedly and found me on my knees with my sleeves rolled up, washing out my floor, for it was impossible to get a servant to enter the room. Seeing there all the snakes of the country living before him, he was intensely interested, and at once singled out the cobra as an old acquaintance, for he had spent much of his life in India. Many things he told me of Indian snake-charming; but when I made the cobras dance, faint away as if dead, and by a touch return them to life again, he asked in some astonishment how it happened that I did so without the aid of music. I explained the "dancing" as the natural tactics of the cobra in defense and attack, and the fainting and recovery as consequences of an extremely nervous and overexcitable temperament. But my visitor clung to his old opinion, saying that my belief that they never really danced to the music was opposed to the teachings of natural history and to the experience of every one who had lived in India.

Next day, when the astute Sir Bartle was on his way to the frontier to charm the turbulent chiefs with diplomacy, I invited a flute-player to charm my snakes. I myself went into the room to note results and sat down in my usual place among my pets, leaving the musician outside in the hall, so placed that the snakes could not see him. He played his sweetest tunes. The "Last Rose of Summer," "Annie Laurie," and "Home, Sweet home" had no effect, so I called to him to play something quick and lively. Accordingly, he gave us "Pop goes the Weasel," "Miss McLeod's Reel," and "The White Cockade"; but never a snake moved. I then invited him inside, but the result was the same, the flute was a failure. Next day I tried the violin. The performer again sat outside, but all his efforts were useless; both quick and slow music were alike lost upon them. On my invitation he came in and sat still a few moments preparatory to commencing afresh. He soon thought himself an Orpheus; for as he began playing, the cobras stood up on the floor. "Aha!" said he, "see that!" However, believing that they were only alarmed at the quick movements of his arm, I stood over between him and them, thus cutting off their view, whereupon they showed that their fears were quieted by gently lowering themselves to the floor.

On the table was a glass-fronted wooden box in which was a large puff adder. I got the musician to sit close opposite to this and play his loudest, but the snake never showed the slightest sign. Then at my request he went round behind the cage and let one end of the violin rest on the top of it. At first he played the higher notes, and the snake showed no sign; but when he touched the deep bass chords the animal swelled himself up and began to blow as if alarmed. Thus from the instrument resting on the wood of the top the vibration was conveyed to the whole box, and the snake *felt* it throughout his entire body where he lay in contact with it, in the very same way that I myself *felt* it when I laid my hand upon it.

Many trials were made with other instruments, but always with the same results, viz., 1. Music from an unseen performer had no effect whatever. 2. If the performer were seen, any noticeable movements of his would alarm the snakes, but in exactly the same way as if he made no noise at all. 3. They gave signs of disturbance when the vibration, especially of bass sounds, was communicated to the material on which they lay.

Thus was proved not only that cobras do *not* dance to music, but that, far from being charmed with the melody, the poor animal is only *frightened* at the movements of the musician, and that the apparent dancing and bowing are only so many half-hearted attempts to strike at the performer or some one moving in his vicinity. Furthermore, I was led to the conclusion that *snakes can not hear any sound* with sufficient distinctness to determine their acts, unless it is so great as to cause objects in contact with their skin to *vibrate sensibly to the touch,* and that even then they can only be said to feel *the sound's effects.*

At the present moment as I write there is on the table before me a glass-fronted box in which are some of our common garter snakes. On the top of this box is placed an alarm clock. Now, when the alarm goes off in this position the garters always move a little, for the vibration is communicated to the wood and can be plainly felt with the finger-tips; but when the clock is on the cloth-covered table close by and not in contact with the wood on which they lie, they never give a sign of having heard it.

Fig. 3.—Skull of Poisonous Snake.

When I lived on the island of Trinidad, I had a large collection of West Indian and South American serpents which it was necessary to feed on animals of many different species. It was always noticeable that neither boa, viper elaps, nor coluber ever gave the slightest heed to the voices of these, while at *sight* of the *moving* prey they manifested very evident signs of recognition. Snakes as a rule are very timid, and as I often had visitors at feeding time, it used to be necessary to warn them that any stirring about of arms or legs would be sure to delay the dinner; but no restriction was ever needed to be placed on conversation, except that the turning of the head was forbidden—each had to talk straight to his front, no matter whom he addressed.

During the past four or five years I have hunted extensively over the woods of northern South America, from the Bay of Panama to the Delta of the Orinoco, often alone, sometimes with others. Now, when I had company it would be frequently necessary to call on their assistance in capturing some of the long, swift-running snakes. If one of these were discovered some distance off, resting close by a fallen tree, it was my method to go round to the other side of the old trunk and come up unseen, often within a yard of him. There I would shout directions to my friends, sometimes at the top of my voice, where to post themselves and where to head him off. This shouting never caused the snake to stir; but should I show the rim of my hat moving up even a hand's breadth over the intervening trunk, he would be off like a racehorse; for the eyes of a serpent, though dull to note form and color, are exceedingly quick to detect motion.

Now, it may be mentioned that snakes have no external ears, their heads being entirely covered, like the rest of the body, with a tough and scaly skin. Yet in how far they may be able to detect sound waves in the air, as a general evidence of something unusual, with the delicate tip of the restless bifid tongue, is a subject that requires investigation; but that they can appreciate music in this or any other way is, as has been said above, absolutely untrue. How such an idea as that snakes are fond of music and milk ever gained credence among men calling themselves scientists only shows how few really scientific observers we have.

Men sometimes do strange things for the love of knowledge, and it was this love which caused me to live on such intimate terms with my scaly but graceful and gentle friends. I took them into my house to live with me. This was the best way to know them perfectly; and the more I knew them, the more I knew that they did not know me. I soon found out that neither cobras nor any other serpents can ever become capable of attachment, nor even distinguish one person from another, nor distinguish a man from any large animal, nor even distinguish a man from a tree stump until he gives evidence of his life by motion.

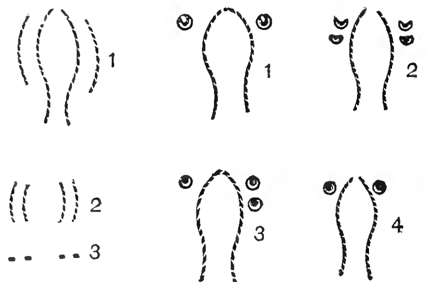
During my stay in South Africa I had many cobras, all of which I captured myself, except those born in my collection. Now, cobra-hunting is a very dangerous kind of sport, and had I known of its perils otherwise than by experience it is probable that I never would have attempted it. The first two or three I caught safely, and nothing particular occurred to show that there was a special danger in taking *them* which did not equally exist in the capture of other deadly snakes. But I found out that in three important particulars of defense and attack the cobra differs from all his fellow-poisoners: 1. He rarely opens his mouth when striking, but actually gives a deadly blow without biting. 2. He bites deliberately when he is in a state of apparent death from muscular contortion, and will then hang on like a bulldog, the venom flowing all the time into the wounds in which his fangs are buried, until he drops off at last from sheer exhaustion. 3. He can squirt the venom from his fangs into a person's eyes, and thus blind him for a time at least.

I had often heard of the "spuugh slang," or *spitting snake*, but, looking at the thing from a *too human* point of view—as we are all, unfortunately, overmuch inclined to do when considering animals—I could not understand how a snake, not having fleshy lips and a bulky tongue, could be said *to spit* as we understand the word; and hence could no more believe in spitting snakes than I would in unicorns or fiery dragons. However, the result proved that oftentimes a story which on the face of it seems impossible has, after all, a certain fund of truth lying concealed somewhere at bottom.

One day, being alone in the bush, I saw a cobra banded with black and white. He was in an open glade, gliding about through the herbage, delaying a little perhaps for an opportunity to get at some birds that were chattering and hopping about on the branches of a thorny, yellow-blossomed acacia. The sun was blazing down fiercely on him as, with half-distended hood held close to the ground, he slowly passed through the leaves and flowers. For a few minutes I watched his movements through my binocular glass; but, fearing he might notice me and escape into some hole, I picked up my six-foot hunting stick and rushed toward him, intending to press his head to the ground with it, and then take him by the neck with my hand. He saw me coming, and, like a valiant warrior that knew his power, he faced round and stood erect with expanded hood and quivering tongue ready to receive me. His bright black eyes sparkled with energetic defiance, and every fiber of his being was electrified with excitement. While I was yet ten feet away he struck toward me with such force that the impetus carried him flat to the ground. In trying to get my stick across his neck he dodged it, and it came instead across the middle of his body. At this moment he was between me and the sun, with about five feet between his face and mine. I looked into his eyes and held him down firmly. His rage seemed redoubled. He leaned backward to make a more vigorous dash at me, and as he struck forward the mouth partially opened, and two tiny streams of venom shot from his fangs as from a syringe, one of them catching me on the face just beneath the eye. Had it gone a little higher up I should have been blinded for months, and perhaps had my sight permanently injured. This unexpected attack made me hasten the capture; so, getting his neck pressed down to the ground with the stick, I soon had him grasped in my hand just behind the head in such a way that he couldn't possibly turn to bite me—which he made every effort to do for some minutes afterward. Taking him home with much satisfaction I made him thereafter my fellow-lodger. While living in his cage, I observed him many times squirt the venom from his fangs against the glass of its front. Thenceforth my doubts about spitting snakes were removed.

In order to understand how it is that he can eject the venom as high as a person's face—which we never hear of the viperine snakes doing—it is well to consider carefully the approximate difference in the fangs of the cobra and those of the rattler. Snakes of the class *Viperidæ* can and do under certain circumstances eject the venom somewhat similarly, but their methods of striking are more deliberate usually, and instead of the first and more copious discharge being thus lost, as is often the case with the cobra, it is, on the contrary, injected into the veins of enemy or prey. This premature squirting out of the fluid in the cobra is not to be taken as a voluntary act. It has been mentioned above that he is so excitable that he will strike at a moving adversary long before he comes near enough to actually hit his object; and it is in striking thus from a distance that the poison-controlling muscles act as if he really struck something, and the distended gland gives way to the pressure, forcing the contents, which in other circumstances would have been injected into the flesh, to go instead in two thin streams through the air.

In regard to the manner in which the cobra strikes with effect without opening his mouth, it is necessary to state that while the fangs of the rattlesnake and other viperine snakes are laid horizontally back along the upper jaw when the mouth is closed and only erected when the mouth is widely open, it is not so in the cobra; but whether his mouth be open or shut, his fangs are always partially or wholly erect, and not in the true sense of the word reclinable. Now, usually when he strikes at an adversary his mouth does not open as does the rattlesnake's, but he simply hits with his chin the point he aims at, so that, the mouth being still shut and the fangs during the act coming out over and slightly below the lower lip, these protruding fang-points penetrate the skin, while at the same instant the potent venom is squirted with force through these natural hypodermic syringes into the superficial punctures. Hence it is that on the bare legs of the natives this so-called "bite" is usually fatal, while the slight protection of trousers saves the European from danger.



Harmless. Venomous.

Fig. 4.—Punctures or Bites of Snakes.

As to the third peculiarity of this snake—viz., the fit of temporary lockjaw into which he is liable to fall and the terribly prolonged and real bite he can give when in that state—the account of an interesting adventure I once had will give a fitting illustration. It was a most wonderful exhibition of reptilian hysterics.

In the midst of a South African summer, when the springs and rivers are dried up, the snakes congregate in unusual numbers around the dams which are built by the colonists to store up in the ravines for themselves and their cattle the drinking supply afforded during the rains by the mountain torrents. At one of these reservoirs in Currie's Kloof, near Grahamstown, I had secured several fine serpents, and was not surprised therefore when one afternoon, as I was sitting by an upper window, I saw a boy running from that direction toward the house, shouting as loud as he could bawl, "A snake, sir—a monster snake!"

I ran downstairs and found him breathless and pale with excitement at the door. The snake, he said, was fully twenty feet long. It had pursued him a little way through the bushes and then disappeared in a hole in the bank. "Aha!" thought I, "this must be the great Natal python I have heard so much about but never seen." With some doubts, nevertheless, about his being twenty feet long—for people usually imagine snakes which scare them to be much bigger than they really are—I took my snake-hunting stick and set off at once to make the capture. On arriving at the pond, which was overhung by poplar trees and nearly dried up, the boy led me across a long stretch of hardened, sun-baked mud to a point in the great earthen dam about twenty feet over from the water's edge, where there was a hole, the mouth of which he had carefully stopped up with a good-sized stone before coming to tell me. This I removed, and as the snake was not there ready to bolt out as I expected, I ran in the stick to dislodge him. This, however, had no effect. So, taking a piece of stout paling wire, I made with it a hook to the end of my snake stick. Running in this arrangement, I managed to catch it in his folds, a proceeding which he resented by slipping it off and by many angry hissings which sounded all the louder from being uttered in the confinement of his subterranean retreat. After several failures he was at last hauled out. "A cobra, by Jove!" said I, as he raised himself up erect with expanded hood on the hard-mud expanse between me and the water. As his head when standing thus was fully eighteen inches high, it was no easy matter to press his neck to the ground so as to catch him safely with my hand. Without at all hurting him I made several attempts to get his neck down, and not without some nervousness, for he might at any moment send a charge of venom into my face. This playing him with the stick to get him into proper position so aroused and alarmed him that at last, overcome by his own excitement, he suddenly collapsed, falling over on his side and lying there motionless, half on his back, with his mouth fixedly open and stiff as if in death. His whole body was rigidly contorted and as unbending as a dried stick. "Ah, you've killed him!" shouted the boy from the top of the dam, whither he had retreated for safety. However, as I had seen this manifestation before, I knew that it was only a hysterical fit. Warning the lad not to approach, I picked up the apparently lifeless snake by the tail-tip and flung him off from me to a distance of five or six feet. As soon as he touched the ground all his life was active again. Up he stood instantly with expanded hood as before, the black eyes glistening angrily and the forked tongue running out quiveringly from the closed mouth as if daring me to approach. A slight touch with the stick on the neck caused him to fall down in a second fit similar to that from which he had just recovered. There he lay again, to all appearance dead, with every muscle rigid and his jaws fixed in a partial gape as if sudden dissolution had prevented their closing. Seeing in this an opportunity of giving the boy a lesson against the danger of meddling with seemingly dead cobras, I called him down to my side. "Do you think that snake is dead?" said I.

"Yes," he replied, "I believe he is surely dead now; you must have given him his death wound getting him out of the hole."

"Well, my boy, I'll show you whether he is dead or not; and from what you will see, take warning that a bite from an apparently dead cobra like this is a thousand times worse than if he were to strike you perchance in the usual way as you pass through the bush."

So saying, I put the end of the stick into the stiff, gaping jaws. Instantly they closed on it like a vise until the fangs were buried in the wood. Then, lifting him up till his tail swung clear of the ground, I bade the boy count the time by his watch, to see how long he would retain his bulldog-like grip. The body was gathered into unbending curves; but, as the minutes went by, these straightened out, commencing at the tail and advancing gradually upward to within three inches of the head. At last this too became limber, the jaws unloosened, and he dropped to the ground as the boy exclaimed: "Well, I'll be blamed! that bulldog snake held on for eight minutes and a half." As he lay now exhausted on the ground he put out his tongue at intervals, but never otherwise moved until I attempted to put the stick across his neck preparatory to taking him, when he stood up for fight as fresh as ever. However, I was nimble with the stick, and by its aid got my fingers round his throat just as he went into his third fit, and held his deadly jaws open again ready to close upon anything they should chance upon. Thus open-mouthed he remained as I carried him homeward, but recovered from his fit as he was placed in his cage.

The fears of the boy had quadrupled the animal's size, but still for a cobra he was large, being considerably over four feet in length. Having him now at home to practice on, I soon learned how to throw him into this state of temporary lockjaw, and instantly restore him again at pleasure. And besides this, I became certain that the ordinary wounds made by a cobra are nothing compared with his terrible bite when in this strange condition.

Among my collection I had at first six cobras. They used to eat frogs and toads, pursuing them around the room as a dog would a rat, seizing them by whatever part they could catch hold of, and swallowing them down whole and alive. After a time the family increased, for one Saturday night an old lady cobra surprised me by depositing on the dressing table a number of living young ones about as thick as a large cigarette and seven inches long. In these little snakelings the instinct of self-defense was born; for, before they were a minute old, they stood up erect, ready to strike like their parents. They were provided with poison, too, but could not expand their hoods till they were a week older.

Dear, pretty, little venomous babies!—infant criminals of the reptile kind—they had no more knowledge of nor affection for their mamma than if she were an old tree root or something else inanimate lying in their way and troublesome to be climbed over. Nor would the mother take the slightest notice of her interesting family. Indeed, some of them she never saw at all. Most probably she didn't know that they were any relations of hers, or she would have shown them some little attention.

REDONDA AND ITS PHOSPHATES.

By FRED W. MORSE.

REDONDA is a small island lying between Nevis and Montserrat, in that cordon, commonly called the Windward Islands, which keeps the Caribbean Sea apart from the Atlantic Ocean. It was discovered by Columbus, who named it after an old Spanish cathedral instead of a saint, as he did so many of the smaller West Indies. Some authors, however, claim that Redonda means round, and that it was applied because of the domelike appearance of the island.

In the summer of 1890 the writer had the good fortune to spend a week in the company of Prof. Charles H. Hitchcock on the rock —for rock it is and little else. But the rock contains phosphates, which fact explains our visit to such an out-of-the-way place. I call the island out of the way, because, after being invited by Prof. Hitchcock to accompany him there, we could find no account of it, excepting a casual mention in books on the West Indies. From these brief descriptions the opinion was formed that it was an uninhabited and almost inaccessible rock, furnishing a home only for sea birds. We knew that phosphates were mined there, because we had received specimens from cargoes shipped to this country, but those did not enlighten us with regard to the mode of life upon the rock, and it was with some misgivings that we made our arrangements for a midsummer trip to the torrid zone, with the prospect of roughing it under a tropical sun.

The island was reached by taking the steamship Bermuda, which makes the rounds of the Windward Islands, going to Montserrat and there re-embarking in a small sloop which served as the means of communication between Redonda and the outside world. The sloop was chartered by the phosphate company, and made trips, whenever required, to Montserrat and St. Kitts for mails and supplies. The former island is about fourteen miles away and in plain sight, while the latter is thirty miles distant, but it is the nearest cable office.

The Bermuda first touched at St. Kitts, and to reach Montserrat it was necessary to pass within four miles of Redonda, and it was with great interest that we watched for it to appear. Approached from the northwest, it presented the appearance of two rounded hillocks, one much higher and broader than the other. No trees could be seen and no signs of life, but some small white objects on the southwest side near the sea and some more halfway toward the summit were thought to be houses.

A sail of three hours in the sloop carried us from Montserrat to the island, which we reached just as the sun was setting on the last evening in June. Viewed from the south, the larger peak only of the island could be seen, and this gave it a domelike yet one-sided appearance, owing to the western side being steeper than the eastern.

A nearer approach to the island showed that it rose from the sea with vertical walls to the height of several hundred feet, with the highest cliffs on the western side. At the southern end was a plateau, back of which rose the domelike peak. At the foot of the western cliffs was a narrow beach covered with large bowlders fallen from above, and here a small pier projected into the sea. As we approached the pier, a boat manned by two negroes put off to meet us, with a strongly built man with pleasant face and brown beard and dressed in white linen sitting in the stern. The man proved to be Captain H——, the superintendent of the mine, who welcomed us to Redonda and transferred us with our luggage to the shore.

The beach was only a few yards in width, and above us towered the cliffs, over five hundred feet high. Groups of men stood on their brink, looking down at us and appearing like silhouettes against the clear sky. Not far from the wharf the cliffs were broken down by a steep, narrow gorge. The ascent to the plateau above was up this gorge, and was accomplished upon an aërial tramway.

Two stout, heavy wire cables were stretched up the gorge and firmly anchored at both ends. Upon each cable ran a trolley, from which was suspended a large iron bucket. To each trolley was attached the end of a light yet strong wire cable, which passed over a set of heavy pulleys at the top of the cliff, thus causing one bucket to ascend as the other descended. When passengers or freight were to be raised, the bucket at the top of the cliff was filled with water from a tank, and the lighter load at the bottom was quickly drawn up. The speed was regulated by means of brakes applied to the pulleys.

The main cables were eight hundred feet long, and the load was raised to the height of five hundred and twenty-five feet above the beach. In places the wires ran at a height of sixty feet above the uneven surface of the gorge.

We were invited to get into the bucket which was at the foot. Captain H—— stood upon the edge, clinging to the trolley, and we rapidly glided up between the steep walls of the gorge, from whose rocky sides peered round cactus plants like heads of gnomes and several strange shrubs threw down aërial roots as though in a vain effort to reach the thin soil at the bottom. On gaining the landing at the top we were received by the workmen drawn up in two lines, bowing and murmuring, "Good ebenin, massa," past whom we were conducted up the slope a hundred yards to the superintendent's house. The dwelling and office were really two separate buildings joined together by a wide veranda between them and along their front. This arrangement made them seem like one house in a climate where doors and windows are unnecessary. The buildings had been brought there framed and ready for putting together, and were small cottages with two rooms and with roofs of corrugated iron. We were met at the house by Mrs. H—— and her young daughter Dorothea, who, with the captain, were the sole white inhabitants of the island. A small black boy called Chalmers showed us to our room, where we prepared for dinner. By this time the short twilight of the tropics had been succeeded by darkness, and when we returned to the dining room with its bright light we could hardly believe that we were upon an almost inaccessible rock in the Caribbean Sea.

The next morning, just before daybreak, while yet dark as night in the room, we were awakened by the cries of the sea birds, which made their homes by the hundreds in crevices and niches of the cliffs. Very soon a bell rang in front of the house to awaken the workmen in the huts below us. A tropical dawn is as abrupt as a tropical twilight, and by the time we were dressed and on the veranda the sun was coming up out of the sea and sending its beams in long lines of brightness over the waters.

The trade wind, with its steady, powerful breath, made the morning delightfully cool, and as we stood looking at the sea far below us, as smooth apparently as a lake, it was difficult to realize that it was the middle of summer in the tropics.

The workmen were now filing past the house on their way to the mine at the northern end of the island. The bookkeeper, an intelligent colored man, stood at the corner of the veranda and, as each man passed, took his name and checked it in a time book. If a workman failed to have his name checked in this manner he forfeited his day's wages.

The early hours of the morning were devoted to an examination of the phosphate mine, under the guidance of Captain H——. The path to the mine led us along the eastern slope of the island to the northern face of the main peak, where a wide and deep ravine separated us from the smaller peak. The distance from the house to the mine was about three fourths of a mile. The path was very steep in places as it ascended toward the summit in order to avoid a deep gorge, and sometimes so narrow that a misstep would give one a bad fall down the slope.

The phosphate occurred in the form of a cement filling the crevices among the masses of volcanic rock of which the island consists. In places it would be in sheets of the thickness of one's finger between the bowlders, and in others pockets would be filled with several tons. It could be seen cropping out all along the path, but the mining was at that time carried on at the north end for convenience in shipping.

The mining was done by negroes, and both men and boys were employed in the work. The men were engaged in blasting the overlying rock and breaking up the mass of phosphate underneath, while the boys cleaned the phosphate from the gangue and carried it in baskets upon their heads to a wire tramway, by which it was taken to the pile of dressed mineral awaiting shipment. Boys were also engaged in picking out the mineral from small surface pockets wherever a few pounds might be obtained.

The gangue was thrown down the gorge between the two peaks into the sea. While we were there a large bowlder was rolled over for our benefit. It went bounding from ledge to ledge, leaping a hundred feet at a bound, shot over a precipice and struck upon a rock with a loud report, finally splashing into the water. Great quantities of dust were formed by the blasting and digging, and caused much discomfort to the workmen by particles of it getting into their eyes.

The cleaned rock was piled at the head of a gorge which had been broken through the cliffs on the northwestern side of the island. Down this gorge and extending out about fifty yards into the sea was stretched another wire tramway, twelve hundred feet in length, by which the phosphate was loaded into lighters to be transferred from the shore to the ship. The usual anchorage was on the leeward or western side of the island, about four hundred yards from the shore, though deep water extended to within fifty yards of the cliffs.

The phosphate differed in its appearance from any other rock phosphate which I have ever seen. The prevailing color of a pile of dressed mineral was grayish brown, but many lumps were observed of chocolate and ferruginous shades, and many more mottled and streaked with all three; the light-colored variety sometimes shaded to milk-white. The appearance was generally earthy, except with the white variety, which was translucent and resembled flint or opal. The structure was partially oölitic, with many minute cavities, which were usually lined with a white coating. The grayish-brown and chocolate varieties were also frequently amygdaloidal, and the latter kind yielded a few specimens which were beautifully inlaid with ovoidal forms as large as coffee grains, of a lighter brown than the surrounding mass. Most of the phosphate was amorphous; but occasionally the surfaces of hollows or cavities in the pockets and of crevices or seams in the gangue would be covered with the opal-like variety in botryoidal forms of varying sizes, from that of a mustard seed to that of a currant.

The composition of the mineral is that of a hydrated phosphate of aluminum and iron, with a variable amount of silica and other insoluble matter. The commercial article was guaranteed to contain thirty-five per cent of phosphoric anhydride, while the purest specimens yielded about forty-two per cent. Scarcely more than a trace of lime has been found in any specimen.

By the time at which we had concluded our examination of the mine the sun had become very hot, and we returned to the house, where we spent the middle of the day in the shade of the veranda. Perched up there, six hundred feet above the sea, with the water almost beneath us, we enjoyed a view as novel as it was interesting. The air seemed cool, although out on the rocks the heat was scorching in its intensity. The sea, so far below us, looked like a lake just rippled by the breeze. To the east could be seen the low, cloudlike outline of Antigua. Directly in front of us, to the south, lay Montserrat, its nearest headland seeming but a few miles away, and having a white ledge near the sea which resembled the sail of a sloop rounding the point. Once a cloud spun down from the sky in the form of a funnel, and, touching the sea, formed for an instant a waterspout, but there was not enough volume to last. A steamship plowed its way toward Montserrat, and to us, in our rocky eyrie, appeared like a toy. The sea was the same, and yet different every minute.

On the rocks about the house were also objects to attract the attention. Lizards, both brown and green, ran over the ledges and among the cactus, which grew in large masses on the slope below the veranda, while above them might almost always be seen a tiny hawk hovering in the air, looking very much like a martin with its dark-blue back and white belly, but betraying its identity by its movements. Bright green humming birds poised themselves before the red and yellow blossoms of the cactus, and a little insect-eater, in sober brown with a ruby patch on its head, searched busily among the plants.

Several sheep and goats, two dogs, some hens, two peacocks, and a white cat comprised the domestic animals of this Crusoe-like home. From time to time the sheep and goats had become wild and had taken to the almost inaccessible parts of the cliffs and gorges, where it was exciting sport to pursue them.

After lunch, when the sun had begun to descend toward the west, Captain H—— took us down to the plateau below the house to look at the quarters occupied by the workmen. The buildings consisted of two long sheds with close shutters instead of glass windows, and contained for furniture nothing but a tier of bunks, or rather shelves, of rough boards along the walls. Each man furnished his own bedding, which was seldom more than a rude cushion for a pillow. This pillow, together with his other personal belongings, he kept in a box which served him for a trunk.

Near the buildings were ovens where their baking was done by one of their number who served as cook. Their fare was very simple, consisting of bread and salt beef. The foremen and skilled workmen occupied two smaller houses, but lived in the same manner. Water for drinking was obtained by catching the rain on large inclined surfaces of corrugated iron, and collecting it in reservoirs. Such a reservoir was built at each end of the island for the use of the men, and the superintendent's dwelling was provided with capacious tanks connected with the roof.

We were on Redonda just at the time of the full moon, and there was something about the beauty of a moonlight night on that rock which can not be put in words. The sea sparkled with silver gleams as we looked down upon it. Montserrat's rugged outline could be dimly seen, with lights twinkling here and there on its hillsides. Below us the workmen could be heard singing and dancing to the sound of a tambourine. After the hot glare of the daytime everything seemed to be enjoying the delightful coolness of the trade wind. Indeed, so cool was it that it caused me great surprise to find the thermometer registering seventy-eight degrees.

The second morning we descended to the beach by means of the tramway, and at Captain H——'s suggestion I stood upon the edge of the bucket and clung to the trolley. It was exhilarating to glide swiftly down through space, with the cliffs close beside us and the beach far below, yet it was with a breath of relief that I sprang from the bucket to the ground when we had reached the end of the wire.

For a distance of about fifty yards the beach had been cleared of bowlders, and room thus secured for two or three small buildings, the pier, and woodpile. The wood was all brought from Montserrat aboard the sloop. An engine and pump raised water from the sea to the cliffs above, to serve as ballast for the buckets of the tramway whenever passengers or goods were to be taken up.

Entering a boat manned by two negroes, we were rowed along the western side of the island from one end to the other. The cliffs on this side showed a beautiful system of stratification, consisting of alternate layers of solid trap rock and coarse volcanic sand extending from the sea up the whole face. These strata were not horizontal, but in the form of broad arches, the largest of which could only be compared to the rainbow for magnificence of extent. In one place was to be seen a fault, where the upward pressure which formed the arches had caused one to break and the trap rock had been forced upward through three other strata. At the southwest side of the island the sea was gradually washing out the lowest stratum of sand, leaving low arched caverns like the entrances to vaults.

At several points about the island masses of rock resembling the pinnacles and buttresses of a Gothic cathedral appeared to have been thrust up by the upheaval which had caused the bending of the strata. Rude, arched openings extended into them or through them, and one cavern at the north end, nearly forty feet in height, seemed the portal to the very center of the rock. The sea dashed into this opening with a loud noise, and, as an unusually large wave thundered against the innermost walls, a jet of water gushed outward from a small blow-hole in the western cliff, about forty yards from the mouth of the cavern and at a man's height above the sea.

The colors of the cliffs were various shades of gray and ferruginous. The smaller of the two peaks was of a light ferruginous, while the main peak was grayish white.

Perched upon the rocks, and sitting in rows along the gunwales of the lighters, were hundreds of birds. Terns were the most numerous, and were apparently limited to two species which congregated in different parts of the cliff. A black and white species chose the western side, while a blue species, resembling in color a blue pigeon, built its nests on the southern. The nests were mere bunches of grass and feathers, and were so carelessly placed on the shelves of rock that both eggs and young were often found on the beach. Ducks with black bodies and white heads were plentiful, and frigate birds with wide-spreading wings sailed overhead, reminding me of our osprey or fishhawk.

The sea around Redonda was very clear, and Captain H—— gave us an opportunity to look through a water glass. The instrument consisted of a long, narrow box, open at one end, and closed at the other by a piece of plain glass. The box was slung over the side of the boat, with the glass end submerged; and on putting one's face at the open end a new world was revealed below the surface. From two to five fathoms below us the rocks were covered with sponges and corals, and strange fishes swam calmly among them. One large fish was a beautiful creation of purple and silver, and there were many of the red and gold fish so often seen in an aquarium. These latter were the principal food fish of the region. The anchors and chains to which the tram wires were moored were covered with a dense growth of seaweed, which looked very pretty in the sunlight streaming down through the water.

The third day was spent upon the eastern side of the island and upon the summit. Two gorges ran down the slope, beginning nearly at the top. One was covered over much of its surface with fragments of whitish rock, and ended in a cliff a hundred feet in height. The other was the widest and steepest gorge about the island, and extended to the sea; however, it was impracticable of ascent, because of its steepness and its situation on the windward side of the island. The sea was steadily carving away the slope, and had made a deep bay with cliffs on either side three hundred feet high.

The climb from the cliffs at the edge of the island to the summit was very fatiguing on account of the steep ascent. In shaded spots among the rocks beautiful gold and silver ferns grew abundantly, and there were occasional holes where rain had settled which afforded water for the wild goats and sheep. Almost at the summit was the remnant of a deposit of guano. The deposit was never a large one, but it led to the discovery of the mineral phosphate. A few air plants, a species of *Tillandsia*, clung to the projections of the rocks and formed almost the sole vegetation at the extreme summit. The apex did not consist of a solid mass of rock, but was a pile of huge bowlders without the phosphatic cement of the lower slopes. Looking down the almost vertical western wall, it seemed as though one could leap into the sea one thousand feet below. From this point could be seen Nevis, to the north and near by; while in the distance was St. Kitts with its cloud-capped Mount Misery.

One of the drawbacks to exploring the island was a variety of cactus which the workmen spoke of as "suckers." It resembled the prickly pear in form and had a yellow blossom. Its joints or sections were thickly covered with thorns or spines, which were from three fourths of an inch to an inch and a half in length and barbed at the tip. The joints were easily broken off, and clung to anything upon which their spines could catch. The animals about the place were almost always seen with from one to a half dozen of these "suckers" clinging to them. When a barbed spine became imbedded in the flesh it produced a sore unless removed at once, and it was usually necessary to cut it out in order to remove it. The phosphatic soil and hot sun seemed peculiarly fitted to its growth, and it formed the principal vegetation of the eastern slope. Ordinary domesticated plants of the temperate zone rushed to a speedy maturity under the same conditions.

The remainder of our stay was spent in collecting and preparing specimens of the phosphate, and also of the plants and animals. The negroes brought us many lizards and some big land crabs, and were especially requested to procure us some centipeds and an iguana which were said to be occasionally seen among the rocks. They failed, however, to bring us any during our stay, though subsequently an iguana was sent to Prof. Hitchcock by Captain H——.

The glorious Fourth came while we were there, and Captain H—— favored us in the evening with a display of signal fires and rockets. The compliment was highly appreciated by us, and also by the workmen, who sent up a vigorous shout from their quarters below as each rocket went off.

On Sunday morning, after breakfast, the workmen were summoned by the bell to meet in front of the house and answer to their names. In order to have better control over his men, Captain H—— had devised the arrangement of dividing a man's weekly wages into seven portions instead of six, and obliging him to report at roll call on Sunday or forfeit his weekly earnings. This method put them on their good behavior during this day as well as the others, whereas they had previously claimed Sunday as their own in which to do as they pleased. It was an interesting sight to see the line of black faces, varying in intelligence from refinement to brutishness. The foremen and skilled workmen were dressed in neat white shirts and trousers, serge or linen coats, and polished shoes, and had bright, strong features. Nearly all the men had changed their working garb of shirt and overalls for clean shirts and trousers, and had their usually bare feet covered with shoes, to which they seemed painfully unaccustomed.

As the roll was called I was astonished to hear the names Michael and Patrick coupled with Sweeny and Burke, names very familiar to my ears, but there responded to by men with shining, ebony faces. On inquiry I learned that these men belonged in Montserrat, which was settled over a century ago by Irish refugees, whose family names had descended through their slaves to these miners.

The men were mostly procured from Montserrat and St. Martin's, and were engaged for a term of three months, at the expiration of which they were at liberty to go home if they chose, or were discharged if no longer needed.

On that Sunday there were one hundred and one people on the island, of whom five only were white. However, this proportion of black to white was no greater than in the neighboring islands.

In the afternoon, while taking a nap, I was awakened by what I vaguely thought to be the thunder of a coming storm; but it proved to be Chalmers trying to drive a goat off the iron roof, to which it had sprung from the steep incline behind the house. Though it was now the beginning of the hurricane season, the weather was calm and fine during our whole stay in the tropics.

On Monday the brigantine Foley arrived for a cargo of phosphate, and we went to the lookout west of the house to see her drop anchor. We were at least six hundred feet above the sea, and as the vessel lay in the shelter of the cliff she looked like a boy's ship floating on a pond. The wind was blowing briskly at the time, but the island afforded a perfect shelter against it, and the calm area could be seen extending like a shadow over the sea for half a mile. This protection from the wind also caused it to be almost unbearably hot down on the beach in the afternoon sun, which was reflected from water and cliffs.

On Tuesday, July 8th, we bade good-by to Mrs. H—— and Miss Dorothea, and descended the wires for the last time. Captain H—— went with us aboard the sloop which was to take us to Montserrat. We were soon on our way, and the ensign of Great Britain, flying in front of the house, was dipped three times. We waved a final adieu, and the lofty walls of Redonda were thereafter seen by us only from a distance.

Mr. Jacques W. Redway expresses the opinion in the Geographical Journal that the reason why the prairies and plains of the United States are treeless, is because they have never been seeded with trees, and this because they have never been exposed to inundations from tree-bearing districts. "Water," he says, "has been the chief agent in the distribution of trees, and the treeless regions are the greater part in regions that have not been disturbed by physiographic agencies. From the southern limit of glaciation to the made lands along the coast of the Gulf of Mexico, the central plain of the United States is the level bed of a Palæozoic sea. Excepting such places where the streams of Champlain times have cut channels through the upper strata, the surface of this vast plain is undisturbed; it is at once a sedentary soil of Silurian disintegrations and a Quaternary epoch. Throughout much of its extent it is treeless, not because of prairie fires, nor yet of unwholesome conditions of the soil, but from the simple fact that the seeds of forest trees have never been distributed over its surface at fortuitous times. Prairie fires have doubtless had more or less to do with retarding the distribution of forestry; so undoubtedly have unwholesome conditions of the soil. Neither condition, however, is sufficiently potent to prevent the *emboisment* (tree-clothing) of a treeless area; it is still less able to deforest a timbered area."

THE SIOUX MYTHOLOGY.

By Dr. CHARLES A. EASTMAN.

THE tendency of the uncivilized and untutored mind is to recognize the Deity through some visible medium. The soul has an inborn consciousness of the highest good or *God*. The aborigines of our country illustrate this truth. I wish to write of the mythology of the Sioux nation, more particularly that portion of the tribe dwelling east of the Missouri River, with which I am very familiar, although the others are not distinctively different in their religious customs.

The human mind, equipped with all its faculties, is capable even in an uncultured state of a logical process of reasoning. Freed from the burdensome theories of science and theology, it is impressed powerfully by God's omnipresence, omniscience, and omnipotence. Alexander Pope's worn-out lines—

> "Lo, the poor Indian! whose untutored mind
> Sees God in clouds and hears him in the wind"—

are true, in that the Indian recognized a power behind every natural force. He saw God, not only in the sky, but in every creation. All Nature sang his praises—birds, waterfalls, tree tops—everything whispered the name of the mysterious God.

The Indian did not trouble himself concerning the nature of the Creator. He was satisfied that there was a God, whose laws all must obey, and whom he blindly or instinctively worshiped as the "Great Mystery."

The relation between God and man he conceived from the analogy of Nature. His God is a gracious yet an exacting parent. He punishes both the disobedient and the evil-doer, and forgives and helps the penitent and the good. He hears prayers. He is called *Wakantanka*, or the Great Mystery. The word *wakan* means mystery or holy, and *tanka* means great, mighty, or supreme. Neither of the two words signifies *spirit*; however, it may imply that. The word *wakan* may also mean reverenced or sacred.

Before the coming of the missionaries the Sioux never prayed or gave any offering direct to God, except at a great feast once a year. It was believed that he was too great to be approached directly, but that a prayer or a gift through some of his attributes would reach him. The legend is that God occasionally descends to earth in the shape of some animal, or envelops himself in a great wind. If any person beholds his face he dies instantly, although the same person may be born again as a child and become a great "medicine man."

Before the advent of the white man these people believed that the earth was flat, with a circular form, and was suspended in a dark space, and sheltered by the heaven or sky in the shape of a hollow hemisphere. The sun was regarded as the father and the earth the mother of all things that live and grow; but as they had been married a long time and had become the parents of many generations, they were called the great-grandparents. As far as I can judge, the moon seemed to be their servant; at least, she was required to watch, together with her brothers, the stars, over the sleeping universe, while the sun came down to rest with his family.

In the thunder-bird they believed God had a warrior who presided over the most powerful elements—the storm and the fearful cyclone. This symbolic creature is depicted as an impatient and wrathy god of war, at whose appearance even the ever-smiling grandfather, the sun, hides his face. In the realms of water the whale is the symbolized chief of the finny tribes. In every great lake the Sioux imagines a huge fish as ruler of its waters.

Yet none of these possess the power of speech. The Great Mystery had shown them some truths denied to man, but he did not trust them fully, therefore he made them dumb. They can only show to man some supernatural things by signs or in dreams; as, for instance, to foretell future events or explain the use of certain powerful remedies. The savage holds that the key of heaven is vested in the visible phenomena of the universe. All creatures, save man, are assigned to a peculiar paradise, in which there is a forbidden fruit—namely, the apple of speech and reasoning. Hence the animals and inanimate things are exempted from sin. Thus it is that rocks, trees, and rivers are surrounded with an atmosphere of grandeur, beauty, and mystery. Nature is the interpreter of the Great Mystery, and through her man is convinced of truth.

The root-eating animals were believed to be intrusted with the mysteries of medicine. They were the medicine-givers. The sun and the thunder-bird also possessed efficacious treatments, but without the use of roots and herbs. On account of these beliefs the practices of no two medicine men among the Sioux are exactly the same. Each claims that his knowledge of medicine was obtained from some particular animal, of whom the bear, beaver, etc., are first in the profession. Those who found their treatment upon the power of the sun or the thunder-bird do not use any medicine. There was but one general organization among the Sioux, and this was based upon medicine and religion combined. It was called the "Holy Medicine Lodges." There were many of these lodges, each one different in its medicines and medicine songs, but alike in all other respects. They had a common form of initiation. It was effected publicly at a union meeting of all the lodges. Whenever a member of one of the lodges died, a candidate was introduced, and he was instructed by a select committee of experienced and pure men, according to the savage notion.

The novice must bear in mind that purity and feast making are the foundations of the lodge, and pleasing to the Great Mystery. "Thou shalt often make a holy feast or a lodge feast to the God. Thou shalt not spill the blood of any of thy tribe. Thou shalt not steal what belongs to another. Thou shalt always remember that the choicest part of thy provision belongs to God." These were some of their commandments. It is a peculiar fact, already mentioned, that the Great Mystery was never directly approached except upon special and extraordinary occasions, such as the union meeting and dance of the "medicine lodges" once a year. Then a chosen priest usually made a prayer to the Supreme Being. The material rewards of a godly life were looked for in the immediate future; and yet there was a feeling of satisfaction in the savage bosom that God was pleased with his efforts.

The spirits of the departed Sioux were, it was supposed, admitted at once into the mysteries of God, except those of the very wicked, who were returned to this world in the form of one of the lower animals. This was their punishment. Yet such a spirit might retrieve its misfortune by good behavior, and thus be promoted to its former shape.

In man there were believed to be three souls. One of these, as I have said, immediately enters heaven by the "spirits' path"—the milky way—escorted by the stars. The second remains where the body is placed, as guardian of the grave; while the third lives and travels with its relatives. On this account the natives believe that everything said of the departed is heard by them. I do not know just how this triune conception originated. No doubt it had a reasonable explanation somewhere in the early life of the race, but the legend connected with it is lost.

There is a strong implication that the Great Mystery has made man after himself, and that he is in shape like a man, but with a few modifications. For instance, he is supposed to have horns, symbolic of command; and his eyes are like the sun—no one can gaze into them. The Sioux formerly believed that every created thing can hear what is said of the Creator. Therefore, an Indian fears to take God's name in vain, and there is no profane word in their language. Whenever God's name is used it is done with reverence. In this connection I may be permitted to add that when the Indian found that his white brothers used the name of God indiscriminately and irreverently he was shocked.

It was further observed by him that, inasmuch as there are pairs or opposites in all things, there is a good and an evil spirit; yet both of these are appointed and controlled by the Great Mystery. There were no angels in the Indian's theology. As there is a spirit of antagonism among animals, so also the Indian believed that the elements do often wage war upon each other, and sometimes upon the animals. For instance, it was supposed that the thunder-bird often goes upon the warpath, traveling over vast tracts of country and chastising both animate and inanimate things.

SOME ANALOGIES AND HOMOLOGIES.

By W. T. FREEMAN, F. R. C. S.

READERS nowadays like to have things made easy for them. The student has worked for year after year at one new subject after the other; it has been hard work for him, he has painfully struggled to master the new facts, the new ideas, and the time comes when he has reached the acme of his work; he thinks more for himself, reads magazines more than books, and prefers to digest the articles in his armchair, and they must be put for him in an appetizing form, must reach him in fact as the old ideas amplified and reclothed. Very pleasant reading the old lore brought home again, very refreshing to regain what is nearly lost by the help of a few chatty words in every-day tones; nice to dream, even among the words of the scientist, and to drift into illusive paths of speculation which are pointing dimly through and away beyond the veil of thought. May this little paper then be simply a series of dips here and there into the teachings of the unity of type and ideas, leaving the workings of the deeper mines for those who are fit for the labor.

Analogues and homologues are words with a practical ring about them, but they can not always be dealt with in a practical manner. The analogies of the creation teach us that everything is spun of the same stuff and upon one plan. Let a powerful example of this fact be taken in hand at once, and some portion of the animal creation be utilized. Now, we have all of us necks, some of us graceful necks, some of us apoplectic necks, and some of us no necks at all to speak of; again, the giraffe has a very long neck, the elephant a very short one, and the porpoise apparently stops short of one altogether, but in each and every case we find seven cervical vertebræ—*and seven only.* Again, they, and human beings also, all have the same number and variety of muscles and ligaments. Some of them certainly are simply mere representatives; for instance, the powerful ligamentum nuchæ of the horse is but very feebly represented in man. "Padding" accounts for all the rest—a little more or less of fat and cellular tissue.

> "Every face however full,
> Padded round with flesh and fat,
> Is but modeled on a skull,"

and it tells the same tale of the rest of the figure. It seems an odd statement at first sight, but there are many millions of beings who have an outside instead of an inside skeleton. What a miserable existence these poor creatures must have if they have a good figure, for it can not be exhibited! The lobster is of the 40-exoskeleton type.

I have dealt with necks, now for the other extreme. It might be argued that one great difference between ourselves and the rest of the vertebrates is marked by the fact of our having no tail. We all have tails. 'Tis true they are wretched specimens, but they exist universally. We do not wag our tails, but only the other day I spoke with a gentleman who had a dog whose caudal vertebræ were anchylosed together. A little careful selection with this dog, and it is probable that a race of dogs might be developed with an os coccygis like ourselves. Disuse invariably leads to abortion. The little mass of anchylosed vertebræ that we call the os coccyx is our best apology for a tail, but this region of the spinal column becomes wonderfully modified and developed if we compare it with its homologue in other members of the creation. It may act as a hand, may be the exclusive locomotive organ, it may contain the only free vertebræ in the body. In the spider monkey it is prehensile and is often used as a hand. In some sharks the number of the vertebræ amounts to two hundred and seventy. In tortoises the coccygeal vertebræ are the only free vertebræ. In the sole the neural spines and the hypophyses are remarkably developed. Finally, the bone may be even more rudimentary than in man. In the bat there are but two coccygeal vertebræ.

Quite a developed tail has, says Marshall, been discovered in the human race in certain rare and anomalous cases.

In the embryonic stage of the vertebrates the spinal column is represented by the so-called notochord, *and this notochord is temporarily represented in the Ascidians, a class of animals bearing not the remotest resemblance to the Vertebrates.* This is a highly interesting fact in connection with the interrelation of species.

One other most interesting fact: *At an early period of our development—that is to say, at an early part of our embryo existence—the os coccyx is free and projects beyond the lower extremities.*

One other less interesting fact: What tail we have is always carried between our legs—no doubt, in the majority of instances, there is good reason for it!

Our limbs form beautiful subjects for comparison. Throughout the vertebrates they never exceed four in number. They are all modifications of one type, whether we take the fins of fish, the wings and legs of birds, fore and hind legs of quadrupeds, or arms and legs of man. Comparing the leg of a bird with the leg of a man, we see that the complete leg of a bird shows first the thigh bone, then the tibia or lower leg bone, and then in the place of the tarsus and metatarsus a single bone, with, at its lower extremity, a small bone supporting the four toes. Primarily the analogy between the last five bones of the bird and the so-called tarsus, metatarsus, and toes of man does not seem very complete, but if the chick in the egg be examined, its leg will be found to consist of the thigh bone, of the tibia, of two tarsal and three or four metatarsal bones, and the toes or phalanges. The upper tarsal bone subsequently becomes anchylosed with the tibia and the lower one with the consolidated metatarsus. Now the analogy becomes much more complete.

The horse has but a single metatarsal bone (the third), with rudiments of the second and fourth. These rudimentary metatarsal bones of the horse are very interesting. By means of them it is comparatively easy to trace out his descent. I may be pardoned for mentioning such well-known facts and analogies as the following, among the vertebrata—that the whale possesses the rudiments of hind legs, that the boa constrictor possesses also the rudiments of a leg and a pelvis, and that the rudiments of the wings are discoverable in the apteryx.

A few other animal analogies: The third eyelid of the bird exists also in some amphibians and reptiles and in sharks; also in man as a rudimentary structure.

The manner in which cows, deer, and sheep tear up the grass when they are feeding, plucking away at the tufts, is familiar to any observant man. The incisors of the upper teeth are wanting. The interesting analogy is the fact that the teeth are really there, but they are uncut—that is to say, they have never pierced the gum.

The skin with its appendages forms a beautiful story of analogy. Our own microscopical epidermic scales are strictly comparable with the cells that make up the scales of fish and of reptiles; their further development into hairs and nails again compares with the feathers of birds and the hoofs and horns of animals.

We call ourselves a hairless race, but everywhere on our bodies are the small lanugo hairs. Stimulation will readily cause these hairs to grow to any extent. The surgeon has frequent opportunities of witnessing this retrograde progression toward a lower type.

Molting has its analogy throughout the animal kingdom. We indeed molt invisibly, are continuously shedding our scales, but there are some animals that get through this process even more quickly than do birds, as, for instance, the shedding of the skin as a whole by the newt, eft, and snake.

Sir James Paget has noted that some people have a few extra long hairs growing out from the general mass of the eyebrows. These few long hairs are representatives of a permanent condition in the chimpanzee and some baboons. They grow out separately from the general hairy mass over the superciliary ridges.

Darwin notes as a significant fact that the palms of the hands and the soles of the feet of man are quite naked of hairs, like the inferior surfaces of all four extremities in most of the lower animals.

Something about the ear. The lobule of the ear is peculiar to man: there is, however, a rudiment of it in the gorilla. Happy gorilla—and man!

About the brain of man and apes. The whole comparison is one of degree, and in the case of the Bushman's brain with that of a well-developed ape, the comparison becomes nearly equal. Richard Owen once claimed that the hippocampus minor, a trifling portion of the interior of the brain, was the only exclusively characteristic human part, but it has since been demonstrated in the orang and chimpanzee. In truth there are no specific distinctions between the brain of the ape and that of man! I possess in pickle the brain of a monkey; I am sure that my own brain is of much greater proportional weight and complexity. It is a pleasing reflection!

To turn to a totally different class of analogies, picking them out and noting them from the thousands of examples in the world of manners, thoughts, and ideas. The effects of civilization and town life upon man and some of the lower creation is very well exemplified by the town sparrow being seldom caught by a cat or slain by a missile, while the bumpkin bird is easily overtaken by the one or the other. *Experientia docet*—at one time the gulls of the Serpentine used to slay the sparrows; they knew not their enemy, but with each new generation of their victims the gulls had fewer meals. Instinct has been described as the accumulated experience of the race. We have had a good example of it here; that it is common enough among the different races of mankind and the various animals of the creation goes without saying, and Dr. Taylor nearly proves that it exists among plants.

Parents watching the characters of their children observe that at one time the traits of the mother are to the fore, and that at another period of the child's existence he or she shows the chips of the old block by exhibiting some mannerism or peculiarity of the father. Apparently the male points are as easily inherited as the female points, and most certainly when the male tendencies are most evident, then the female tendencies are more or less in abeyance, and *vice versa*, and these variabilities may of course occur at any period of the being's existence, often, alas! when least desired. It has been disputed whether the female points of a plant are not more readily inherited than the male. A few years ago it was stated that the chances were as much as three to one in favor of the female side. Messrs. Sutton's foreman has experimented on these lines, particularly with wild potatoes and a cross with gloxinias. He seems convinced that the hereditary traits of the male are shown as often and as decisively as those of the female. But he is also convinced that, while the staminal tendencies are to the fore, the pistillate tendencies are more or less in abeyance. For a considerable period of the plant's growth he has noted nothing but the male tendencies; suddenly the whole bearings of the plant have changed, the staminal tendencies have absolutely died off, and a plant with all the traits of its mother rapidly shows up in its place.

The reasons why a plant should always be called a plant, and an animal an animal, are not always very apparent. An animal is a conscious being. I mean that it knows how to discriminate between this and that, reasons about what is good for it, rejects what experience has informed it is not good for it, and has special sences. It is a conscious being—indeed reasons, discriminates. Here is a great gulf between the animal and the plant! Most of us are ready to acknowledge such simple truths, and we are all wrong, for the differences when sifted are only those of a greater and lesser degree. Some plants like shade, some like light. Why? Well, why do we under some circumstances prefer dark, and under others light? When we are healthy we can digest meat, and reject, with good reason, a meal of sticks and stones. A carnivorous plant receives and digests a proportionate meat meal, but feed it with pebbles and bits of stick, and it refuses to receive such dainties. We bend beneath a blow, we protect ourselves from further injuries that we judge may follow—so do the sensitive plants. With the aid of a specialist in this class of work I am trying to demonstrate the presence of nervous tissue in plants. So far, we have not been successful, but the circumstantial evidence is so strong that we may feel quite certain that better methods of demonstration will give ocular evidence of what we seek. The proofs of the struggle for existence in both animal and plant life have been prettily told by Taylor.

The part that color and get-up plays in the propagation of species is precisely analogous, alike in the doings of man, the lower animals, and plants. This I have more thoroughly touched upon in a previous paper.*

The perfumes attached to plants and the animate creation are in both instances used for like purposes, generally to attract, sometimes to repel.

The feasting and temporary entrapping of the flies within the spathe of the arum until the pollen has been dusted upon their backs for distribution, have been compared to the feasting of the old-day voters at the candidate's expense.

The intermarriage of near relatives, or the interbreeding among home flocks, is most disastrous in its effect upon the offspring. Plant life appears to be aware of all this, and adopts the most startling devices for its confutation. Some of these devices are worth tabulating:

I. Staminate flowers, pistillate flowers—these may be monœcious or diœcious.

II. Pistils elevated above the stamens.

III. Pistils arranged at different heights, as in the pin-eyed and rose-eyed roses.

IV. Different sizes and lengths of both stamens and pistils, as in the purple loosestrife.

V. Their own pollen acts injuriously to the pistils of some flowers, as in the primroses.

VI. Most startling observation of all—the pistil is cleft and the two stigmatic portions are maintained closed until the pollen of the flower is removed—as in the salvias.

VII. The catkins of the oak are beautiful devices for the winds of spring to scatter the pollen.

VIII. The facts collected by Darwin in the natural history of orchids.

IX. The milkweeds are said to be able to discriminate between those insects that will be able to cross them and those that will not. Their vengeance upon the useless intruder is indeed vindictive—they seize upon and hold him till he dies.

X. The stamens and pistils do not always ripen at the same time.

XI. In order to save their own increase and insure crossing, some flowers denote to insects an absence of honey by a change in the color of their petals.

An observant gardener informs me that races of plants improve and improve by proper cultivation and care until they reach their zenith. The zenith being reached, the greatest care is necessary, lest the decline should begin; but, with the necessary amount of care, the height of their prosperity may be prolonged indefinitely, but once the decline begins, the fall to probable extinction has inevitably commenced. How well may this be likened to the career of nations! Internal dissensions and the agitator's wile may ruin the backbone and trade of a country, and hasten on its fall. The noble and broad-minded statesman is the conscientious

* See Something about Natural Selection, Gentleman's Magazine, August, 1892.

and hard-working gardener striving to outwit the enemies and parasites of his time, saving and enwreathing his cares in the glory of the achievements of the past.

The animal moves—most gifted and superior animal that possesses a power which the plant does not! Is this a truism? Among many kinds of fungi, water-weeds, sea-weeds, mosses, and even ferns, the spores and male organs actually possess locomotive power, and by means of cilia and flagella are able to move from the parent plant, and distribute themselves to some distance.

The suicidal mania is apparently appreciated by not man only. In Africa, ants have been seen marching by thousands for days together into a stream, and being swallowed by crowds of fish as fast as they could get into the water. Butterflies have been known to migrate in numbers to the sea. Similar tales have been told of rats.

We say that the existence and possession of a soul, the something that dogmatic theology asserts can exist after the death of the brain, after the death of the individual, is the attribute of man alone, and marks him as the head of the creation. Every thought that passes through our mind, every effort that guides our pen, is brought about by the molecular energy of the brain and of the muscle cells; this power is dependent upon the proper nutrition of these cells and of the body as a whole. Starve the tissues of the brain and muscle—thought no longer flows, the pen is no longer guided. The lower animals think, move, have instinct; they are conscious of ill or wrong, of joy and remorse, and herein lie the totalities of the soul. Soul is only the name for a mystery that we can not explain, and this mysterious combination which leads us to dwell upon a life devoid of mechanism, a life freed from the trammels of matter, with its repellent forces and energies, surely belongs to us only in degree. What rights have we, what proofs have we, to help us to assume to ourselves a one exclusive evolving soul, fitting itself for a newer and purer existence, and yet to deny all that we base our hopes upon to the whole of the rest of the creation? Surely the lower animals have their degree of soul, and a chance of a lesser heaven as well as our important selves. Our thoughts and actions are bestial, only too often to a loathsome degree; and on the other hand not only the ape world, but also still lower creatures, point us daily many a useful moral or loving lesson. Does the existence of the soul mark the gulf that separates man from all other living beings? Does the lowest Bushman of to-day possess a soul denied to the highest anthropoid ape, and if he does not, who shall draw the line where the animal is separated from beatified man?—not man, at all events.

In the frightful and only too common form of insanity, "the general paralysis of the insane," at different periods the actions and behavior of the unfortunate patient become horribly monkey-like. The continuous chattering, the restless clawing movements, and the stage at which the food is seized and crammed into the mouth, and, too, the half-childish, half-monkey-like gibes and smiles which wreath the poor wretch's features as he pours his grandiose ideas into the listeners' ears, create a sickening impression for the observer to think upon.

A little more old lore concerning apes and man, including a little recapitulation.

Man compares with the anthropomorphous apes in that the relative weight of a Bushman's brain compared with that, say, of an ordinary gorilla is only as three to two. The furrows and convolutions are really the same in both, and the ape does possess a hippocampus minor. The anthropomorphous apes possess, as do men, five molars; this of course includes the bicuspids with the molars. Even a prehensile toe is not unknown as a human attribute—i. e., the tendency to oppose the big toe to the others. In the gorilla especially the contrast between hand and foot is nearly as distinct as in man. Then again there is the discoidal placenta with, as in the chimpanzee, its two umbilical arteries and one umbilical vein. It is to be noted that the anthropomorphous apes differ far more from the lower apes than do they from man. Lucia and others have said much regarding the fact that the ape as he grows becomes more bestial, and man more human.

Man's descent from the ape is not direct; apart from this, the laws of heredity forbid the retrogression of the one species to any great extent, or the exaltment of the other. Man's kinship, however, is not upset by the bestial strength of the teeth of the ape, or by the enormous protuberances on the skulls of this animal. The embryonic and youthful skull of the ape exhibits a plastic and well-formed cranium. Later, in form and character, it strikes out into a divergent and disastrous path.

Two of the supposed great distinctive marks of division between plants and animals are now disproved. Cellulose was believed to be found alone in vegetable tissue, but now starch, chlorophyll, and cellulose are known to occur in the lower types of the animal kingdom. Animals were supposed to subsist only upon ready-made organic material, while plants were known to be able to convert inorganic into organic material. This partition wall has also been overthrown.

Stinging and prickly plants may be fairly said to possess and use weapons of defense. The sensitive plant, too, in a timid manner resists to the last the attacks of its attackers, and I am convinced that it appreciates the current from an electric machine. I have tried to reason with myself that my observations have been fanciful, and have been forced to the conclusion that these plants possess not only nervous ganglionic centers in their leaves, but cords of communication running even to the stem, where possibly there may be the rudiments of a spinal cord communicating, may be, with other ganglia in the roots, the totality of which would represent a brain. Nuclei and tracts of special sensations (unless they be special plant sensations), apparently, they do not possess—I mean such sensations as sight and hearing. They are, to some extent, sensitive to a breath of wind when no actual contact takes place.

Men are wise in their generation—the wisdon of man is indeed a remarkable trait of the creature—but the weather wisdom and the immigration wisdom of birds are traits equally remarkable. If the bird lore is due to the accumulated experience of the race, just so much can be said also about the wisdom of man.

Man loves alcohol; man includes the teetotaler who loves alcohol also, but who most wisely refrains, as he doubts his own powers of resistance to excess. Here, possibly, there is a gulf between man and the lower animals. The lower creatures, as far as I know, never refrain from alcohol in excess, if they can get it. Many tales have been told of alcoholism in the lower animals, none of moderate drinking, if the alcohol were available; therefore, perhaps, the only great difference between man and the lower animals is that man may be a moderate alcoholist. Monkeys are peculiarly fond of arrack and such stuff. Possibly, therefore, our own love of spirits is simply an unfortunate hereditary ancestral trait.

Comparisons are at the best odious; however, the most tender of us can always console himself by remembering that the comparison between man and animals and plants is only reasonable when we descend, as far as man is concerned, to the very lowest species of humanity, and even then he has to be compared with the highest type of the creatures below him. Therefore, indeed, what magnificent creatures we are—or, anyhow, might be!

I have seen dogs and, I think, other animals gazing abstractedly at and evidently following something. They were troubled, sometimes whining, or positively crouching in awe or dread. Such behavior in a dog during the course of a long life is not uncommon, and it would be ridiculous to declare all such dogs to be rabeitic. I believe other animals suffer from illusions. I know two men with whom I have spoken, and who are reasoning, rational beings, and otherwise very practical, who are able to make a chair waltz round the room or go up-stairs without in any way, directly or indirectly, having contact with it. Having started the chair on its career, it is kept going by mere suggestion. I question and cross-question these gentlemen, and before witnesses, and they maintain their assertion stolidly; and I believe that they do see in their own mind the chairs doing all they say; but what this peculiar condition of mind implies I know not. To the majority of readers such tales appear mere vaporing. I can offer no explanation, except that these visions are not delusions, for the perpetrators are reasoning beings and sane; they are not illusions, for such gentlemen (and ladies, too, I believe, but I have not met them) believe that they are actually moving solid furniture merely by the force of their own suggestion. Such acts, so interpreted, appear to me to be only able to be likened to those of a deity—and a deity is beyond our comprehension. They are not due to animal magnetism. They are not dreams. The effect of suggestion by means of "hypnotism," with its startling results, has been witnessed by thousands, but any similar explanation breaks down here. If these things be true, then the connection between the animate and inanimate creation is complete. For obvious reasons, names can not be introduced into such a paper as this; but I believe that I could gain an introduction to one or both of these gentlemen for any person, sufficiently well known, and desirous of investigating such material.

The lower animals, then, in a degree, do almost all that we can do. Plants do many things that were once considered to be solely the doings of the animal creation. The ultimate structural elements of either will some day assist in the formation of mountains and seas. Therefore, indeed, we are all one—animal, plant, mountain, sea. The component elements and molecules of the animal and plant creation have simply become highly idealized and specialized. The marked difference between man and a mountain lies in the constant dissipation of energy by man and its passive retention by the mountain. The mountain is a mere reservoir of energy; man one of the compounds of elements used for the dissipation of energy.—*Gentleman's Magazine*.

The difficulties that many have experienced in understanding the writings of the alchemists are accounted for by M. M. Pattison Muir by showing that the names they used and which have survived as the names of well-known substances were applied only to certain principles or properties that matter was supposed to possess. Thus the word sulphur represents the principle of changeability, and the word mercury the principles of malleability and luster which the metals exhibit. The alchemists used expressions of this kind partly to hide their secrets from the uninitiated, and partly to preserve themselves from the suspicion of dealing with the evil one, who was considered to be the possessor of the earth. The mystical language was derived, to a large extent, from theology. Possibly the alchemists attached some definite meanings to the fantastic terms they used, but the meanings are lost to us.

THE CHEMISTRY OF CLEANING.*

By Prof. VIVIAN LEWES.

As a great city grows, and the agglomeration of struggling humanity increases, such questions as the disposal of sewage and other waste matter rise from comparative insignificance into problems of almost insurmountable difficulty; and while we are able to put the burden of cleansing our towns upon the urban authorities, the responsibility of keeping our homes and bodies in a condition of at least sanitary cleanliness devolves upon the individual, and a knowledge of the causes of dirt and the methods by which it can be removed can not be regarded as devoid of interest, or at any rate of utility.

Observation shows that in our town houses only a very short interval of time is needed to cause a considerable deposit of dust upon any horizontal surface, while vertical surfaces and draperies, especially if their surface be rough, also accumulate a perceptible quantity, although of a lighter and more finely divided kind. We also find that this dust is borne to its resting place by the air which penetrates from the outer atmosphere, and that its deposition is caused by the comparative condition of rest insured to it by the absence of wind or violent currents.

The presence of these air-borne particles of solid matter can be made visible in any town by allowing a beam of sunlight or a ray from an electric lantern to pass through the air of a darkened room. If the room be filled with air previously filtered by passing it through cotton wool, the beam of light is invisible until it strikes the opposite wall; but if the air be unfiltered, the path of the beam is mapped out by the suspended matter reflecting and dispersing portions of it, and so becoming visible to the eye as "the motes in the sunbeam." The heavier the nature of the particles the more quickly will they settle, with the result that the dust on horizontal surfaces, such as the tops of sideboard, piano, and mantel-board, may be expected to differ somewhat from the lighter form, which has continued to float until contact with vertical surfaces has brought it to rest.

These particles of dust are composed of matters of the most varied nature, and will be found, when collected, to consist partly of mineral and partly of organic substances.

The heavier portions of the dust are found to contain ground-up siliceous matter, pulverized by traffic in the road; small particles of salt carried inland by winds from the sea, together with sulphate of soda, with other impurities of a local character. If a

* Abridged from a lecture delivered at the London Institution.

sample of dust be collected and carefully ignited, the organic matter will be burned away and any ammonium salts volatilized, while the mineral portion will be unacted upon; and in this way it has been shown that more than one half of the suspended matters in the air are of organic origin, a large portion of this organic matter consisting of germs which are capable of setting up fermentation, disease, and decay.

It is only within the last few years that the importance of the work done by the solid particles of dust floating in the air has been recognized, and it is to Pasteur that we owe the knowledge that these germs set up the various processes of organic decay, by which the waste matter derived from vegetable sources is once again resolved into the water vapor and carbon dioxide used by Nature as the foundation of all organic creations. It is the almost imperceptible germs floating in the air which start this marvelous natural action—germs so minute that it requires the strongest microscope to detect them, yet so potent that the whole balance of life hangs on their existence. These facts show us that not only has dust a most marvelous history, but that in it Nature has disguised her most important factor for cleaning the face of the earth from waste matter of both mineral and vegetable origin.

The surface soil when mixed with water gives the mud which dirties our boots, and forms clots on the train of our skirts; but this, as well as the dust which has settled in our living rooms, and merely clings mechanically to the surfaces upon which it has deposited, may be removed by such simple physical means as the duster and brush. When dust has found its way into a fabric such as a carpet, it requires considerable force to again dislodge it, and this is applied by means of the broom; but in vigorous sweeping we find that the largest proportion of the dust is driven up into the air, only to resettle once again on other surfaces, so that although we can make the nuisance "move on," we do not in this way remove it, and experience has taught our servants that wet tea-leaves scattered on the carpet before sweeping lessen this evil. In some cases, instead of using this method, it has been argued that it must be the moisture which acts in preventing the raising of the dust, and the carpet has been sprinkled with water. This converts the dust into mud, which remains fixed in the fabric while the sweeping is going on, but as soon as the water has evaporated from it, again reasserts its right of rising as dust.

When, however, wet tea-leaves, damp sawdust, or even moistened sand is scattered over the surface to be swept, the dust when dislodged adheres to the moistened substance and is removed. In choosing moist bodies for this purpose, the only points to consider are that they must have no staining action on the carpet, must not be too wet, and must not be so finely grained as to sink into the fabric, nor so clinging as to resist easy removal by the broom.

It is manifest, however, that the mechanically held dirt which we have been considering differs very considerably from the dirt on our skins, and on linen in contact with our bodies, which, although derived from the same sources as the dust on the furniture, resists any ordinary mechanical process for its removal, and rinsing dirty hands or linen in cold water has but little cleaning effect, while if the hands are afterward dried in the usual way a transfer of a portion of dirt to the towel takes place. If we carefully notice the portions of our skin and shirt which become most soiled, we at once observe that it is where the skin is exposed to air, while the linen, which is in contact with both air and skin, becomes dirty more quickly than when exposed to either alone.

The part played by the atmosphere is made clear by the facts which we have already been considering, but the action of the skin introduces a new and most important factor. For the healthy carrying on of the functions of life, nothing exceeds in importance the skin with which our body is covered. We may live for days without giving our stomach any work to do, the liver may cease action for several days before death ensues, but it is impossible to survive for the same length of time if the functions of the skin are entirely stopped. The skin not only plays an important part in throwing off and getting rid of waste matter from the system, but it is also credited with being an important auxiliary to our lungs; and experiments have clearly shown that if the skin of animals be coated in such a way as to completely stop its action, a very few hours will bring about death.

If we examine the structure of the skin, we find that it is built up of two distinct layers, an outer skin called the cuticle or epidermis, and an inner termed the cutis or dermis. A third layer intermediate between these two used to be looked upon as a third skin, but more recently has been recognized as being only a transition form of the outer skin. The cuticle or outer skin consists of several fine layers of scales which gradually assume a more rounded and granular form the deeper one gets into the cuticle. These rounded granules form the middle skin of the old observers, and as the outer portion of the cuticle roughens and scales off as scurf, these granules gradually flatten and form the new surface to the outer skin; and we differ therefore from other scaly reptiles by being continually in a condition of renewing our skin, while most reptiles and fish cast their scaly covering in one operation.

No nerves or blood-vessels find their way into this outer skin, as may be seen when it becomes detached from the inner skin in the formation of a blister, the outer portion of which is devoid of sensation. The lower or true skin varies in thickness, being thicker in the palm of the hand and sole of the foot, where most resistance is needed. When we look at the skin of the hand, we notice delicate grooves in it, which, examined through a magnifying glass, are seen to be pierced with small orifices; and if the hand be warm, minute shining drops of perspiration will be seen issuing from them.

The glands for the secretion of the perspiration are set in the lower side of the inner skin and are in connection with the capillary network of blood-vessels which cover the surface of the body. The gland or duct which conducts the perspiration to the surface of the skin is about a quarter of an inch in length, and is straight in the true skin, but becomes spiral while traversing the outer skin. Over thirty-five hundred of these small ducts have been found to exist in a single square inch of the skin, and it has been computed that the aggregate length of the sudoriferous ducts in the body of an ordinary-sized man is about twenty-eight miles. These little glands and ducts perform the important function of throwing off the moisture produced during the combustion of waste tissue by the blood-borne oxygen of the body, and secrete about twenty-three ounces of perspiration in the twenty-four hours, which under ordinary conditions evaporates, without our noticing it, into the air, but under conditions of considerable exertion or unusual heat accumulates as beads of perspiration.

The throwing off of the perspiration and its evaporation on the skin is a beautiful natural contrivance for regulating the temperature of the body, as the conversion of the perspiration into vapor renders latent an enormous amount of heat, which, being principally derived from the body, keeps it in a comparative state of coolness even when subjected to high temperatures.

In the twenty-three ounces of liquid so secreted in the course of the twenty-four hours there will be found rather more than an ounce of solid matter, which is left when the liquid portion of the perspiration evaporates, and tends to clog the pores of the skin, and it is the removal of this by the morning tub and rough towel which is responsible for a considerable portion of the refreshing influence of the bath.

Besides these sudoriferous glands, however, there is a second set, called the sebaceous glands, the ducts of which are spiral, and open generally into little pits, out of which the fine hairs which stud the skin grow, and these glands secrete an oily or waxy substance, which nourishes the hair, and also keeps the outer skin smooth and pliant. This waxy substance is developed in largest quantity inside the ear, where it serves to protect the more delicate portions of that organ; and, next to the ear, these glands are found most abundantly on the face and other portions of the body which are exposed to external influences and friction.

It is the presence of this oily secretion which holds the dirt glued to the skin, and being also rubbed off on the inside of the wristbands and collars of our shirts, causes these portions of our linen to become the most soiled. We may look upon this form of dirt, therefore, as being glued on to the surface by oleaginous materials, which being insoluble in water resist any mere rinsing; and the most important function of our cleansing materials is to provide a solvent which shall be able to loosen the oil, and so allow of the removal of dirt from the skin. The skin, however, is not the only source of oily matter, and in all fibers of animal origin more or less fat is to be found, which, although not in sufficient quantity to play any very important part in the fixation of dirt, still adds its iota to the general result.

We notice, moreover, that the air of a big town has a far greater dirtying effect than country air, this being partly due to the fact that the number of solid particles per cubic foot of atmosphere are greatly increased, but chiefly because country air does not contain certain products of incomplete combustion, which are to be found in all large towns. In London we annually consume some six million tons of bituminous coals, and if we examine the smoke which escapes up our chimney during the imperfect combustion which the coals undergo in our fire grates, we find that not only will that smoke contain small particles of unconsumed carbon in the form of blacks or soot, but also a considerable quantity of the vapor of condensible hydrocarbon oils, which, depositing on the surface of the solid particles of floating dirt, gives them an enhanced power of clinging to any surface with which they come in contact.

Hydrocarbon oils of this character are not as a rule affected by the solvents which we utilize for loosening the dirt which is held to our skin by animal grease; but there is no doubt that the dirtying influence of town air is greatly increased by their presence.

If we take any grease of vegetable or animal origin, we find that it can be dissolved in liquids containing free alkalies, this term being applied to the compounds formed by water with the soluble metallic oxides, which, when dissolved in water, give solutions having a soaplike taste, affecting the color of vegetable extracts, such as that obtained by the red cabbage, and possessing the power of neutralizing the acidulous properties of the compounds we call acids.

If we take two metals discovered by Sir Humphry Davy in 1807—potassium and sodium—and expose them to dry, pure air, they rapidly become converted into a white powder by absorbing oxygen from the atmosphere, and form compounds which we term respectively oxide of sodium and oxide of potassium. These oxides, when dissolved in water, enter into combination with a portion of it, producing sodic hydrate and potassic hydrate, two substances which have pre-eminently the properties which we term alkaline, and which exert a strong solvent action upon all forms of animal and vegetable grease. These solutions exercise a wonderful power of cleansing upon the grease-bound particles of dirt which veil our skin, but so strong is their solvent power upon animal membrane, that not only do they dissolve fatty matter, but also the cuticle itself, so that they are manifestly unfitted for removing dirt from a tender skin, and we are forced to look further afield for a grease solvent.

If instead of dissolving our sodic and potassic oxide in water we had left them exposed to ordinary air, we should have found that they gradually attracted from the atmosphere a gas called carbon dioxide, which exists in all air to the extent of four parts in ten thousand, and that by combining with this gas they became converted into sodic and potassic carbonates, bodies which we call salts, and which, although not so violent in their action upon the skin, will retain to a certain extent their solvent action on fatty matters.

The carbonates of sodium and potassium are found in the ashes of many vegetable and animal substances, and in the earliest records which have been discovered we find mention of the cleansing power of wood ashes, the ashes of certain marine plants, seaweed, and "natron," which is an alkaline efflorescence from some kinds of soil; nor has the use of ashes for this purpose entirely died out at the present time.

As early as A. D. 69, however, we find that the elder Pliny mentions another form of cleansing material made from tallow and ashes, the components most recommended being goat's suet and the ash of beechwood; while the ruins of Pompeii were found to contain a fairly perfect soap factory.

Although soap and Christianity date from the same period, it was only at the commencement of this century that the classical researches of Chevreul on the constitution of fats gave the key to the reactions taking place during its formation, while even at the present time we probably only know a true explanation of part of the actions which lead to its cleansing effect upon the skin.

If we take sulphuric acid diluted with water, we find that it has certain well-marked characteristics which leave no room for doubting its acidulous nature; and if we pour a few drops of it into the violet-colored solution obtained by boiling sliced red cabbage in water, the violet solution at once becomes bright red. On repeating this experiment with the violet cabbage solution and a few drops of sodic hydrate solution, we obtain a vivid green color; and now on mixing the solution rendered red by the acid, and the second one turned green by the alkaline base, we once more obtain the original violet color, and on examining the solution can find no trace of either acid or alkali, but can distinguish the presence of a compound called sodic sulphate, which can be obtained in the crystalline form by concentrating the solution, and such a compound formed by the union of an acid and a base we are in the habit of calling a salt. During the combination of the sulphuric acid and sodic hydrate to form sodic sulphate, we also had water being formed, which, like the neutral salt, had no action upon our colored solution. If we had carefully weighed our sulphuric acid and the sodic hydrate, we should have found that it is only in certain definite proportions that they unite to give a solution without effect on the vegetable coloring matter.

One of Chevreul's greatest discoveries was that in tallow—the fat of oxen or sheep—you had a salt of organic origin, from which, by decomposing the tallow with heated steam, you could obtain the sweet viscous liquid "glycerin," which played the part of base in the compound, and two acidulous compounds—one a lustrous white wax, called stearic acid, and the other an oil called oleic acid.

Now a salt can have its base replaced by another base. If I take two solutions, the one containing sulphate of copper and the other chloride of iron, and add to each sodic hydrate, decomposition takes place in each case, sodic sulphate is left in solution, and the hydrates of copper and iron being insoluble in water, separate out as precipitates. In the same way, if we add sodic hydrate to tallow, glycerin separates out, and two salts—sodic oleate and sodic stearate—are formed, a process which we call saponification, as the two sodium salts are "soaps."

It is not necessary to use tallow; any vegetable or animal fat or oil will give reactions of a similar character, and it may be broadly stated that soap is formed by the action of sodic or potassic hydrate upon fats or oils which contain fatty acids.

It is only potassic and sodic hydrates which can be used for ordinary soap-making, as the soaps formed by the combination of other metallic hydrates with the fatty acids are insoluble in water, and therefore useless for detergent purposes. The soap formed by using sodic hydrate has the property of setting hard, and all the ordinary forms of washing-soap contain sodium as the base. The potash soaps are far softer, and do not set; the soft soap used for scrubbing and cleansing in many manufacturing processes, and also a few toilet creams and shaving pastes, being of this character.

It would occupy far too much time, and would, moreover, be outside the scope of this lecture, to go into the details of the manufacturing methods by which soap is made on the large scale, and if I give a rough idea of the general processes employed it will be sufficient for the purpose.

Carbonate of soda is first converted into hydrate by dissolving it in water and then boiling with quicklime. Quicklime consists of calcic oxide, and this, when put into the vat containing the sodic carbonate in solution, combines with water, forming calcic hydrate, which then reacts with the sodic carbonate, forming calcic carbonate or chalk, which being insoluble sinks as a mud to the bottom of the vessel, while sodic hydrate remains in solution.

The solution of sodic hydrate, called caustic lye, is made in different strengths, and tallow is first boiled with a weak lye, and as the conversion into soap proceeds, so stronger lyes are used until the whole of the fatty matter has been saponified. If a strong lye had been used at first, the soap as it formed being insoluble in strong alkalies would have coated the surface of the fat and prevented its complete conversion.

If at the end of the saponification process the alkaline solution is sufficiently strong, the soap will, on standing, separate as a fluid layer on the surface of the spent lye, which contains the glycerin set free during the saponification; but in any case separation can be rapidly brought about by adding salt to the liquid, when the soap, being insoluble in salt water or brine, separates out and is removed and placed in molds to harden. The block of soap so cast is then cut first into slabs and then again into bars. A soap made in this way with tallow or lard as the fatty matter would be "white curd," while if yellow bar is required, rosin is added to the mixture of lye and soap after most of the fat has saponified.

When rosin is boiled with alkaline solutions, a compound is formed by the direct union of the resinous acids with the alkali, which strongly resembles ordinary soap, so that the yellow soap is really a mixture of fatty and rosin soap, and when the ingredients are of great purity the product goes by the name of "primrose" soap. Bar soaps so made on a large scale are, as a rule, the stock from which the various forms of toilet soap are made by processes intended to render them more attractive for personal use, but generally the consumer gets far better value for his money, and far less injury to his skin, by using a good "white curd" or "primrose" soap than by employing a high-priced toilet soap, while cheap toilet soaps, especially cheap transparent soaps, should be studiously avoided.

The demand made by consumers for cheap soaps, which in many cases are sold retail at prices considerably below the wholesale market price for a true soap, has given rise to the introduction of highly watered soaps, caused to set hard by the addition during manufacture of sodic sulphate, which enables the manufacturer to make a so-called soap often containing less than twenty per cent of true soap.

Having got our soap, the next point is to try and gain an idea of the way in which it acts as a detergent. Supposing we are fortunate enough to have a sample of pure neutral soap, we find that, on dissolving some of it in water, it undergoes a partial decomposition into alkali and fatty acid, this action being called the hydrolysis of soap. The small quantity of alkali so set free attacks the fatty matter which glues the dirt to the skin, and by dissolving it loosens and enables the water to wash off the particles of dirt. If this were the only action, however, soap would have no advantage over soda, a solution of which would equally well perform this part of the operation. As the soap decomposes and the alkali removes the grease and dirt, the fatty acid liberated simultaneously from the soap comes in contact with the newly cleansed skin, and not only softens and smooths it, but also neutralizes any trace of free alkali, and so prevents irritation and reddening of the cuticle.

These are probably the main actions by which soap cleanses, but other causes also play a subsidiary part. We know that a solution of soap causes a lather when agitated, this being due to the cohesive power given to the particles of which the liquid is built up by the presence of the soap a phenomenon which also enables us to blow bubbles with the soap solution on account of the strength of the fine film of liquid—a property which is not found in water alone.

The power of cohesion which the soap solution possesses is in all probability an important factor in removing the particles of dirt from the skin at the moment that they are loosened by the action of the alkali. Prof. W. Stanley Jevons suggested yet a fourth way in which the soap solution might act: when finely divided clay is suspended in water, the microscope reveals the fact that the minute particles are in rapid movement, and hence settle but slowly in the liquid. This movement he christened pedetic action, and he observed that the addition of soap or silicate of soda—often used in soap—to the liquid enormously increased this agitation of the particles, which would tend to aid the breaking away of the dirt particles the moment they were set free.

Many soaps, even among the varieties intended for the toilet, contain a considerable excess of free alkali, which, being greater than the liberated fatty acids can neutralize, causes most painful irritation of the skin, as is testified by the smarting which annoys the chin after the use of certain shaving soaps; and every lady knows that an alkaline soap, when used for washing the hair, renders it harsh and brittle, and destroys the gloss; but a rapid rinse with water containing a few drops of vinegar will neutralize the free alkali and prevent much of the mischief.

We have now dealt with our grease solvents and dirt looseners, but without the aid of water they would be useless; and experience teaches us that the source of the water used for cleansing has a great deal to do with its efficiency.

As the newborn raindrops fall from the breaking clouds, they are practically pure water, containing at most traces of gaseous impurities which the mist has dissolved from the upper strata of air while journeying in the form of cloud, and where the rain is collected in the open country, it gives us the purest form of natural water healthful to drink, because it is highly aërated, and free from all impurity, organic and inorganic, and delightful to wash in because of its softness and the ease with which the soap gives a lather.

In towns, however, a very different state of things exists, as the rain in falling washes the air from a large proportion of the suspended organic matters inseparable from a crowded city, and also from the unburned particles of carbon, which incomplete combustion allows to escape from our chimneys; and charged with these, it still collects more dirt of various kinds from the roofs of our houses, and finally finds its way into our water-butts as the semiputrid sludge which often causes the true-bred cockney to wonder "if this so-called purest form of natural water is so foul, what on earth must the other forms of water be like?" If in the country the rain water is collected and stored in suitable reservoirs, then we have the most perfect water that can be obtained for washing and cleansing purposes.

In the passage of the rain through the air small quantities of carbon dioxide or carbonic-acid gas are dissolved from the atmosphere, while in slowly percolating through the surface soil on which it has fallen the water is brought in contact in the pores of the soil with far larger volumes of this gas, which is being continually generated there by the decomposing vegetation and other organic matter in a state of decay. Under these circumstances the water becomes highly charged with the gas, and sinks on through the ground until it comes in contact with some impermeable strata through which it can not penetrate, and here it collects until a sufficient head of water has been formed for it to force its way along the strata to the surface of the earth, where it now appears as a spring, and during this passage through the earth it has dissolved everything that will yield to its own solvent action or to the activity of the carbon dioxide, which dissolved in water forms the weak carbonic acid, a compound which will dissolve many substances insoluble in the water itself, such as calcic carbonate, occurring in the soil as marble, limestone, or chalk, and also the carbonates of iron and magnesium. If we examine a spring water, we shall find that its dissolved impurities can be divided into two classes: for instance, taking the Kent water supplied at Greenwich, and obtained from deep wells in the chalk, we find its saline constituents in grains per gallon are:

Calcic carbonate	16·30
Calcic sulphate	5·37
Magnesic sulphate	0·93
Magnesic nitrate	1·20
Sodic chloride	2·64
Sodic nitrate	1·21
Silica, alumina, etc.	0·97

And of these the calcic sulphate, magnesium, and sodium salts are dissolved by the solvent action of the water in the same way that sugar would be, while the chief impurity, calcic carbonate, is scarcely at all soluble in the water itself, 16,000 parts of pure water only dissolving one part of the carbonate, but is readily soluble in the carbonic acid, in the water which converts it into soluble calcic bicarbonate.

In the household, waters are roughly classified as hard or soft waters, and the property of hardness manifests itself, as a rule, to the householder by its action upon soap, and also by the amount of "fur" which it causes in the kettle, these actions being due to calcic bicarbonate, calcic sulphate, and the magnesium salts present in it, all of which act upon soap and cause it to curd instead of forming a lather by converting the soluble sodic oleate and stearate into insoluble lime salts, while the bicarbonate by decomposing and depositing "chalk" causes the fur.

A more careful examination, however, reveals the fact that this property of hardness owes its origin to two different causes; for if we boil water until all the bicarbonate is broken up and the calcic carbonate deposited, the clear water left behind it is yet hard, though to a far less extent, and will still decompose a certain proportion of soap. The hardness which can be got rid of by boiling is due to bicarbonate of lime, and sometimes also bicarbonate of magnesia, and is called "temporary hardness," while the hardness left after boiling the water is due to calcic sulphate and the soluble magnesium sulphate, chloride and nitrate, and is called "permanent hardness."

The relative hardness of waters is estimated by the amount of soap they will destroy—i. e., convert from the form of soluble sodic oleate and stearate into the condition of insoluble oleates and stearates of lime; and one grain of calcic carbonate, or its equivalent in sulphate or salts of magnesia, dissolved in a gallon of water, is said to equal 1° of hardness.

PHILIBERT COMMERSON, "THE KING'S NATURALIST."

ONE of the most successful exploring and scientific expeditions of the eighteenth century was that of Louis Antoine de Bougainville, which, starting from one of the ports of France in the last days of 1766, passed through the strait of Magellan and entered the south seas, still for the most part unexplored; sailed through the Paumotu Archipelago, discovering several islands then yet unknown; visited Tahiti; touched the New Hebrides, passed the eastern coast of Australia, the Louisiade Islands, and the Solomon Islands; stopped at New Ireland to repair the ships; passed the northern shore of New Guinea; visited Booro, in the Moluccas; and returning, reached St. Malo in March, 1769. Not the least among the scientific gains of the expedition were those in botany, and these accrued wholly through the fidelity to science and diligent industry of Philibert Commerson, than whom, says the Edinburgh Review, "no explorer of the globe ever conveyed to Europe so large a number of valuable plants, previously unknown."

Commerson was recognized in Europe, though personally but little known, as one of the first botanists of the age. He was the correspondent of Linnæus, the friend of Haller, and the colleague of the two Jussieus. He was the grandson of a retired nobleman of the days of Louis XIV, who had dropped the *de* distinctive of his rank, and the second son of Georges-Marie Commerson and Jeanne-Marie Mazuyer, and was born at Châtillon-les-Dombes, in Burgundy, November 18, 1727. He studied while a child under a Gray Friar at Bourg-en-Brosse, who became interested in him, and, taking him on his daily walks, inculcated in him the first principles of botany and a love of plants and of natural history. The district abounded in fish ponds, and wandering among them he gained a familiarity with fresh-water fish to which may be attributed his subsequent skill as an ichthyologist; and "his facility in manipulating, preserving, and drying certain fit specimens of the smaller fry, like plants, between sheets of coarse paper, first practiced by him for scientific purposes," was evidently acquired by him during this period. After two years at Bourg, he was sent to the Benedictine College near Mâcon, about 1742, to study for the law; but the scientific books of the abbey library had more attractions for him than the law books, and he was fonder of outdoor life than of studying his dry text-books. His father, willing that he should follow in the direction of his tastes, sent him to the University of Montpellier to read for the medical degree in 1747. He had already begun the preparation of a herbarium, and spared no efforts to make it the most complete in existence.

He spent four years at Montpellier after taking his degree, and in botanizing in the Cevennes, the Pyrenees, and Provence, and on the littoral of the Mediterranean. He soon became known throughout Europe as a naturalist of exceptional talent and experience. He was introduced to Linnæus and was commissioned by him to describe the fishes of the Mediterranean for the museum of Queen Louisa Ulrica at Dronningholm, near Stockholm. He prepared a list of all the botanists who had suffered in the pursuit of their calling, entitled the *Martyrologie de la Botanique,* in which he came near having his own name recorded even thus early, having been poisoned by the saliva of his own dog gone mad, and he wrote to one of his friends that he expected some day to figure upon the roll. This work seems never to have been published, and it is not known where the manuscript is. Coming to Dijon in his travels, M. de Beost, an officer of the states of Burgundy, gave him the privileges of his fine garden, glass houses, and library. Having explored Savoy, he visited the mountains of Switzerland, and, calling upon Voltaire at Geneva, received from him the offer of a secretaryship, which he declined. Then he settled down for a time at Châtillon, his native home, where he put himself in communication with correspondents who furnished him seeds and plants. He studied and explored and experimented with a reckless devotion which called forth from Lalande another prediction that his zeal would some day kill him. His overwork resulted in fever, in the convalescence from which he made the acquaintance of the young woman—"a sensitive plant," he called her—who became his wife: a daughter of M. Jean Beau, who died after two years of happy married life, leaving a son who survived him many years. To the memory of his wife, making a fanciful translation of her maiden name, Beau, he dedicated the genus *Pulcheria*—a plant not distinctly identified, but which was described as bearing a fruit that inclosed two kernels united in the shape of two hearts.

He removed to Paris in 1764, where, introduced by Lalande and Bernard de Jussieu, he was readily welcomed into the inner circle of learned society and gained the position and recognition he merited. In October, 1766, Commerson was appointed by the French Minister of the Marine, on the recommendation of Poissonier and the Abbé Lachapelle, of the Academy of Sciences, "botanist and naturalist of the king" to Bougainville's expedition of circumnavigation, then in course of organization at Nantes and Rochefort. The title given him was very grateful to him on account of the privileges it brought; that of botanist to the king had been conferred on only two or three men of science, and always led to a pension, while that of naturalist was a distinction which no one before him had obtained. He was first directed to draw up a report regarding the class of observations on natural history which he proposed should be carried out during the expedition. It suggested observations in three kingdoms of Nature, animal, vegetable, and mineral, to which was added a fourth class of physical and meteorological observations. "The class of quadrupeds," he said, "being subordinate to man, that being should always first attract the attention of the traveler naturalist. . . . The first shade after man is that of the anthropomorphic animals or apes with a human figure, of which it would be desirable to know all the series, because they establish an insensible passage from man to the quadrupeds."

Before leaving Paris for his voyage, Commerson made his will, in which he provided for the endowment as a *Prix de Vertu* of a medal of two hundred livres, bearing on its obverse face an inscription signifying that it was a reward for the practice of virtue, and on the reverse one signifying that the unworthy "P. C." had dedicated it. It was very like the Montyon prizes, afterward established and carried into effect. Having set out from Rochefort, after considerable delay, the expedition reached the mouth of the Rio de la Plata in May, 1767, and remained for some time at Montevideo to repair damages suffered from a storm. Here Commerson was astonished at the superfluity of horses and cattle, and wrote to his brother-in-law, further: "I have not failed to reap a fruitful harvest of plants, birds, and fishes, and I am anxious that nothing should escape me; but what can I do? I am neither an Argus nor a Briareus; a single day's hunting, fishing, or even a walk places me in the embarrassment of Midas, under whose hands everything became golden. Ofttimes I do not know when or how to begin, and I have scarcely time to eat or drink, so that my excellent friend, our good captain, is obliged to forbid my lamp being kept alight after midnight, because he has foreseen that I should deprive myself of sleep all night to gain sufficient time to examine all which is before me. The keen admiration which seizes me in viewing so many varieties, most of them new and unknown to science, has forced me to become a draughtsman."

From Montevideo the vessel, L'Étoile, proceeded to Rio Janeiro. In one of his excursions Commerson noticed some trees having a rosy mauve or magenta tint, which further examination showed him was given them by their brilliantly colored bracts. They were trees of a new genus, which he named Bougainvillea, after his commander. The genus has become familiar in conservatories. Returning to the Rio de la Plata, Commerson declined an invitation from the viceroy, Don Francisco Bucarelli, to go with him across the Andes to Chili and Peru. Proceeding onward again in November and December, 1767, the expedition sailed into the strait of Magellan. Thence they they went northwesterly into the Pacific Ocean; passed the Paumotu, or Low Archipelago; and visited Tahiti, of which Commerson has left a famous description in a letter to Lalande; continued to sail westwardly; sighted Samoa; were perplexed by the Great Barrier Reef, and had to make a back track along the Louisiade Archipelago to the Solomon Islands; between New Britain and New Ireland; along the northern shores of Papua; thence to Batavia; and finally, to Port Louis. Here M. Poivre, intendant of the colony, had orders from the authorities at home to retain Commerson for service under his direction; while Véron, the astronomer, was directed to proceed to India, to observe the forthcoming transit of Venus. Commerson was the first European to ascend the native volcano of Bourbon and to make a complete collection of mineralogical specimens from its hardly accessible craters. His account of a pygmy tribe inhabiting the mountain regions of Madagascar, after having been long contradicted, has recently been confirmed by the Rev. E. O. MacMahon, of the Society for the Propagation of the Gospel.

Commerson's career now soon came to an end. Among the results of political changes in the colony and in France were the withdrawal of ministerial patronage from him, the stoppage of his salary as naturalist to the king, and his dismissal. His health had already given way in consequence of the exposures to which he had subjected himself, and he was suffering from dysentery and rheumatism. He gave himself up to the study of the flora of Mauritius, writing to his friend Lemeunier: "My plants, my dear plants, have consoled me for all. I have found the nepenthe, the sweet assuagement of cares." He sought rest in another part of the island, but died, March 14, 1773, at the house of M. Bézac, a planter, near Flacq.

Commerson left his collections of plants, fishes, minerals, and manuscripts, thirty-two cases in all, to the Royal Museum of Natural History in Paris. They included, with two hundred folio volumes of herbaria, five thousand plants, of which three thousand species and one hundred and sixty genera were new to science.

In a collection made by Captain W. G. Thorold in Thibet of plants growing at elevations between 15,000 and 19,000 feet, fifty-seven, or one half, were found between 17,000 and 18,000 feet, five between 18,000 and 19,000, and one, *Saussurea tridactyla*, at 19,000 feet. A large majority of the plants hardly lift themselves above the surface, the characteristic type being a rosette of small leaves closely appressed to the ground with a central sessile inflorescence. Judging from the fact that many of the species are found in the most widely separated parts of the country, there must be very few local species; and the circumstances indicate that the distribution marks the remains of a once probably much richer flora.

SKETCH OF SEARS COOK WALKER.

A FEW years before the middle of the present century the condition of science in America was far from inspiring. Although this country had long since ceased to be a dependency of Great Britain politically, it still seemed unable to rise out of such a position intellectually. In science and letters English authority was paramount. To the generality of American scholars a grudging mention in an English publication outweighed domestic honors of a much higher grade. Scientific treatises emanating from Great Britain were accepted as gospel, while the science of the rest of Europe was known only through British translations. There were a few men of science who were independent in the midst of dependency. The above description shows the general character of a period happily long since brought to an end, and among those most active in bringing about its end was the subject of the present article.

Sears Cook Walker was born March 28, 1805, in Wilmington, a small town of Massachusetts, about sixteen miles northwest of Boston, where four generations of his ancestors had lived and died. His father's mother was descended in a direct line from the celebrated Elder Brewster, who came over in the Mayflower. Sears was a delicate child and so precocious intellectually that he early became the wonder of the village. His father had died when he was a mere infant, so that his whole care and training devolved upon his mother. She fortunately realized the importance of providing for his physical welfare and checking his too great fondness for books. It was a constant struggle with the boy's natural inclinations to do this, but the effort was successful. He joined heartily in many of the sports of his companions, and gradually gained a good measure of health and strength.

Young Walker took the studies preparatory for college at the academies of Andover, Tyngsborough, and Billerica; then went to Harvard, where he was graduated in the class of 1825. Immediately after his graduation he took up teaching as an occupation and followed it for ten years—the first two years in the vicinity of Boston and the rest of the time in Philadelphia. From 1836 to 1845 he was actuary of the Pennsylvania Company for the Insurance of Lives and Granting Annuities. His life in Philadelphia was a period of prosperity and comfort; he, moreover, early took on a corpulent habit of body, so that whatever influence his circumstances exerted was adverse to any strenuous intellectual exertions, and to the obtaining of adequate physical exercise. Yet his mind was one that could not be idle. "While engaged with his school," says Benjamin A. Gould, in his memorial address,* "he studied medicine, and went through the whole course requisite for the attainment of a degree. He devoted his leisure for a period to the study of natural history, and was no mean proficient in geology and mineralogy, as well as in physics and chemistry. He was an active member of the Pennsylvania Geological Society, of the Committee of the Franklin Institute on Science and Art, and one of the most useful members of the American Philosophical Society. By frequent articles upon scientific topics in the various prints, by elaborate reports upon various subjects to the Franklin Institute, and by monthly announcements in its Journal of occultations and other celestial phenomena, he kept awake the interest and sympathy of the community for studies of this character. Among other labors, he prepared, in 1834, an ingenious set of parallactic tables, by which the time required for computing the phases of an occultation was reduced to less than half an hour. These were calculated for the latitude of Philadelphia, and it was his intention to publish them in a more general form adapted to different latitudes. But, as this would have been a work requiring considerable time, he subsequently abandoned the project, believing that he could employ his leisure hours more usefully. He continued the computation of the occultations without interruption for six years, and then induced our well-known colleague, Mr. Downes, to undertake the continuance of the work. It has been prosecuted to the present time, with what success we all know, and has of late years been published by the Smithsonian Institution and the Astronomical Ephemeris. Astronomy and geography in America are much indebted to Mr. Walker for these labors, since many already in possession of the necessary means were stimulated by the periodical announcements, and by his personal exertions in still other ways, direct and indirect, to observe these phenomena. An extensive series of such observations was collected by Mr. Walker and published in the Proceedings of the American Philosophical Society."

During most of Walker's residence in Philadelphia he must be regarded as an amateur rather than a scientist. For many years his interest in Nature was spread over several fields, but gradually it concentrated upon astronomy. He had procured an astronomical clock, a twenty-inch transit instrument, and a small Dollond telescope, and from about the time when he gave up his school to become actuary of the insurance company all his leisure was devoted to astronomical observation and study. "In 1837,"

* An Address in Commemoration of Sears Cook Walker, delivered before the American Association for the Advancement of Science, at its meeting in Washington, April 29, 1854. From this address many facts concerning Walker's life and work in addition to the above quotation have been drawn.

Dr. Gould's account continues, "he was invited to propose a plan for an observatory in connection with the Philadelphia High School, an invitation which he accepted with eagerness. In accordance with his suggestion, the committee in charge of the school imported from Munich the excellent Fraunhofer equatorial and Ertel meridian circle which, in his hands and those of his accomplished brother, the present director of the observatory, have done so much for astronomy in America—not merely by the number of observations made with them, but also by the incentive which they afforded to the lovers of astronomy in other parts of the country. It is unquestionable that in several instances they induced successful efforts for the procurement of similar and even superior apparatus elsewhere." The results of Walker's researches appeared from time to time in the publications of the American Philosophical Society and various journals. It was in 1841 that he may be said to have "earned his spurs" by a paper on the periodical meteors of August and November, which for many years remained the most important memoir on the subject that had appeared. From that time on he is to be ranked among scientific investigators.

In 1845 Mr. Walker's affairs underwent a revolution. Certain commercial operations turned out disastrously and entirely bereft him of means. The sense of defeat, the loss of luxuries at a time of life when habits have become fixed, together with anxiety for the future, made the blow a hard one. But it revealed to him, and to the world, the extent of his own scientific ability, and opened the way to higher intellectual gratifications, which he quickly learned to appreciate. The Secretary of the Navy offered him a position in the observatory at Washington which he at once accepted. Here, for the first time, the facilities which his special gifts required were at his disposal, and he immediately proceeded to make good use of them. After a short time he gave up his position at the observatory to accept the direction of the longitude department of the Coast Survey—an office which he ably filled until his last illness.

Early in 1847, while engaged in researches upon the then newly discovered planet Neptune, he became convinced that a star observed by Lalande in May, 1795, must have been this planet. With the telescope of the Naval Observatory Prof. Hubbard confirmed this conjecture, and astronomers were thus furnished with an observation of Neptune made fifty-two years before, which afforded means for a most accurate determination of the planet's orbit. The American was none too soon to secure priority, for, quite independently, the same important fact was laboriously hunted down in Europe by Petersen only a few weeks later. Walker now attacked the problem of Neptune's orbit; Benjamin

Peirce was at the same time calculating the planet's perturbations. The approximate results of each furthered the computations of the other, so that within eighteen months from the discovery of the planet these two Americans had attained a remarkably accurate statement of its theory.

In conjunction with Prof. A. D. Bache, Superintendent of the Coast Survey, Walker developed the method of determining differences of longitude by telegraph. What was the separate share of each of these two men in this work will probably never be known, for each ascribed the chief merit to the other. One feature introduced by Walker was the application of the method of coincidence of beats to the comparison of timekeepers—one indicating mean, the other sidereal time—at the two ends of a telegraphic line. These beats were signalized from one station to the other by taps of an observer upon the telegraph key. Such signals are, of course, subject to the errors that always attend the action of human nerves and muscles, so the next problem was to make the clock give its own signals. Two methods had been proposed, but there were fears—groundless they have since been proved—that either of these would injuriously affect the running of the clock. Mr. Walker sought diligently for some apparatus that would not arouse any such fears. He propounded the problem to several astronomers, and two or three contrivances were devised for the purpose.

This mode of observation and the apparatus invented to meet its requirements proved valuable not alone for determinations of longitude, but also for all other astronomical observations requiring minute precision in the determination of time. The mental effort required of the observer being reduced to a minimum, many more transits could be observed at a single meridian passage. Walker immediately modified the transit instrument to suit the new requirements, and, instead of five, seven, or at most nine threads, he provided it with several tallies of five threads each. There remained but one requisite to complete the American method of observation. This was some mechanical contrivance for securing a uniform rotary motion of the record sheet. It had not been attained when Walker died, although some progress toward the solution of the problem had been made.

It is proper for the biographer to point out the share which Walker personally had in this series of inventions, although he was far from making any such claims for himself. With a fine comradeship he was jealous only for the credit of the organization of which he was a member—the United States Coast Survey. Speaking to the American Association for the Advancement of Science, Walker said: "With the single exception of the experiment between Baltimore and Washington, in 1844, I know of no telegraphic operation for longitude, and of no step in the improvement or perfectionment of the art, in Europe or America, which has not been the work of the officers proper of the Coast Survey, or of commissioned officers and civilians acting temporarily as assistants. . . . I will not here allude to the respective claims of Americans for priority or superior excellence of inventions and suggestions, believing that it will be becoming for all of us to look to the great work that has been accomplished by our united efforts, rather than to the single share of each."

The transmission of observations by telegraph between Cambridge, New York, Philadelphia, and Washington furnished Walker an opportunity for another important discovery. He found that an appreciable time was required for the passage of these signals, and that this time was less than one tenth of that required for the passage of light over an equal distance in space. This result was so greatly at variance with the ideas of electricity current at the time that it was not accepted in America until the celebrated velocity experiments between St. Louis and Washington put it beyond question, and even after that some European physicists still refused to be convinced. While the matter was in dispute Walker was generous with aid and encouragement to those who sought to test his discovery, whether their results seemed likely to conflict with or to confirm his own.

The English Nautical Almanac for 1856 (issued in 1853) contained a profound discussion, by the astronomer Adams, of the amount of the lunar parallax. In this paper Adams showed that the tables of Burckhardt, which had been the standard ones, contained errors sometimes amounting to 6″, and pointed out the effect that such errors must have upon determinations of longitude from occultations. In the greater part of this discovery Walker had anticipated the renowned Adams by more than four years. In April, 1848, he had presented to his chief in the Coast Survey a report on longitudes in the course of which he pointed out the chief errors of Burckhardt's tables, giving four out of the five principal terms with remarkable precision.

Mr. Walker's intellectual labor was intense and unremitting; it was scarcely interrupted even in summer, when he was accustomed to betake himself to Cambridge, to escape the heat of Washington. During one of these summer sojourns, in August, 1851, he suffered a slight attack of paralysis, which for a few days deprived him of the use of one hand. This warning and the entreaties of his friends were not enough to induce him to relax his exertions. In the following autumn he took charge of the expedition for determining telegraphically the differences of longitude between Halifax, Bangor, and Cambridge. Immediately after his return to Washington, at about the end of December, symptoms of mental alienation appeared, and he was taken to the hospital at Mount Hope, near Baltimore. Thence he was removed in the following April to Trenton, N. J., where under the skillful care of Dr. Buttolph, the superintendent of the institution, his disordered brain gradually regained its normal tone. Visits of friends, correspondence on the subjects of his researches, and finally his books and papers were allowed him. While still at Trenton he computed the ephemeris of Neptune for the American Astronomical Ephemeris of 1855. In the fall of 1852 Mr. Walker left the asylum apparently cured, although much debilitated by his illness, and went to Cincinnati for a visit to his brother, Hon. Timothy Walker, intending to remain until the following spring. He took in hand certain labors for the Coast Survey and prepared to resume in full his former sphere of activity. He had fixed a time for returning to Washington and re-engaged his apartments in the city, but he was not destined to make the journey. An attack of fever was followed by other maladies, and Walker soon found himself engaged in a second severe struggle with disease. In this condition Hamlet's problem—"To be, or not to be"—forced itself upon his thought with all its puzzling considerations. The sound mind in a sound body can give but one reply to this problem, but coming as it did to Walker at a moment when Reason was not firm in her seat, it elicited the opposite response, and on January 30, 1853, he launched himself into the mysterious after-life. His remains were placed in Spring Grove Cemetery, near Cincinnati.

The character of Sears Walker was marked by a childlike simplicity which many persons could hardly realize was not assumed to cover shrewd designs. He was impulsive, but his impulses were always noble and generous. Highly magnanimous, he was always prompt to acknowledge an error, and to overlook not only mistakes but even lapses from honor and justice in others. Intellectually he had the ability of genius. He was unadapted and disinclined for participation in the world's affairs, and could not refrain sufficiently for his physical welfare from intellectual labor.

Although his fame was won in the abstruse field of mathematics, his linguistic attainments were of a high order. In college he was as conspicuous for his classical as for his mathematical ability. During his years of teaching his knowledge of the languages was in daily use, and throughout life the literatures of Greece, of Rome, and of Italy were a source of enjoyment to him. His powerfully retentive memory was stored with long passages from the poets of the past, Tasso being his especial favorite.

EDITOR'S TABLE.

BACK TO DOGMA!

THE Marquis of Salisbury did not adopt the above words as the motto of his recent presidential address to the British Association, but he might have done so, for they fairly sum up the drift and spirit of that able but decidedly reactionary performance, the full text of which will be found in our present number. His lordship, it will be seen, thought it well to remind his hearers of "the condition in which we stand toward three or four of the most important physical questions which it has been the effort of the last century to solve," or, as he also described them, "stupendous problems of natural study which still defy our investigation." It is well to have our attention drawn as often as may be necessary to unsettled problems, provided it be done for the purpose of facilitating and encouraging further effort toward their solution. Whether that was the object which his lordship had in view, or at heart, is rendered a little doubtful by the tenor and particularly by the conclusion of his discourse. He showed that chemical science has not yet succeeded in explaining the nature and origin of the so-called elementary bodies, of which not less than sixty-five are recognized. He next observed how completely we had also failed to obtain any knowledge of the ether beyond the necessary assumption that it is an undulating medium. Turning to biology, he dwelt upon the fact that, although chemists have succeeded in manufacturing certain substances which had previously only been produced in living bodies, no living organism had ever been produced by human art, nor had the principle of life ever discovered itself to human investigation. Lastly, after a courteous acknowledgment of the services rendered by Darwin to biological science, he reached the point to which all his previous remarks had been tending, proclaimed his personal conviction that the doctrine of natural selection was inadequate to explain the origin of species, and that there was nothing left for us but to fall back on the hypothesis of intelligent and beneficent design as the ruling and guiding principle in the universe.

The end of his lordship's address thus throws light on the beginning. In reality it was an allocution not to the British Association for the Advancement of Science, but to the British public. The British Association did not require to be reminded that the ultimate atom of matter had not yet been discovered, nor that the ether still remained not much more than a working hypothesis, nor that chemical synthesis had not yet compassed the production of a definite living organism. The British public, on the other hand, would find a general declaration of failure on these several lines of research more or less comforting; seeing that, like most other publics in so-called civilized countries, while it is quite prepared to acclaim the results of science when they take the form of cheapened goods or increased conveniences of life, it dearly loves to think that philosophers make blunders and meet with disappointments, and, on the whole, are not so much wiser than other people. Consequently, the communication that was of little value or significance to the learned body to which it was addressed, was of much (misleading) significance to the unlearned body of the public for whom, we can not but believe, it was mainly intended.

In dealing with the doctrine of natural selection his lordship does not seem to us to have been altogether fair. He made as much as possible of the difficulties in the way of its acceptance, but gave no hint of the considerations which have forced it on the belief of nearly all students of zoölogy and biology. In like manner he brought forward the objection urged by Sir William Thompson (now Lord Kelvin) and Prof. Tait, as regards the time limit fixed by the laws of radiation for the possible existence of life on the earth, and left it to be understood that it was of an altogether insuperable character, which is far from being the case. The greatest disservice, however, which he did to the cause of science was in taking his stand, against the theory of natural selection, upon the doctrine of design. It needs but a few moments of careful and candid consideration to show that the doctrine of design means the death of scientific investigation. If things are so because they were intentionally made so, or because certain processes were miraculously expedited, then the universe may be the theater of Will, but not of forces the operation of which we can hope to understand. It is worthy of remark that his lordship did not even mention the familiar phenomenon of the struggle for life. That is something which can not be denied; and yet nothing is plainer than that the struggle for life means natural selection, and must, under certain circumstances, tend to the formation of new species. Prof. Karl Pearson, discussing this point in the Fortnightly Review for September, well observes that "every man who has lived through a hard winter, every man who has examined a mortality table, every man who has studied the history of nations, has probably seen natural selection at work." Lord Salisbury himself admits that Darwin "has, as a matter of fact, disposed of the doctrine of the immutability of species. . . . Few" (he adds) "are now found to doubt that animals separated by differences far exceeding those that distinguish what we know as species have yet descended from common ancestors." Well, how has this been brought about? Did the Divine Being, by an arbitrary act of will, simply change at a given moment the progeny of a given pair of animals so that one or more new species, or what we call species, should be originated, or was there some natural process of physical causation at work to produce the result? If the former alternative is to be adopted, then, as we have already said, all investigation of causes becomes futile: if the latter, then it matters little whether we accept Darwin's theory or some other; and certainly no one would wish to take his stand on Darwin's theory if a better—one which would fit the facts more closely—were available. The reason why the doctrine of design is so popular is partly because it is such a saver of intellectual toil, and partly because, by making knowledge impossible, it glorifies ignorance. It reduces biology to that "merely statistical" level from which, according to Lord Salisbury himself, it was the glory of Darwin to have raised it. What is left for the student of Nature save to record facts as he finds them, when every question as to how things have come to be as they are receives but the one reply, "The Creator designed them so"?

The unfriendly attitude of Lord Salisbury toward the doctrine of evolution is clearly shown by a remark he dropped when talking about the elements. "If," he said, "they were organic beings, all our difficulties would be solved by muttering the comfortable word 'evolution'—one of those indefinite words from time to time vouchsafed to humanity, which have the gift of alleviating so many perplexities and masking so many gaps in our knowledge." Lord Salisbury was addressing a presumably learned audience: why should men of the caliber of his hearers be disposed to "mutter" the word evolution without regard either to its proper meaning or to its application to the matter in hand? What the unlearned public would mutter is not much to the point, but it would hardly be the word "evolution." Prof. Pearson, however, in an article already alluded to, furnishes plausible reason, as other writers before him have done, for holding that "evolution" might be a very pertinent word not to mutter, but to utter, in connection with the very question his lordship had in view, and certainly a better word than "design." Lord Salisbury says that, although it is not easy to give a precise logical reason for the feeling, still the feeling is irresistible, that there can not really be sixty-five primordial bodies, but that the facts as cognized by us to-day conceal some much simpler condition of things. Why? If, when we are confronted with the difficulties which beset the origin of species, our duty is to fall back upon the doctrine of design, why should we not equally fall back on that doctrine when confronted with a seemingly ridiculous number of elements? It is very difficult to see why dogma should interfere to cut off one line of investigation and not another. Is it because Lord Salisbury is chiefly interested in physical studies that he repudiates for them the fetters he is only too willing to impose on biology? It would almost seem so; but if he is not impious in wishing to free physics from all dogmatic entanglements, neither is the biologist who desires and claims as much for the study of his choice.

It is too late to try to turn men aside from the unfettered, unbiased pursuit of natural knowledge. The method that Lord Salisbury prescribes for the students of organic Nature has been abundantly tried in the past and been found abundantly unfruitful. The more excellent way which Darwin has shown has, according to Lord Salisbury's own confession, already fertilized wide fields of knowledge; and its impulse and efficacy are far as yet from being exhausted. Darwin never supposed that he had furnished a key to all the mysteries of organic Nature, nor do the wiser of his followers entertain any such notion to-day. If some are foolish enough to think so, they will become wiser in time; but better far is it to place undue faith in a definite physical principle than, abandoning the search for causes, to adopt an arbitrary and stereotyped explanation which raises a barrier to all further intellectual advance.

POPULIST LOGIC.

A Missouri paper of the "Populist" faith predicts that when the state assumes control of the railways—which it says is but a question of time and a very short time at that—"the employees will be well paid, and we will hear no more of strikes and boycotts, while the great mass of the people who patronize the roads will for the first time know how little it actually costs to transport persons, products, and intelligence." As an instance of how cheaply the Government can do things, it cites the fact that a newspaper publisher can send one hundred pounds weight of his papers all over the country by post, and have them delivered, say, to twelve hundred different persons, for one dollar—a charge, it goes on to say, which is found "ample to meet all expenses." It is a great pity that journals which profess to deal with facts, and especially those which, from a basis of supposed facts, venture to draw most important and sweeping conclusions, do not take a little more trouble to state things correctly. What evidence is there, we would ask, that one cent per pound postage on newspapers is a paying rate? It is not to be found in the Postmaster General's report, which shows for the year 1893 a deficit of $5,177,171. This deficit arises on the whole business of the Post Office, which includes the carrying of letters at the rate of about fifty cents a pound; so that, could this part of the business, which undoubtedly yields a profit, be separated from the carrying of inferior grades of matter, the deficit arising on the latter would be vastly greater than that shown by the general balance sheet. Again, could newspaper matter paying only a cent a pound in bulk be separated from matter paying one cent per ounce, one cent per two ounces, and one cent per four ounces, it would still more clearly be seen at what an enormous loss the conveying of newspapers at the rate mentioned is carried on. It is too bad that people should be imposed on in this way; they support a paper specially to defend their interests, and it does so by feeding them with sophistry and misinformation. That is not the way to bring on the millennium.

THEOSOPHIST LOGIC NO BETTER.

In the August number of the Nineteenth Century a leading theosophist writer, Mr. A. P. Sinnett, undertakes to explain to us by an analogy the position of superiority which persons who are theosophically enlightened enjoy with reference to those who use only their ordinary senses and faculties. Conceive, he says, that mankind at large, while sensitive to light and shade, possessed no sense for color, but that a certain number of individuals were endowed with such a sense: the result would be that the latter would be regarded by the great majority "as guilty (to say the least) of a very gross affectation in professing to regard the tints of a flower as more agreeable to the eye than the color of a lump of clay." If the color-distinguishing minority were to go a step further and profess to be able to distinguish claret from sherry by simply looking at them, they would offend, we are told, still more deeply the common sense of the majority and would create doubt "as to the healthiness of their understanding."

It is indeed, we must confess, very difficult to have full confidence in the healthiness of the understanding of a writer who tries to palm off upon us an argument of this kind. In the case supposed the persons possessing the more-developed faculty would demonstrate every day of life, and in matters coming within the cognizance of all, that they had a definite power not possessed by men in general; and, instead of offending the common sense of the majority, they would be in high honor, and would have their choice of lucrative employments. But if these persons merely professed to have a sense, and now made a hit and now a miss, but far more often a miss than a hit in the pretended application of it, and if they charged money for their exercises in guess work they would make some dupes, but they would certainly offend both the common sense and the common honesty of right-thinking people. We venture to say in the most positive manner that theosophists can do nothing whatever parallel, in the world as it is to-day, to the distinguishing of colors in a color-blind community. If they can, tests can be made anywhere and everywhere, before any class of persons, with equal and unvarying success. The person who could distinguish claret from sherry by the color could go on doing it all day long, and it would not matter in the least to him before whom he exercised the power. He would do it so infallibly, so unvaryingly, and under such every-day conditions, that the non-recognition of his possession of a special faculty would be out of the question. But is there any theosophist to-day who, as theosophist, can claim to be able so much as to play an unvaryingly successful game of poker, to take a most familiar, and we hope not too vulgar, illustration? If there is, a grand career is open to him in some of our social circles. But Mr. Sinnett makes no such claim for his co-religionists. He goes no further than to say that, "although still a minority as compared with the whole, those persons who exercise what occult students generally call the 'astral senses' in varying degrees, are sufficiently numerous *to confirm one another's observations and reports*." The Italics are ours. Here we have the whole case. Reducing it to the terms of the former illustration, instead of the persons claiming to be endowed with the color-sense being in a position to experiment before the whole world in the distinguishing by sight of claret from sherry and other similar feats, they simply form a clique who perform experiments in more or less secret conclave, and then profess "to confirm one another's observations and reports." The two things are very different. Mr. Sinnett had better have chosen a different illustration.

LITERARY NOTICES.

Collected Essays. By T. H. Huxley. Vol. VI. Hume, with Helps to the Study of Berkeley. Pp. 319. Vol. VII. Man's Place in Nature, and other Anthropological Essays. Pp. 328. Vol. VIII. Discourses, Biological and Geological. Pp. 388. New York: D. Appleton & Co. Price, $1.25 each.

In the preface to the first of these volumes Prof. Huxley repeats his conviction, often expressed, that Descartes, if any one, may claim to be the father of modern philosophy; or that his general scheme of things, his conceptions of scientific method, and of the conditions and limits of certainty are far more essentially and characteristically modern than those of any of his immdiate predecessors and successors. A ruling axiom in his work, obedience to which was the source of his great merit—and an axiom which seems, moreover, to have inspired Prof. Huxley in all his studies—was expressed in his famous resolution "to take nothing for truth without clear knowledge that it is such"; "the great practical effect of which," says the author, "is the sanctification of doubt; the recognition that the profession of belief in propositions, of the truth of which there is no sufficient evidence, is immoral; the discrowning of authority as such; the repudiation of the confusion, beloved of sophists of all sorts, between free assent and mere piously gagged dissent; and the admission of the obligation to reconsider even one's axioms on demand." In the reform of philosophy since Descartes, Prof. Huxley thinks he finds the greatest and most fruitful results of the activity of the modern spirit, perhaps the only great and lasting results, in those first presented in the works of Hume and Berkeley, one of whom carried out the Cartesian principle to its logical result, and the other extended the Cartesian criticism to the whole range of propositions commonly "taken for truth." The essay on Hume was prepared originally for the English Men of Letters series, with some hope of passing on to others the benefits the author had received from the study of his works. The author hoped, also, at one time to add an analogous exposition of Berkeley's views, but was unable to carry out his desire, and is forced to content himself with giving two preliminary studies.

The first three essays in Man's Place in Nature recall an incident in the history of science, when, thirty-seven years ago, Prof. Huxley, after due study of the subject, ventured to differ with his fellow zoölogists or anthropologists, and to maintain that so far from certain features of the brain being peculiar to man and separating him far from other mammals, they were shared by him with all the higher and many of the lower apes. The rash philosopher was helped, to some extent, out of the troubles this indiscreet assertion brought upon him by the appearance of Darwin's Origin of Species. In 1860 he delivered six lectures to workingmen on the Relation of Man to the Lower Animals, and the subject was discussed before a "jury of experts" at the Oxford meeting of the British Association; and in 1862 Sir W. Flower publicly demonstrated the existence in apes of those cerebral characters which had been said to be peculiar to man. Besides the three lectures, first published in their present form in 1863, which embody the principles about which controversy raged, the volume contains lectures on the Methods and Results of Ethnology (1865), Some Fixed Points in British Ethnology (1871), and The Aryan Question (1890).

In the third of the volumes the author declares that he has never been able to regard a popular lecture as a mere side-work, unworthy of being ranked among the serious efforts of a philosopher, and is not one of those "who keep their fame as scientific hierophants unsullied by attempts—at least of the successful sort—to be understanded of the people"; but has found that the task of putting the truths learned in the field, the laboratory, and the museum, into language which, "without bating a jot of scientific accuracy," shall be generally intelligible, taxed such scientific and literary faculty as he possessed to the uttermost. Yet the popularization of science has its drawbacks, and success in it has its perils for those who succeed. "The 'people who fail' take their revenge, . . . by ignoring all the rest of a man's work and glibly labeling him a mere popularizer. If the falsehood were not too glaring, they would say the same of Faraday and Helmholtz and Kelvin." The volume contains eleven lectures, among which are some considering the origin and beginnings of life and the date of the beginnings, and involving the questions concerning which the biologists and the physicists are at odds. In literary style these essays are fit to rank among the most vigorous and idiomatic examples of English expression.

A Treatise on Astronomical Spectroscopy. Being a Translation of Die Spectralanalyse der Gestirne. By Prof. Dr. J. Scheiner. Translated, revised, and enlarged by Edwin Brant Frost. Boston: Ginn & Co. Pp. 482, with Plates. Price, $5.

This book was prepared in the original German because, although the astronomical was one of the most important applications of spectrum analysis, no suitable text-book was found especially devoted to it; the popular works, like Schellen's, admirable as they were within their range, were not suitable for the serious study of the subject, nor adapted as handbooks to scientific investigators; and while Kayser's Lehrbuch treated the subject in a more scientific way, it dealt with celestial spectroscopy in too brief and incidental a manner. The author felt, therefore, as the domain of astronomical spectroscopy was widening constantly, an increasing need of a work presenting an exhaustive account of all the modern methods and results of research in this branch of science. For like reasons, and because of the welcome that was given to the book, the translator regarded it as desirable that it should be made more available for instruction in the higher institutions, and more accessible to English-speaking persons interested in astrophysics. The author has endeavored to satisfy the requirements of both practice and theory, while at the same time giving a record of the results thus far accomplished; and, to make it more useful for practical work, has added a number of spectroscopic tables and an ample bibliography. The translator has found the advances in the science during the three years since the original was published so great that much had to be added giving the results of recent observations. As a rule, the portions so added are not distinguished from the original, all that is attempted having been to make the work thoroughly homogeneous and to present the facts and theories as impartially as possible. While this has been done with Prof. Scheiner's consent, he has opinions of his own on some of the points thus added, which he expresses in the preface. The work is divided into four parts, which relate severally to Spectroscopic Apparatus, Spectroscopic Theories, the Results of Spectroscopic Observations, and Spectroscopic Tables.

Great Commanders. General Washington. By General Bradley T. Johnson. New York: D. Appleton & Co. Pp. 338. Price, $1.50.

The author approached the duty of preparing this biography for the Great Commanders Series with much diffidence, because of the multitude of lives of Washington, the industrious authors and translators of which had spared no effort to find all that could be learned about him, so that "no new facts could be adduced to throw light upon his career or his character." Yet he believes that his work is the first attempt to consider the military character of Washington and to write his life as a soldier. While we may admit with General Johnson that the superhuman glamour with which a grateful child-nation invested Washington in the years just after the Revolution has fallen away and given place to a more reasonable estimation of him as simply a man of extraordinary virtues, we can not agree with him that any diminution in the general respect for the abilities of the Father of his Country has taken place; and we can not conceive that he has ever been regarded by the American people as no more than "an honest, well-meaning gentleman, but with no capacity for military and only mediocre ability in civil affairs." His place has never been other than first in the three fields in which the celebrated eulogy gave him that position; and the steady drift toward giving him his proper place in history and his appropriate appreciation as a soldier and statesman which the author acknowledges to have been going on for twenty-five years, was never less constant than it is now. Not words of eulogy, but rational appreciation of facts and calm estimates of deeds and appreciation of the bearing of the statesman's counsels and words constitute the highest admiration; and in these the American people have not been wanting toward Washington. In this work General Johnson has made a welcome contribution to our knowledge of Washington as he was.

Micro-organisms in Water. Their Significance, Identification, and Removal. By Percy Frankland and Mrs. Percy Frankland. New York: Longmans, Green & Co. Pp. 532. Price, $5.

The purpose of this work is to present in a compact shape the results of investigation of the bacteriology of water, the literature of which is extensive and very much scattered. The authors have therefore endeavored to present in it in connected form an account of the more important work that has been carried on in this department, in the hope that it may be of service to the student, the investigator, and those who are practically concerned with the hygienic aspects of water supply. They give, first, a survey of all the more important general methods of bacteriological study, describing in detail those which are specially applicable to the examination of water; second, an account of the principal results hitherto arrived at by the use of these new bacteriological methods in the study of the different kinds of water, and the changes which they undergo through natural and artificial agencies. Particular attention has also been bestowed on the behavior of pathogenic bacteria in water; and a concise description is appended of the principal characters of all the micro-organisms, numbering more than two hundred, which, so far as the authors have been able to ascertain, have hitherto been found in water. The first chapter treats of sterilization and the preparation of culture media, describing the forms of sterilizing apparatus and the use of them, and giving directions for the preparation of the media, with estimates of their value and particular application. The second chapter is devoted to the staining and microscopic examination of micro-organisms; the third, to the examination of water for micro-organisms. In the fourth and part of the fifth chapters, account is given of the numbers of micro-organisms that are found in waters derived from different sources, as ice, hail, rain, rivers, lakes, etc. The various methods of purifying water for drinking purposes are described and discussed in the fifth chapter. The subjects of the succeeding chapters are the multiplication of micro-organisms; the detection of pathogenic bacteria in water; the vitality of particular pathogenic bacteria in different waters; the action of light on micro-organisms in water and culture mediums; and tabular descriptions, with illustrations, of the various micro-organisms found in water.

How Gertrude teaches her Children. By Johann Heinrich Pestalozzi. Translated by Lucy E. Holland and Francis C. Turner, and edited by Ebenezer Cooke. Syracuse, N. Y.: C. W. Bardeen. Pp. 256. Price, $1.50.

This is described on the title-page as an attempt, given in the form of a report to the Society of the Friends of Education at Burgdorf, to help mothers to teach their own children, and an account of the method. But little of it has been translated before, those portions given in Biber's Life of Pestalozzi being, according to the editor, all. There are difficulties in the way of translation, on account of the use of peculiar terms for which there is no adequate English rendering. The translators have tried to give a literal translation without paraphrase and without omissions. They do not regard their work as perfect, and will "gladly and thankfully" receive any help which will make the authors' thought still clearer. The translation is preceded by a biographical and historical introduction. The position of this work is defined by the editor as along with the Method and the First Letter from Stanz, the place of the method being after Letter I of this book, in which Pestalozzi gives the history and circumstances that led him to those principles which he first definitely stated in the Method. These three essays form a complete group, and are estimated as Pestalozzi's most important educational works.

Woolen Spinning. By Charles Vickerman. New York: Macmillan & Co. Pp. 352.

This work is designed to be a text-book for students in technical schools and colleges, and for skillful practical men in woolen mills, which the author believes has long been wanted. The want is accentuated by the retrograde position into which the woolen industry has drifted during late years. The object of the book is to restate the principles that underlie the various processes and operations of the earlier portions of the woolen manufacture, and to assert their importance from the nature of the material in its raw state onward through every operation up to its being ready for the loom. The special subjects are considered of the nature and qualities of wool, sources of supply, sorting, scouring and drying, bleaching and extracting, dyeing, teasing or willeying, burring, mixing, oiling, carding; spinning, its history, principles, and progress; and the self-actor mule. The text is made clearer by the aid of numerous illustrations.

Bible, Science and Faith. By the Rev. J. A. Zahm. Baltimore: John Murphy & Co. Pp. 316. Price, $1.25.

The purpose of this book is to discuss the relationship between religion and science, and to prove that there is no antagonism between the truths of the Bible and the truths of Nature as revealed by scientific research. Some of the topics treated were presented before the Catholic summer school in 1893, and excited much interest and discussion. The author recognizes that a more extensive acquaintance with the natural and physical sciences, and the accumulation by Egyptologists and Assyriologists of new historical facts of far-reaching importance, have thrown much light on many parts of the Bible that were previously ill understood, if at all, and have supplied us with the necessary data for the solution of numerous perplexing problems which before were regarded as inexplicable mysteries. The notion is contradicted that reliance upon the Bible as a divinely inspired book should interfere with the freedom of investigation any more than reliance upon the compass or lighthouses should cripple the mariner's freedom of sailing. The truths of faith and the truths of science, though belonging to different categories, can never come into conflict. Both have God for their author. Guided by these views, the author discusses the Mosaic Hexaemeron in the Light of Exegesis and Modern Science (showing in the discussion how St. Gregory of Nyssa foreshadowed the nebular hypothesis and St. Augustine was an evolutionist); the Noachian Deluge, particularly with reference to its geographical, zoölogical, and anthropological universality; and the Age of the Human Race according to Modern Science and Biblical Chronology.

The Natural Law of Money. By William Brough. New York: G. P. Putnam's Sons. Pp. 168. Price, $1.

In this work the successive steps in the growth of money are traced from the days of barter to the introduction of the modern clearing house, and monetary principles are examined in their relation to present and past legislation. It is shown in the beginning that money came into use on account of its inherent fitness for certain services and men's appreciation of its value for such services before laws were made for its regulation and independently of laws. This argument is further developed to show that legal regulation can not, does not, and never did give value to money or affect it in any way save that unwise enactments may limit its elasticity and usefulness. "Clearly there is no need of making coin a legal tender at any weight whatever. If governments would confine their legislation to fixing by enactment the fineness of the precious metal and the number of grains that shall constitute each piece of a given size, they may safely leave the maintenance of the coinage in its integrity and the value of the pieces to be regulated by individual interest and action. Practically this point of monetary advancement has been reached by most of the civilized nations; but in the useless, although comparatively harmless, act of decreeing that coin shall be a legal tender at its bullion worth is manifested the extreme conservatism which still clings to the old delusion that legislation may in some vague sense regulate the value of coin. Although this delusion is harmless, as now exhibited in coinage acts, it becomes extremely mischievous when the attempt is made to regulate the value of the silver and gold coin at a fixed ratio of weights under the ruling of bimetallism; and it is only in a less degree mischievous when one of the money metals is ejected from the circulation under the ruling of monometallism." The argument is further carried out in chapters on Paper Money and Banking; the Monetary System of Canada; Money, Capital, and Interest; and Mandatory Money and Free Money; and is enforced by citation of The Hoarding Panic of July, 1893, when business found temporary relief from embarrassment in a method of its own spontaneous devising independent of legislative enactments.

The Steam Engine and other Heat Engines. By J. A. Ewing. New York: Macmillan & Co. Pp. 400. Price, $3.75.

The author of this work is also author of the article on the same subject in the Encyclopædia Britannica. Starting to expand that article into a university text-book, the additions and changes became so considerable that a virtually new work, except for parts of one or two chapters, was the result of the effort. The design has been to treat, besides the thermo-dynamics of the steam engine, of other aspects of the subject that admit of theoretical discussion, such as the kinematics of the slide valve and the kinetics of the governor and of the moving mechanism as a whole, and to give a general, if brief, account of the forms taken by actual engines and of the manner of their working. No attempt has been made to describe details particularly, but the distinguishing features of certain types have been indicated. In doing this, the greatest amount of space has been given to the less familiar forms, on the principle that a student need be at no loss to learn the construction of engines of the commoner kinds. Under "other heat engines" are included air, gas, and oil engines. The author has endeavored throughout to make evident the bearing of theory on practical issues; and the experimental study of steam engines is described at some length. In the course of the work are reviewed the Early History of the Steam Engine, the Elementary Theory of Heat Engines, the Properties of Steam and the Elementary Theory of the Steam Engine, the Behavior of Steam in the Cylinder, the Testing of Steam Engines, Compound Expansion, Valves and Valve Gears, Governing, the Work of the Crank Shaft, Boilers, Forms of the Steam Engine, and air, gas, and oil engines.

Papers and Notes on the Glacial Geology of Great Britain and Ireland. By the late Henry Carvill Lewis, M. A., F. G. S. Edited from his unpublished MSS., with an introduction by Henry W. Crosskey, LL. D., F. G. S. London and New York: Longmans, Green & Co. Pp. 469.

Had Carvill Lewis lived the ordinary span of life, the problem of the glacial deposits would have been pushed well toward solution by his efforts. One is fully convinced of this by an examination of the materials and the observations upon them accumulated by him which are now given to the public. His energy and ability are evident in his unfinished work, and, being thoroughly acquainted with geological principles and having the means to devote himself to his chosen researches, he would undoubtedly have accomplished important results. His last labors were done upon the glacial deposits of the British Isles. The whole of Scotland, nearly the whole of Ireland and Wales, and the northern part of England are included in the glaciated area of those islands. The volume before us opens with introductions by Dr. Crosskey and Mrs. Lewis, then follow five papers on various phases of the general subject. The greater part of the volume is made up of Prof. Lewis's field note books, which embody his observations made in the several glaciated counties of England and in Ireland during a visit in 1885 and another in 1886. Some field notes made in Switzerland, Italy, Germany, Belgium, and Holland are given in an appendix. From these materials we can derive Lewis's theory of glaciers as it was when his labors ceased. Not all glacialists will agree with it, for there are wide differences of opinion upon glacial theory. There is not even agreement as to matters of observation. But every one must admit that his hypothesis is clear and consistent, and requires no extravagant assumptions. It conceives the ancient ice sheet as formed thus: From many groups of mountains there radiate glaciers which meet and unite, but do not entirely lose their individualities. Each may be traced in its course by the nature of the stones which it carries, and the furthest advance of each will be marked by a terminal moraine. These glaciers would frequently form lakes by damming rivers, and the lakes would make deposits which must be distinguished from those dropped by the ice. The former he calls bowlder clay and the latter till. Many earlier theories and beliefs are vigorously shaken up in these notes. In the freely expressed opinions jotted down, in its evidence of the forming and abandonment or modification and development of views, this volume has a peculiar value that a finished treatise would not have. The investigator who would carry this subject forward should read the posthumous contribution of Prof. Lewis carefully and often.

Essays in Historical Chemistry. By T. E. Thorpe, Sc. D., F. R. S. London and New York: Macmillan & Co. Pp. 381. Price, $2.25.

In the dozen or so of lectures and addresses which Prof. Thorpe has gathered into this volume he tells how most of the great chemical discoveries of the past two hundred and fifty years have been made, and gives us an acquaintance with the personalities of the men who made them. The lectures are arranged in historical sequence, the first sketching the life and work of Robert Boyle, and the others dealing successively with Priestley, Scheele, Cavendish, Lavoisier, Faraday, Graham, Wöhler, Dumas, Kopp, and Mendeleeff. In this volume we may read how oxygen and the composition of water were discovered, and what were the respective shares of Priestley, Cavendish, and Lavoisier in these discoveries; how Wöhler broke down the barrier between organic and inorganic chemistry, and how the wonderful Russian, Mendeleeff, evolved the periodic arrangement of the elements. We may, moreover, learn also that Cavendish was intensely shy, a hater of noise and bustle, and had a house made up of laboratories and workshops, very little of it being set apart for personal comfort; that when young Faraday was traveling on the Continent as amanuensis to Sir Humphry Davy he wrote of Lady Davy, "Her temper makes it oftentimes go wrong with me, with herself, and with Sir Humphry," and similar interesting facts about the other men included in the volume. The lectures have been delivered as occasion has called them forth, to a variety of audiences, and the author is far from claiming that they constitute a history of the time from Boyle to the present day.

An Introduction to the Study of Society. By Albion W. Small, Ph. D., and George E. Vincent. American Book Company. Pp. 384. Price, $1.80.

The inquiry for a syllabus of sociological method printed in 1889 by one of the authors of this manual furnished surprising evidence of demand for scientific exposition of social relations. The interest in philosophical sociology has continued to increase in this country. Since the organization of the Department of Sociology in the University of Chicago applications for information about a suitable text-book of the subject have been incessant. No such text-book existing, this manual has been prepared as a guide to the elementary study. It does not presume to be a contribution to sociological knowledge or a report of research on the material of social knowledge, but a help in the training of beginners, the proposal of a method of preliminary investigation, a "laboratory guide"; the outgrowth of experience in teaching sociology under difficulties. It aims to commend a method that shall emphasize the necessity of precise knowledge of social facts, and shall confirm students in the habit of widening their comprehension of particulars by relating them to the containing conditions. The first book, on the Origin and Scope of Sociology, starts with the beginnings of the science, and goes on to treat of its development, its relation to the special social sciences and to social reforms, and of the organic conception of sociology. The second book, on the Natural History of a Society, takes the family, composed of the man and his newly married wife going to open a farm and settle on the native, solitary prairie, and traces the gradual growth of the community through the increase of the family, the accession of new settlers, the beginning of local trade, the constitution of the village and its development by the organization and division of industries, the establishment of communications, the formation of various social groups, and all the processes of commercial and municipal growth into the town and the city. The third book concerns social anatomy and the analysis of the elements and factors in the development described in the preceding book; the fourth book, the physiology and pathology of society; and the fifth book, its psychology. The essay is illustrated by five maps and charts delineating the several stages of the growth of the social organization.

Progress in Flying Machines. By O. Chanute, C. E. The American Engineer and Railroad Journal, 47 Cedar Street, New York. Pp. 308. Price, $2.50.

The subject of aërial navigation has become quite prominent of late by reason of important advances in this field that have been made during the past few years. The idea of controlling the course of a great bag of gas through the currents of the atmosphere has been well-nigh abandoned, and reliance is being placed more and more upon mechanical motors, the buoyancy of the air as exerted under large horizontal surfaces, and the force of the wind. Flying machines are now deemed much more practicable than dirigible balloons. Mr. Chanute's book consists of a series of illustrated articles contributed to The Railroad and Engineering Journal, the chief aims of which were to show whether or not man-flight is possible; to save waste of effort on the part of experimenters by making known what forms of apparatus have failed; and to enable investigators to judge as to whether new machines that may be proposed in future are worthy of trial. The author divides flying machines into three classes: (*a*) Wings and parachutes; (*b*) screws to lift and propel; (*c*) aëroplanes. Flapping wings in imitation of those of birds were early tried, and Mr. Chanute describes many curious forms of them, the earliest authenticated proposal being credited to Leonardo da Vinci. The first known proposal for an aërial screw was also his. Aëroplanes, however, do not date back much before the middle of the present century. Like the first-mentioned class of machines, their principle is derived from an action of birds—in this case the soaring or sailing action. Most of the flying machines described are shown in simple drawings. The results attained by Maxim, Lilienthal, and other recent experimenters are given, the book having been held back from the binder to append Lilienthal's own account of his latest work.

Six General Laws of Nature (a New Idealism) is a compendium, by *Solomon J. Silberstein*, of a large work which he contemplates publishing, on Divinity and the Cosmos. It is intended to contain "the primitive cause of force and matter, an explanation of all the physical phenomena in the actuality of the universe, and an attack on the modern scientists and philosophers." The author has satisfied himself by careful analysis that all the systems of philosophy are incomplete, unsatisfactory, and insufficient to the deep, logical, and honest thinker, and that most of the laws or axioms in modern natural science are very often defective, and even false. He therefore issues this work in correction of these errors, with the arguments and demonstrations through which he believes he has discovered the mystery and explained the physical phenomena of Nature.

The fields of biology and physics meet in the *Investigations on Microscopic Foams and on Protoplasm*, by Prof. *O. Bütschli*, of Heidelberg, which has recently appeared in an English translation (A. & C. Black, London, $6.25). Protoplasm is conceived of in this work as having the structure of a froth or foam in which minute droplets of a watery liquid take the place of air in the bubbles of an ordinary foam. The author has carefully investigated this structure in an effort to throw light upon the physical conditions of the phenomena of life. He has imitated it in oil foams and studied the phenomena of these, and has also investigated the structure of protoplasm in various organisms. About half the work is devoted to a summary of the views of other investigators upon the structure of protoplasm. The volume contains a list of works referred to, an index, twelve lithographic plates, and a number of figures in the text.

In preparing a series of essays on *The Relation of Biology to Geological Investigation*

(United States National Museum), Dr. *Charles A. White* had in view, among several objects, a further presentation of elementary matter pertaining to biological geology than has heretofore been published, the defense of biology as an indispensable aid in geological investigation, the repudiation of certain untenable claims that have been made in its favor, an application of the principles discussed to the practical work of the geologist, and the demonstration of the necessity of the preservation of fossil remains in public museums as storehouses of evidence upon geological questions.

How to Build Dynamo-Electric Machinery, by *Edward Trevert*, is intended to be a practical treatise, and in no way to be considered technical. Some theory, however, is given to help the reader in a general way. Its purpose is to give directions for building small dynamos and motors, accompanied by working drawings which will enable the reader to understand the text more clearly. The machines described have been carefully selected for efficiency and beauty of form and as being easy to build. Chapters on commercial dynamos and motors are added to show the general construction of large machines; and chapters on management, armature winding, and field-magnet winding, and a chapter of useful tables are inserted. The machines described are all American. (Published by the Bubier Publishing Company, Lynn, Mass. Price, $2.50.)

In *Hydraulic Power and Hydraulic Machinery* (J. B. Lippincott Co., American publishers) Henry Robinson has drawn from his own practice and utilized the experience of others, as reported in the proceedings of various professional societies, to record, in a form convenient for reference, existing experience in the engineering of water-pressure machinery. Special attention is given to the subject of the flow of water under pressure and to the employment of water-pressure mains to transmit power through the streets of a town on the principle which the author terms "power co-operation." Since the first edition was published, in 1886, the author has had constantly in view the desirability of enlarging and improving it. The present, second, edition is the outcome of this desire and contains much new matter, with better treatment of the old. Some compression, both of subjects and of descriptions, has been necessary to accomplish this, but the author thinks the illustrations selected of the innumerable applications of hydraulic power will be considered fairly to meet the circumstances.

PUBLICATIONS RECEIVED.

Agricultural Experiment Stations. Bulletins and Reports. Iowa Agricultural College, Nos. 24 and 25. Thirteen articles on various subjects Pp. 60 and 48.—Massachusetts: Commercial Fertilizers. Pp. 8.—Michigan State Agricultural College: Fertilizer Analyses, by R. C. Kedzie. Pp. 17. —New York: Analyses of Commercial Fertilizers. Pp. 36 —North Dakota: Weather and Crop Service, July. Pp. 15.—Purdue University: Wheat. Pp. 24. Commercial Fertilizers. Pp. 11, with Table.

American Association. Twelfth Annual Report of the Committee on Indexing Chemical Literature. Pp. 4.

American Chemical Society. Journal. September, 1894. Monthly Edward Hart, Editor. Easton, Pa.: Chemical Publishing Company. Pp. 72. $5 a year.

American Historical Register, September, 1894. C. H. Browning, Editor in Chief.

Barrett, John P. Electricity at the Columbian Exposition. Chicago: R. R. Donnelly & Sons Company. Pp. 501.

Bech-Meyer, Nico A Story from Pulmantown. Chicago: Charles H. Kerr & Co. Pp. 110. 25 cents.

Boaz, Franz. Address, Section of Anthropology, American Association. Pp. 29.

Brunacbe, P. Le Centre de l'Afrique, autour du Tchad (The Center of Africa, around the Tchad). Paris: Félix Alcan. Pp. 349, with Map. 6 francs.

Butler, George P. School English. American Book Company. Pp. 272. 75 cents.

Carus, Dr. Paul. Fundamental Problems. Chicago: The Open Court Publishing Company. Pp. 373. 50 cents.

Cope, E. D. Third Addition to the Knowledge of the Batrachia and Reptilia of Costa Rica. Pp. 12.

Dunham, W. R., M. D. The Science of Vital Force. Boston: Damrell & Upham. Pp. 198.

Dwight, Thomas, M. D., Harvard University. The Range and Significance of Variation in the Humsn Skeleton. Pp. 29.

Fiske, John. A History of the United States for Schools. Houghton, Mifflin & Co. Pp. 474. $1.

Geologic Atlas of the United States. Ringgold Folio, Georgia-Tennessee, six sheets.—Placerville Folio, California, five sheets.—Livingston Folio, Montana, six sheets. Library edition. Washington: U. S. Geological Survey.

Grimsley, G. P., Columbus, Ohio. The Granites of Cecil County, Maryland. Pp. 50.

Grotenfelt, Gösta; Woll, F. W., American Editor. The Principles of Modern Dairy Practice from a Bacteriological Point of View. New York: John Wiley & Sons. Pp. 285. $2.

Hancock, Joseph L. Ornithophilous Pollination. Pp. 5. with Plate.

Hunt, E. Geometry for Grammar Schools. Boston: D. C. Heath & Co. Pp. 100.

Interstate Commerce Commission. Sixth Annual Report of the condition of the Railways of the United States for the Year ending June 30, 1893. Washington.

Kunz, George F. Natal Stones. Sentiments and Superstitions connected with Precious Stones. New York: Tiffany & Co. Pp. 17.

Lefèvre, André. Race and Language. New York: D. Appleton & Co. Pp. 424. $1.50.

Massachusetts. Third Annual Report of the Trustees of Public Reservations. Pp. 56.

Michigan Mining School, Houghton. Catalogue, 1892-'94. Pp. 215, with Maps.

National Editorial Association. Souvenir of the B nquet tendered to it by F. W. Harper.

New York: State Reformatory at Elmira. Eighteenth Year B ok. Pp. 183.—University Regents' Bulletins. No. 27. Extension Teaching. Pp. 72.—No. 28. University Convocation. Pp. 275.—No. 29. Extension Schools. Pp. 84.

Nichols, Edward L. A Laboratory Manual of Physics and Applied Electricity. Vol. II. Macmillan & Co. Pp. 438, with Chart. $3.25.

North Dakota Weather Service. First Annual Report. B. H. Bronson, Observer. Pp. 70.

Palmer, Walter K. Mechanical Drawing. Columbus, Ohio: Charles B. Palmer. Pp. 51.

Parker, John D. Historical Paper of the Western Scientific Associations. Pp. 8.

Planetary Publishing Company, Chicago. The Play of the Planets. A Game, with Book. $1.

Powell, J. W., Director of the United States Geological Survey. Tenth and Eleventh Annual Reports of the Bureau of Ethnology. Pp. 822 and 553. Washington: Government Printing Office.

Richter, Eugene. Pictures of the Future. New York: Optimus Printing Company. Pp. 190. 50 cents.

Shinn, Millicent Washburn. Notes on the Development of a Child. University of California Studies. Vol. I, Nos. 1 and 2. Berkeley. Pp. 178.

Smithsonian Institution. Annual Report of the Board of Regents to July, 1893. Washington. Pp. 763.

Storer, F. H., and Lindsay, W. B. An Elementary Manual of Chemistry. American Book Company. Pp. 453. $1.20.

Turner, J. B. The New American Church. Chicago: B. F. Underwood. Pp. 60. 25 cents.

Van Norden, Charles. The Psychic Factor. New York: D. Appleton & Co. Pp. 223. $1.25.

POPULAR MISCELLANY.

Geology at the Brooklyn Meetings.—The Geological Society of America held its sixth summer meeting in Brooklyn, N. Y., August 13th to 15th; and the forty-third annual meeting of the American Association for the Advancement of Science was held in the same city, August 15th to 22d. The number of papers presented before the Geological Society was twenty-six, and exactly the same number also were read before Section E (Geology and Geography) of the association. This year a few distinctly geographical papers were presented in Section E, notably in contrast with several years preceding, which have had almost exclusively geological papers. One especially timely subject was the Geographic Development of China, Corea, and Japan, by Hon. Gardiner G. Hubbard, President of the National Geographic Society, Washington, D. C. On account of the importance and increase of work for both geology and geography, it is proposed that a special section of the association be devoted to each.

The vice-presidential address of Prof. Samuel Calvin, before Section E, on The Niobrara Chalk, called attention to the extensive beds of chalk in the middle division of the Cretaceous series of the upper Missouri River region. It has been generally taught in our geological text-books that no true chalk deposits exist in America; but explorations along the Missouri show that strata of chalk, ranging from sixty to ninety feet in thickness, extend from the mouth of the Niobrara to that of the Sioux River, on the west boundary of Iowa. The best outcrops are near Saint Helena, Nebraska. Microscopic examination reveals the same forms of foraminifera, coccoliths, and rhabdoliths which make up the chalk of England and portions of continental Europe. The close identity of conditions in these two widely separated regions was commented on as a fact of great scientific interest. At the same time with the deposition of the much thicker European chalk-beds, far away to the West, beyond the ninetieth meridian, and thus distant more than a quarter of the way around the globe, with an intervening abysmal ocean and a continental mass of land between these areas, there was another clear sea in which the same or very similar microscopic types of life were developed in incomprehensible profusion to make the chalk-beds of Iowa, South Dakota, and Nebraska.

Papers on the Archæan and Palæozoic rocks were presented by J. F. Kemp, C. H. Smyth, Jr., R. S. Tarr, W. P. Blake, E. O. Hovey, N. H. Darton, Arthur Winslow, C. W. Hall and F. W. Sardeson, C. H. Gordon, C. S. Prosser, N. H. Winchell, and J. P. Smith. Several papers relating to the Mesozoic and Tertiary formations were by H. W. Fairbanks, J. P. Smith, W. H. Dall, and Arthur Hollick. Dr. Dall confirms the Miocene age of the brightly colored and highly inclined fossiliferous strata of Gay Head, at the west end of Martha's Vineyard. Above the Miocene beds, however, and unconformable both with them and the overlying glacial drift, is a fossiliferous horizon of Pliocene age.

The large share of attention which is now being given to the Quaternary era, comprising the Glacial and Recent periods, is marked by the number of papers—eight before the Geological Society, and an equal number before the association, which pertained to this latest geologic era. Among these, perhaps the most notable was by Arthur Hollick, on the disturbance of the Cretaceous and Tertiary clay and sand strata next beneath the glacial drift along the course of the terminal moraine in northern New Jersey, on Staten and Long Islands, Martha's Vineyard, and Nantucket. The crumpled and distorted condition of these beds he ascribed to the crushing force of the ice advance. The dislocations and tilting are of similar character with the disturbances which have been shown to have resulted from the thrust of the Scandinavian ice sheet on the islands of Möen and Rügen in the Baltic Sea.

The recession of the ice sheet from the region of the Great Lakes tributary to the St. Lawrence was discussed in a paper by Warren Upham, tracing the successive stages of the ice-dammed lakes of that region, as known by their beaches, far above the present lake shores. From the relationship of those glacial lakes, held by the barrier of the waning ice sheet on their north and northeast sides, it was shown that the ice sheet in its retreat was melted away from the northern borders of the United States west of Lake Ontario somewhat earlier than from New York and New England. The measure of the Postglacial or Recent period, from the end of the Ice age until now, was thought from the rate of erosion of the gorge below Niagara Falls to have been about seven thousand years. Prof. J. W. Spencer, however, in another paper argued that the duration of this period has been some thirty thousand years.

Prof. Spencer also read a paper on the late Tertiary and Quaternary changes of level of the West Indies, in which great movements of uplift and depression of Cuba and the adjacent Antilles were held to have united these islands repeatedly to the North and South American continents, while the Gulf of Mexico and the Caribbean Sea were connected with the Pacific Ocean.

The Quaternary history of the Mississippi Valley was considered by Oscar H. Hershey, who regarded the loess of Illinois, Iowa, and the States farther south as the deposit of a somewhat late stage of the Glacial period.

Prof. Calvin's address is published in full in the American Geologist for September; most of the Geological Society's papers will soon be issued in its Bulletin, and abstracts of the association papers will appear, probably about a year hence, in the Proceedings of this meeting.

Officers of the American Association.—The following officers of the American Association have been elected for next year: President, E. W. Morley, Cleveland, Ohio. Vice-Presidents: A, Mathematics and Astronomy, E. S. Holden, Lick Observatory, Cal.; B, Physics, W. Leconte Stevens, Troy, N. Y.; C, Chemistry, William McMurtrie, Troy, N. Y.; D, Mechanical Science and Engineering, William Kent, Passaic, N. J.; E, Geology and Geography, Jed. Hotchkiss, Staunton, Va.; F, Zoölogy, D. S. Jordan, Palo Alto, Cal.; G, Botany, J. C. Arthur, Lafayette, Ind.; H, Anthropology, F. H. Cushing, Washington, D. C.; I, Economic Science and Statistics, B. E. Fernow, Washington, D. C. Permanent Secretary, F. W. Putnam, Cambridge, Mass. General Secretary, James Lewis Howe, Louisville, Ky. Secretary of Council, Charles R. Barnes, Madison, Wis. Treasurer, R. S. Woodward, New York. Secretaries of Sections: A, E. H. Moore, Chicago, Ill.; B, E. Merritt, Ithaca, N. Y.; C, William P. Mason, Troy, N. Y.; D, H. S. Jacoby, Ithaca, N. Y.; E, J. Perrin Smith, Palo Alto, Cal.; F, S. A. Forbes, Champaign, Ill.; G, B. T. Galloway, Washington, D. C.; H, Mrs. Anita Newcombe McGee, Washington, D. C.; I, E. A. Ross, Palo Alto, Cal. The association decided to meet next year in San Francisco, Cal., provided acceptable terms were secured from the railroads.

The Falling of the Leaves.—According to a paper by Prof. Trelease, quoted in Garden and Forest, three more or less distinct periods are observable in the falling of the leaves. The first, occurring on an average a week earlier than the main fall, is marked by the loss of the leaves of weakly twigs; the second comprises the main defoliation; the third embraces the period during which straggling leaves, mostly on branches that have been shaded during the growing season, successively disappear. This period is often limited only by the beginning of growth the next spring. Most leaves fall in consequence of the formation of a distinct joint, usually at the base of the leaf stalk. In very many of our trees the weakened twigs also are annually cast off by a similar process. This is especially observable in the willows, which are often spoken of as having brittle branches, although their wood is tough except where the joints referred to occur. The cottonwood and white elm show the same peculiarity well, the joints being formed at the beginning of the year's growth, so that the growth of from one to seven or eight years is often pruned off by a gale in autumn; and it is observable on oaks and many other trees. There seem to be two reasons for this provision: The fallen twigs of species that grow in wet places have been observed to strike root, thus serving as natural cuttings for the propagation of the species; on the other hand, it is clearly an advantage to the tree to lose weak branches that would make at best but a poor growth, while shedding and otherwise interfering with the development of the stronger shoots.

Standards for Professional Schools.—President Eliot, of Harvard University, in a recent address before the New England Association of College and Preparatory Schools, pointed out as one of the evils of the present system of management the fact that the requirements for admission to the scientific, technological, and agricultural schools of the country are, as they always have been, much lower than are exacted by the classical colleges. It is another evil that the schools of law and medicine have been, as a rule, "wide open to anybody walking into them from the street, without passing any admission examination whatever, or submitting to any inquiry into previous academic training. . . . This is the condition we have to confront: Three grades of attainment are required for the three different classes of institutions for the higher education—the colleges have the best grade, the scientific schools the next best, and the schools of law and medicine the lowest." The feasibility of finding a remedy for these conditions is held to be largely dependent on the colleges, scientific schools, and secondary schools co-operating. "Imagine the nine principal subjects, represented in these nine conferences" (which are held within the association), "actually put on an equality with each other in seriousness, dignity, and disciplinary value; and imagine a great variety of four-years' courses, all made up from the schedule of the combined conference recommendations, and carried out in hundreds of high schools and academies. Should it make any difference to a college whether a given candidate for admission to the college had studied this set of four or five subjects recommended by the conferences for a four-years' course, or that set of four or five subjects, both sets being taught in the manner recommended by the conferences? Should it make any difference whether the candidate for admission presented—to state the case in an extreme way—Latin, Greek, English, French, and German, or mathematics, physics, natural history, and history? Clearly, if the recommendations of the conferences had been effectively carried out, the education received by the youth who had taken the first group should be just as good as that of the youth who had taken the second group. . . . I need not say that we are not in sight of such a condition of things now. Most of you are perfectly familiar with the kind of substitute which is now offered to a boy in a high school for the classical course, which consists of Latin, Greek, mathematics, with a little history, and possibly the elements of a modern language. The substitute now offered ordinarily consists of English, mathematics, history, geography, botany, zoölogy, astronomy, geology, mineralogy, political economy, ethics, and perhaps the elements of one or two modern languages—an extraordinary number of scraps of miscellaneous subjects, instead of a limited number of substantial subjects, each treated with some thoroughness. Our adverse opinion concerning the possibility of making subjects equal for training value is really founded on our own convictions of the great superiority of the old-fashioned, solid classical programme in the academy and the high school, to the scrappy, ineffective programmes which are substituted for the classical programme in the inferior courses of our high schools and academies. . . . We shall never attain to an equality of subjects until the English or modern course in secondary schools has been made as solid as the classical. No elementary, superficial, and hasty treatment of a long series of subjects can possibly commend itself to the educated community as likely to produce the good effects of the consecutive, thorough, and prolonged treatment of a smaller group. We shall never know, for example, whether Latin and history are equally well adapted to secure the suitable development of the human mind until we have given history the same chance that we have given Latin."

The Coals of Missouri.—All the coals of Missouri, Mr. Arthur Winslow, State Geologist, informs us, are bituminous, except the cannel coals, which are found in local and small deposits. The bituminous coals have, as a rule, a high percentage of ash, as compared with the best bituminous coals; they are comparatively soft, suffer much from excessive handling or long exposure, and almost always carry pyrites. Most of the mines are less than two hundred feet deep. The Randolph shaft, in Ray County, is four hundred and twenty feet deep to the coal, and is one of the deepest. The deepest operated—which is, exactly speaking, within the State—is near Hamilton, in Caldwell County, and is about five hundred feet deep. At Leavenworth, Kansas, along the State line, however, a coal bed of only twenty-two inches is extensively worked at depths varying from seven hundred to eight hundred feet. For markets, the Western bituminous coal field, of which the Missouri mines are a part, besides the home market, looks chiefly to a great area in Nebraska, Kansas, the Indian Territory, and Texas, which is destitute of coal, and in which the supply of wood is small. Its only competitors are in the deposits of Dakota, Wyoming, Colorado, and New Mexico; but they can furnish only limited supplies.

Sanitary Inspection of Schools.—The English Education Department has started upon a detailed inquiry into the sanitary condition of the schools, and with this purpose has issued forms to the inspectors embodying questions bearing on that subject, to be filled up by them. The thirteen questions relate, for the most part, to the site, structure, and sanitation of the schoolrooms inspected. The inspectors are required, in noting any matters calling for alteration, to press for immediate attention to them, and are given power to use their discretion in enforcing changes. They are also instructed to bring under notice of the managers and the department serious defects in the convenience of the schoolrooms for teaching purposes or in their sanitation, with a view to their immediate removal. The objects of this action are to find, for the purpose of applying adequate means to secure efficiency, how far each existing school falls short of modern requirements, and to furnish a complete statistical record of the condition of school premises throughout the country. Other subjects concerning which inquiry might be made with advantage have been suggested, among which are the lighting of the rooms; the most appropriate closets and their number; the most suitable arrangements for washing—whether basins shall be continued or they shall be done away with and replaced by a stream of running water, affording a means of obviating the danger of communicating parasitic and contagious diseases; and the physical and mental condition of the pupils.

The Lichtenthaler Collection.—Illinois Wesleyan University has obtained by bequest the valuable collection of shells, ferns, and algæ gathered by the late George W. Lichtenthaler, of Bloomington, Ill., which has been placed in its museum as the George W. and Rebecca S. Lichtenthaler collection. It includes shells—between six thousand and eight thousand species, with twenty-five thousand specimens; crustaceans, echinoderms, corallines, corals, fossil shells and plants, minerals, four hundred species of ferns, and eight hundred species of marine algæ. Several cases are filled with gastropod shells cut longitudinally so as to show their spiral structure, and the highly polished specimens are very numerous. The ferns comprise a nearly complete collection of North American species, a complete collection from the Hawaiian Islands, and many from India, China, Japan, Australia, New Zealand, South America, and Europe. Mr. Lichtenthaler, one of the best known of American conchologists, and one of the early members of the American Association of Conchologists, was born about 1833, and removed to Bloomington, Ill., when twenty-two years old. He retired from business "with a snug fortune" after seventeen years of dealing in drugs. During this time he imbibed a taste for natural history, and after his retirement devoted his entire time and the proceeds of his large estate to the gathering and collecting of specimens. After Mrs. Lichtenthaler's death, without children, about ten years ago, he turned his attention more than ever to his chosen work. He died in San Francisco, Cal., February 20, 1893. He was a true amateur, and never sold a specimen or labored for hire, but was always ready to exchange specimens or give duplicates to persons who would appreciate them. In leaving his collection to the Illinois Wesleyan University he took care that his wife's name should be associated with his in the title given it.

The Giraffe.—The giraffe is described by R. Lydekker as the sole living representative of a separate family of the group of ruminant ungulates. It owes its height mainly to an enormous elongation of two of the bones of the legs, combined with a corresponding lengthening of the vertebræ of the neck. Its long neck has no more vertebræ than the neck of the hippopotamus or the extremely short neck of the whale. But while the bones of the whale and hippopotamus are broad and short, those of the giraffe are long—ten inches in full-grown animals—and slender. Accurate information is wanting as to the extreme height attained by the giraffe, but specimens of seventeen and eighteen feet have been described. The most distinctive structural peculiarity of the animal is in the nature of its horns, which take the form of upright bony projections from the top of the head, wholly covered with skin, and are unlike those of any other living ruminant. The giraffe's place in the animal kingdom seems to be between those of the deer and the antelopes; "while, as neither of these three groups can be regarded as the direct descendant of either of the other two, it is clear that we must regard all three as divergent branches of some ancient common stock." Of external features, the giraffe has not those lateral or spinous hoofs which are present in most ruminants. The large size and prominence of the eyes and the extensibility of the tongue are noticeable features The long tail, terminating in a large tuft of black hairs, is a feature unlike any in the deer, though it recalls certain points in the antelopes. "Somewhat stiff and ungainly in its motions—the small number of vertebræ not admitting the graceful arching of the neck characterizing the swan and the ostrich—the giraffe is in all parts of its organization admirably adapted to a life on open plains dotted over with tall trees, upon which it can browse without fear of competition by any other living creature. Its wide range of vision affords it timely warning of the approach of foes; from the effect of sand-storms it is protected by the power of automatically closing its nostrils; while its capacity of existing for months at a time without drinking renders it suited to inhabit waterless districts." When seen away from its habitual surroundings the spots of the giraffe make it seem very conspicuous; but among the tall mimosas in which they feed, "giraffes are the most inconspicuous of all animals; their mottled coats harmonizing so exactly with the weather-beaten stems and with the splashes of light and shade thrown on the ground by the sun shining through the leaves, that at a comparatively short distance even the Bushman or Caffre is frequently at a total loss to distinguish trees from giraffes or giraffes from trees." The giraffe is now confined to Africa, although in Pliocene times it roamed over parts of southern Europe and Asia. It was known to the Romans of the time of the empire as the camelopard, but was afterward forgotten in Europe till about two hundred years ago. It is much hunted for its skins, which are used in the manufacture of the South African *jambok* whips, and is in great danger of being driven out of existence.

Negative Evidence from the Caves.—In the papers of the department of Archæology and Paleontology of the University of Pennsylvania, H. C. Mercer describes explorations of caves and other spots which might yield signs, near Trenton, N. J., and in the South, for evidences of Paleolithic man. At Trenton he found "turtlebacks," explainable as "inchoate cache blades of the latest Indian period," and other turtlebacks not so explainable, "and seeming to betoken a period of unknown direction before the working of the quarries." In Durham Cave, Stroudsburg, Pa., instead of a pre-Indian cave man, a red man was found, "as the contemporary, it seemed, of the peccary and giant chinchilla." In the chalk gorges of southern Texas, apparently promising indications gave only tokens of modern surface loam, which had fallen and mingled with ancient underplaced chalk. The cave at Lookout Mountain was explored to the bottom. Teeth of the tapir close to the layer of occupancy by man, added, however, a new species to the list of extinct North American mammals thus far observed in like association with human remains. The Nicajack Cave, in Marion County, Tenn., likewise failed to yield any earlier than neolithic remains.

Kinds of Ivory.—Four principal kinds of ivory are known in the market: that of Guinea, the Gaboon, or Angola, which is a little greenish, so that it is sometimes called green ivory, and which whitens with age; Cape ivory, which is of a dull, light, somewhat yellowish color; Indian or Siamese ivory, very rare, and white, with a tinge of rose color; and the fossil ivory of Siberia, remains of the mammoths of the olden time. Of these, the West African ivory is most highly prized, being finer and more transparent than the others. It is pretended that experts, when they see a well-preserved tusk, can tell whether the animal that wore it came from East or West Africa, or north or south of the equator. The farther north the animal's habitat, and the more elevated and dry the situation, the more the ivory is coarse and inferior. The principal market for ivory is at Liverpool, and nearly one third of the stock imported there is used in the Sheffield cutleries. Another considerable market is at Antwerp. The annual exports of ivory from Africa represent the product of sixty thousand elephants, and this means a rapid reduction of the elephantine population of the continent. Various artificial ivories, or imitations, are manufactured to supply the increasing demand. There are vegetable ivory—tagua seed from Peru, or wood injected with chloride of lime; sheep bone, macerated with the wastes of white skins; paper pulp with gelatin, celluloid, and caoutchouc; a preparation of potatoes; and a substance obtained by treating milk with certain reagents. The expediency has been suggested of establishing elephant farms, to form a more certain source of supply than hunting wild elephants is destined to become. Ostrich farming has proved practicable; why not elephant farming too?

Migration of Birds.—On the solution of the problem of the migration of birds, Canon Tristram said in the British Association, much less aid has been contributed by the observations of field naturalists than might reasonably have been expected. The observable facts may be classified as to their bearing on the whither, when, and how of migration, and after this we may possibly arrive at a true answer to the Why? Observation has sufficiently answered the first question, Whither? There are scarcely any feathered denizens of earth or sea to the summer and winter ranges of which we can not now point. Of almost all the birds of the holo-arctic fauna we have ascertained the breeding places and the winter resorts. Now that the knot and the sanderling have been successfully pursued even to Grinnell Land, there remains but the curlew sandpiper of all the known European birds whose breeding ground is a virgin soil, to be trodden, let us hope, in a successful exploration by Nansen, on one side or other of the north pole. Equally clearly ascertained are the winter quarters of all the migrants. The most casual observer can not fail to notice in any part of Africa, north or south, west coast or interior, the myriads of familiar species which winter there. We have arrived at a fair knowledge of the When? of migration. Of the How? we have ascertained a little, but very little. The lines of migration vary widely in different species and in different longitudes. All courses of rivers of importance form minor routes. Consideration of all lines of migration might serve to explain the fact of North American stragglers, the waifs and strays which have fallen in with great flights of the regular migrants, and been more frequently shot on the east coast of England and Scotland than on the west coast or in Ireland. They have not crossed the Atlantic, but have come from the far north, where a very slight deflection east or west might alter their whole course, and in that case they would naturally strike either Iceland or the west coast of Norway, and in either case would reach the east coast of Britain. But, if by storms and the prevailing winds of the North Atlantic coming from the west, they had been driven out of their usual course, they would strike the coast of Norway, and so find their way to Britain in the company of their congeners. It is maintained that the height of flight is some fifteen hundred feet to fifteen thousand feet.

The Atlas Mountains.—The great chain of the Atlas forms a mountain system which is described by Charles Rolleston as, for the grandeur and beauty of its romantic scenery, not to be surpassed, perhaps, by any in the African continent. The range extends into the adjacent French possessions in Algeria, but in Morocco its length is about three hundred miles, of which thirty miles, stretching from the sources of the river known as the Ouad Tissout, attain a general elevation of about twelve thousand feet. On approaching this imposing mountain line the aspect is truly sublime. At the time of early dawn of certain seasons the heights are imbedded in masses of white mist, which, under the influence of the rising sun, dissolve with the appearance of a thin, gauzy veil, disclosing a magnificent panorama of mountains rising behind mountains. Toward the Atlantic on the outer side, and in the direction of Algeria on the other, a broad line of snow edges the mountain tops; and at intervals loftier snow-clad peaks tower up, piercing the background of dark blue sky. Just below the region of snow the mountain sides are intersected by broad valleys bounded by wild, craggy heights; but lower still, where vegetation begins, the slopes are furnished with forests, stretching at places into long expanses of parklike woodland of pine, oak, walnut, and larch trees, growing with wonderful luxuriance. The view of the landscape, looking down five thousand or six thousand feet, is variegated and beautiful, for, watered by thousands of rivulets pouring from the base of the Atlas, there stretch away miles of fertile country strewn with Berber hamlets, plantations, and fruit orchards, the deep-green grass land and cultivated fields diversified with gardens and groves of orange, lemon, palm, and myrtle, producing the most charming harmony, combination, and contrast of coloring as far as the horizon, and the whole together presenting a landscape of the most enchanting beauty.

Women Astronomers.—Of six famous women mathematicians and astronomers whose work is mentioned by M. A. Rebière in a recent communication, the first, Hypatia, daughter of Theon, of Alexandria, lived in the fourth century, publicly taught mathematics and philosophy to large classes, and wrote treatises on mathematics. From her the author comes down to Madame du Châtelet, in the eighteenth century, a mathematician, astronomer, and physician, who in a memoir on fire, in the French Academy of Sciences, maintained that heat and light were produced by the same cause. Other women mathematicians mentioned by M. Rebière are Marie Agnesi, born at Milan in 1718; Sophie Germain, who, at the end of the last century corresponded with the mathematician Montucha; Mary Somerville, the friend of Laplace and a student of astronomy and physics during her whole life; and Sophie Kowaleski, born at Moscow in 1850, whose work on the rings of Saturn has been complemented by that of Mademoiselle Klumpke, of the Paris Observatory. Besides these, *La Nature*, in its supplement, names a number of less-known women who have attained a larger or smaller degree of distinction by their labors in this field. The Abbess Herrade, in the twelfth century, was author of a cosmology, the *Hortus deliciarum;* in the same century, Sainte Hildegarde gave, in her *De Physica*, a summary of the sciences of her time. In the thirteenth century, Nontis Sabucco described the function of the white matter of the brain. In the fourteenth century, Thiephaine Raguenel, wife of Duguesclin, was "learned in astronomy." Eimart-Meller, wife of Regiomanes, assisted him in his observations. Croris advocated the decimal system; Dumée defended the Copernican theory; Cunitz calculated the astronomical tables called *Urania propitia;* Ardingheli published works on mathematics and natural science; Bassi taught physics in the University of Bologna for thirty years; Lemère studied the quadrature of the circle; Mésian went to Guiana and published an important book on the insects of Surinam. Maria Mitchell and Yvon Villarceau were well-known astronomers; and among contemporary women of science in different nations the names of Agnes Clarke and Clemence Royer are those of foreign workers best known to our readers.

College Athletics and Health.—Speaking, in an address on the Influence of College Life on Health, of College Athletes, Dr. Edwin Farnham says that "they are, as compared with the whole number of students, but few, and must always be so; for the true athlete, like every real artist, is born, not made. Much has been written about training, as if by some mysterious process an athlete could be developed out of any sort of material. As I understand training, it is a process by which a man is put into a condition which enables him to make the greatest skilled muscular effort of which he is capable, in a certain way, for a certain time. It may be beneficial to health, but that is not its object. You must have the proper material to work upon, or all the training in the world will be of no avail. At many colleges large sums of money have been spent on the various preparations necessary for athletic contests, and a great deal of time and labor devoted to them. At some colleges special privileges have been granted to the men composing the athletic teams. Has an equal amount of attention been given to the care of the health of the students, considered in the light of a subject in no way connected with muscular development? What I know about this matter relates mainly to Harvard University, but I am disposed to think that other colleges would not be found superior to Harvard in this respect. I am, and for more than thirty years have been, interested in athletic sports, but I hold it true that the first duty of a great educational institution is to the scholar — not to his intellectual needs alone, but to everything that makes for the preservation and improvement of health as well. None can know better than the body of physicians here assembled that the use which a man may be able to make in his life work of the knowledge acquired during his school and college days will depend largely on the condition of his health. Physical exercise has been a mania for some time, and much nonsense has been written about it. Even so great an authority as Dr. Parkes says, in his Practical Hygiene, 'Exercise is a paramount condition of health, and the healthiest persons are those who have most of it.' Exercise in the proper amount is indeed one of the means conducive to the preservation and improvement of health, but there are others as important, and some more so. The scholar should always bear in mind that in his case exercise is intended as a means to health which shall enable him to do his proper work in the best manner. He should never try to combine great mental with great bodily labor. I feel sure, from personal experience and from what prominent athletes have told me, that this can not be done with safety."

Archæology at the University of Pennsylvania.—The purposes of the department of Archæology and Paleontology of the University of Pennsylvania are to provide instruction in those subjects and in ethnology, and to extend scientific inquiry by means of original investigation in them. It will accomplish this by means of a library, courses of lectures, and the sending out of exploring expeditions. In the section of Babylonian antiquities excavations have been continuously carried on at Niffur, Mesopotamia; the Temple of Bel there has been nearly uncovered, many inscribed stones, cuneiform tablets, etc., of 4000 years B. C. have been obtained, and a collection of inscriptions published; and Dr. H. V. Hilprecht has spent five weeks in examining the cuneiform inscriptions collected at Constantinople. In the Egyptian section lectures have been delivered by Mr. Cornelius Stevenson; an exhibition of the Graf collection of rare Græco-Egyptian portraits and other objects has been secured. In the section of Glyptology special provision has been made for the Summerville collection of gems and talismans and it has been considerably increased; while no opportunity has been neglected that might afford new acquisitions. A section of casts has been established, and arrangements have been made for filling it. A collection of photographs illustrating archæological objects at Copan, Honduras, has been obtained.

The section of Asia and General Ethnology was formed in January, 1894, and has been enriched with a collection of Oriental games, an important series from the Sultan of Johore, Chinese porcelain images; masks, weapons, etc., from Ceylon; games of all countries, military banners from Corea, and Indo-Greek sculpture, from Afghanistan. The archæological library has grown in one year from a collection of four hundred to one of eighteen hundred volumes.

Oriental Silver Work.—Silver, according to our consul at Amoy, is to the Eastern Asiatics as gold to us, and is worked up by them into innumerable articles of curio and bric-a-brac. One class of designs consists of miniature reproductions of features of daily life, including articles of household and personal use, the goddess of mercy, the Celestial Porole, the King of the Fishes, the sitting Buddha, the dragon, the flying serpent, the begging priest, and animals of all sorts. The largest of these articles do not exceed two inches in length, and they diminish to dainty little objects no larger than a grain of corn. The work and finish are admirable, and the features and hair of the human beings and the scales of the fishes and crocodiles are reproduced with the highest care and skill. Another class of these objects consists of miniature cordage. The metal is solid, but the surface is so cleverly wrought out that at first sight each piece seems a rope, cord, or braid. Some of them are as fine as sewing silk, while others are as thick as clotheslines. These silver cords are used for bracelets, anklets, necklaces, belts, sword hangings, and horses' harness. Though stiff, they are not rigid, and can be bent in any direction. A third class of articles includes household ornaments, such as match boxes, ash cups, joss sticks, bowls, sandalwood urns, plates for opium pipes, button boxes, and so on without end. A fourth class includes filigree work and tissues made from fine silver ware, all marked by the highest skill and beauty. Articles of this class, brought by Marco Polo to Venice, are supposed to have suggested the Italian filigree industry. A design from Fuchan is a bouquet, over which is loosely wrapped a silken veil. It was so perfectly made that the veil looked as though it might blow away at any moment. Through its flimsy folds the flowers and leaves were all visible. Another artistic gem is a little bouquet in which ferns, lilies of the valley, and other plants are completely represented in metals.

NOTES.

Mr. Gerard Fowke calls attention to the fact that, while Ohio has furnished prehistoric articles and relics for hundreds of collections at home and in Europe, and still possesses material to furnish specimens exceeding in number those of all collections combined of American archæology, the State has no adequate collection of its own accessible to all the public. The opportunity to form such a collection is now afforded through the new geological building of the State University, where should be established "the nucleus of a museum of Ohio archæology that would properly represent the great wealth of prehistoric remains within her borders." These remains should be gathered up industriously, "for they are being as slowly but as surely blotted out as are the aboriginal conditions of life which gave them existence."

Prof. Riley read a paper in the British Association on Social Insects and Evolution. He gave an account of the different kinds of individuals in the communities of bees and ants, and pointed out differences which indicated a gradation in the degree of their development. In the colonies of white ants the production of different kinds of individuals was even more under the control of the community. There were also many variations in different species: some had no soldiers; others, supplementary and complementary kings and queens, which were capable of reproduction in their pupal and larval stages. They fed, among other things, on their dead companions, and hence might be destroyed by poisoning a few, who in their turn poisoned their cannibal fellows. In these and other cases which were adduced the competition was between colonies, not between individuals, and, on the whole, the evidence drawn from these insects is in favor of the transmission of acquired characters.

The name Mashona (in Mashonaland) was explained by a Mr. Drule in the British Association as an English corruption of the nickname Amashuina (baboons) given by the Matabele to the Makalanga.

Great interest was awakened in the British Association by the communication of Lord Rayleigh and Prof. Ramsay on a new gas occurring in the atmosphere. Attention was first called to this substance by the fact that the density of nitrogen obtained from atmospheric air differed by about one half per cent from the density of nitrogen obtained from other sources. It was found that if air is subjected to electric sparks, the resulting nitrous fumes absorbed by potash and the excess of oxygen by alkaline pyrogallate, there remains a residue which is neither oxygen nor nitrogen, as can be seen from its spectrum. The same gas may be isolated by exposing nitrogen obtained from the air to the action of magnesium. As the magnesium gradually absorbs the nitrogen, the density of the residue rises to nearly twenty. The newly discovered substance constitutes one per cent of the atmosphere, and gives a spectrum with a single blue line much more intense than a corresponding line in the nitrogen spectrum. Prof. Dewar is of the opinion that this "new element" is an allotropic form of nitrogen.

LIVERPOOL was designated as the place for the meeting of the British Association in 1896. Sir Douglas Galton will be president of the meeting at Ipswich next year. The meeting for 1897 will probably be held in Toronto.

PROF. T. JOHNSON exhibited in the British Association a large collection of algæ from the west coast of Ireland which have the power of strongly incrusting their tissues with chalk and forming hard masses of calcareous matter. He considered that by this means the algæ obtained protection from the ravages of nibbling animals. He also described a number of algæ which possess an entirely opposite property, and by their power of dissolving calcareous matter bore minute holes in the shells of various molluscs and thus completely destroyed them.

PROF. L. H. PAMMEL, in a paper on the Effects of Cross-Fertilization in Plants, cites experiments by Prof. Bailey, of Missouri, who obtained more than a thousand types of pumpkins and squashes by as many careful hand pollinations without having ever seen any influence on the season's crop by mixing, except such as was due to imperfect development. The effects of the pollen were seen only in the offspring of the fruits. The author himself had made similar experiments without obtaining any results favorable to the theory of immediate influence. Prof. Bailey has made a like report of experiments with cucumbers and muskmelons.

IN a paper read in the Association of Economic Entomologists on The Rise and Present Status of Official Economic Entomology, President L. O. Howard reviewed the entire history of official economic entomology in all parts of the world from the time when in the early part of the century Dr. T. W. Harris, of Harvard College, wrote his report on insects injurious to vegetation in Massachusetts, for which he received one hundred and seventy-five dollars, down to the present year, when the United States Government spends one hundred thousand dollars annually in employing some sixty official entomologists in different parts of the country, and when some twenty different countries in all parts of the world have reached the conclusion that it pays to employ trained investigators to study the subject of insects injurious to crops. The speaker asserted that America leads the rest of the world in this branch of applied science.

THE University of Chicago desires to secure for its museum collections illustrating the various religions of mankind, and invites workers in foreign lands, and especially missionaries and teachers, to assist it and co-operate with it. A beginning has already been made in a collection which the university now holds as a loan of objects illustrating Shinto worship and Japanese Buddhism, gathered by Mr. Edmund Buckley in Japan. A catalogue of the Shinto specimens is published in illustration of the kind of objects sought, and for the guidance of persons who may wish to co-operate in the work of collecting.

A COURSE of lectures on prehistoric archæology, outlined by Prof. Frederick Starr for the University Extension Course of the University of Chicago, is to embrace twelve lectures. A syllabus has been published of the first six lectures, the subjects of which are Man and the River Gravels, The Man of the Caverns, The Stone Age in Denmark, Lake Dwellings of Switzerland, Megalithic Monuments, and The Bronze Age in Scandinavia. The subjects of the other six lectures, of which a second syllabus is to be published, are Hallstadt, La Téne, Spain and Portugal, The Copper Age in Hungary, The Hill of Hissarlik, and The Question of Tertiary Man. Topics for exercises are to be given at the end of each lecture, to which answers in writing, to not more than two questions each week, are invited from all persons attending the lecture.

IN a paper on The Relation of Biology to Geological Investigation, Dr. Charles A. White, of the United States National Museum, pertinently observes that a special cause of the perpetuation of extreme views respecting the degree of prominence to be assigned to biology "evidently exists in the form of personal domination by such of those who entertain them as happen to possess unusual opportunities for their enforcement. It is well known that such influence has at various times and in various ways retarded the progress of geological science, and that there is danger of its being exercised in all cases when the personal judgment of an observer is liable to be modified or controlled by official or other temporary authority."

OIL of beechnuts and oil of linden seeds have for some time been manufactured in Germany for use instead of olive oil. The oil of beechnuts has been in active demand for several years, but the crop is uncertain, and a steady trade has therefore not been built up. Experiments were made with linden seeds, of which there never fails to be a good crop, with most satisfactory success. They furnish much more oil than beechnuts; an oil that has a peculiarly fine flavor, does not evaporate or become rancid, has no tendency to oxidation, and does not solidify at a temperature of three degrees below zero of Fahrenheit.

OBITUARY NOTES.

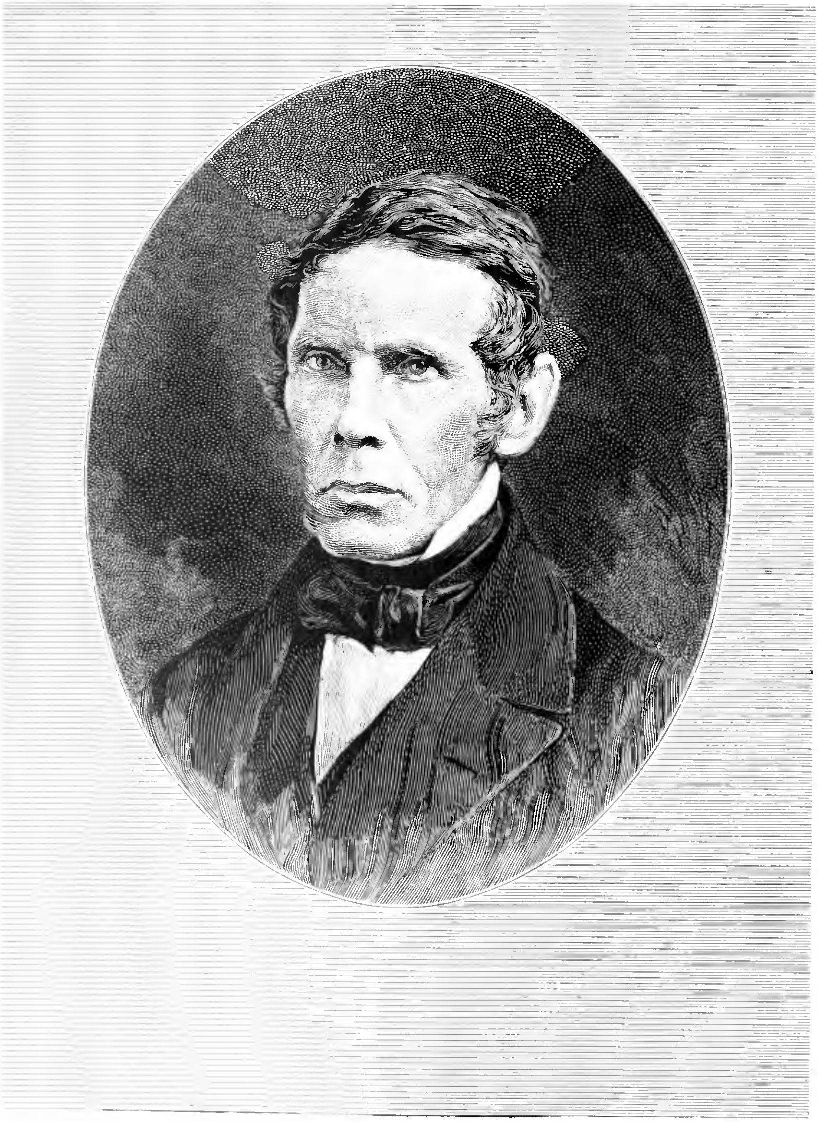
The eminent physicist Hermann Ludwig Ferdinand von Helmholtz died, after a second stroke of paralysis, at Charlottenburg, Prussia, September 9th, in the seventy-fourth year of his age. The outlines of his early life and labors, including his principal researches into the nature of the phenomena of light and sound, the enunciation of the principle of the conservation of force, and the invention of the ophthalmoscope, were given in the fifth volume of the Monthly (June, 1874). His labors since were on like lines, and various, in the fields of mathematics, physics, physiology, psychology, etc. They involved questions of vortex motion, the discontinuity of motion in liquids, the vibrations of sound at the open ends of organ pipes, thermodynamics, electrodynamics, stereoscopic vision, galvanic polarization, the theory of anomalous dispersion, the origin and meaning of geometrical axioms, the mechanical conditions governing the motions of the atmosphere, metaphysics, and mental science. On all these subjects he shed a clearer light than the world had enjoyed before, and in some he made order out of chaos. The event of his seventieth birthday, in 1891, was made the occasion of an international celebration, when the principal rulers of Europe and the scientific institutions of the world vied in conferring their honors upon him. "Science," says Nature, "has had few investigators who have furthered her interests more than Helmholtz. He was constantly exploring new fields of research, or bringing his keen intellect to bear upon old ones. With his contributions he helped to raise science to a higher level." Like other real masters of science, he believed in making it intelligible to the whole intellectual world, and did so. He was ready to recognize the merits and acknowledge the achievements of other workers in the fields he cultivated; and while he did not always keep out of controversies, he so bore himself when engaged in them as to show that his sole desire was to establish the truth.

Prof. Josiah Parsons Cooke, of Harvard University, died at his summer home in Newport, R. I., September 3d, after an illness of about one month. He was graduated from Harvard College in 1848, and, having served for two years as an instructor, he was appointed Erving Professor in the same institution in 1857. He rearranged the system of instruction in chemistry in the institution and brought it up to its present high state of efficiency. He was the author of several important books and papers in chemistry and qualitative analysis, among which may be mentioned The New Chemistry in the International Scientific Series, and a Manual of Laboratory Practice. One of his best published papers was a plea for a broader education of men of science. He was a president of the American Academy of Arts and Sciences. A portrait and sketch of him were published in The Popular Science Monthly for February, 1877.

George Huntington Williams, Professor of Inorganic Geology in Johns Hopkins University, died of typhoid fever July 12th. He was born in Utica, N. Y., and was graduated from Amherst College in 1878. He resided for a short time in Berlin, and afterward studied under Rosenbush in the University of Heidelberg, where he obtained the degree of Ph. D. in 1882. He was associate professor at Johns Hopkins University from 1885 till 1892, and after that full professor. He was author of a book on the Geology of Maryland, a text-book on crystallography, and several memoirs on petrography, and was preparing at the time of his death a work on the microscopic structure of American crystalline rocks.

Prof. H. K. Brugsch, a distinguished philologist, and one of the most eminent of Egyptologists, died September 9th, aged sixty-seven years. He was for many years an officer in the Egyptian service, where he held the rank of bey, and devoted much time to archæological exploration and the study of the Egyptian records. His History of Egypt is one of the best of the works at first hand on that subject.

The British naval commander, Sir Edward Augustus Inglefield, a distinguished arctic navigator and explorer, died early in September, at the age of seventy-four years. During a voyage in the Isabel, on private account, in search of Sir John Franklin, he discovered an open polar sea and traced a coast line eight hundred miles long. From another expedition sent for the relief of Sir Edward Belcher in 1853, an officer returned with him bearing the news of the discovery of the northwest passage. With a third expedition he brought home the officers and crews of five ships which had been abandoned in the ice. For these services he received the arctic medal, and was knighted at the fiftieth anniversary celebration of her Majesty's reign. He devised a hydraulic steering apparatus, a screw-turning engine, and an anchor, which were used on various vessels. He was author of the books A Summer Search for Sir John Franklin, Maritime Warfare, Naval Tactics, and Terrestrial Magnetism.



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ATHLETICS FOR CITY GIRLS.

By MARY TAYLOR BISSELL, M. D.

IF any of my readers should chance to belong to a hardy boat crew or to a college ball team, or if in days past they have ever been numbered in such a muscular community, they will doubtless feel that the title of my paper is its own executioner. For so long as baseball and football and the boat race stand for the national expression of athletics, the experiences of girls in any similar department will seem like comparing moonlight unto sunlight, and water unto wine. In speaking of athletics for city girls, however, we shall use the phrase in a liberal sense, including not only out-of-door sports but also the general feats and training of the gymnasium. The spirit for physical recreation has invaded the atmosphere of the girl's life as well as that of the boy, and demands consideration from her standpoint.

Before we consider the influence of athletics, we may well inquire into the physical status of the girl. What is the type of the city girl, and is there any reason to believe that she is in need of any new influence to further her development? In age she is presumably under twenty; at all events, she has not yet reached that period of stable womanly development which physiology places at about the age of twenty-five. She is presumably well housed, well fed, and more or less well clothed, according to the intelligence of her guardians. She spends at least half of her young life in the schoolroom, most of that time at a desk in more or less cramped and unfavorable positions. The average city schoolgirl spends from two to four hours daily in study, according to her ambition, takes a music, drawing, or dancing lesson in addition twice or thrice weekly, and ends her day with her books or in society, depending upon her environment.

These engagements leave her about one hour's time for out-door life and exercise, and this consists for the most part in a walk on the avenue, or a shopping expedition which often ends in a crowded, ill-ventilated store. Riding and driving are recreations, as a rule, only indulged in by the favored few. Her summer may be a season for physical freedom, but is often one of social dissipation spent in the atmosphere of a fashionable resort.

The product of these various influences is intellectually more or less successful; certainly the American girl, clever, versatile, accomplished, is an interesting type of our civilization. If we analyze her physically we shall find that she possesses the first qualification of a fine physique—viz., height. Bowditch's measurements of ten thousand public-school children in and about Boston show that in stature they surpass their English neighbors, who are popularly supposed to be superior in that respect. The writer has measured between eight and nine hundred New York city girls and women, and has found the average stature with them equal to Bowditch's measurements, sometimes surpassing them, many exhibiting unusual height. In breadth of shoulders, waist, and hips the measurements show them to be fairly well developed, although the American type appears to be less generous in this respect than the English or the German. Happily, the tendency of the day to out-of-door sports has thrown the slim-waisted girl into the shadow of unfashionableness, so that this species of deformity does not necessarily constitute part of the type. In these and certain other respects Nature has evidently intended by her original drawing to give the girls what we may call a fair chance.

But the average city girl of our experience has two or three marked physical deficiencies that are worth considering. The first of these is a shallow chest, the second is a lack of symmetry in the body, and the third is a deficiency in muscular development. The relation of the depth of the chest to the development of the vital organs is a highly important one. The "deep-chested Juno" is given us as a type of noble physical development, and we rightly associate such a conformation with what is known as the *staying* power. A deep chest offers a generous cage for a robust heart and expanded lungs, and is almost invariably found in athletes, who must have endurance, as well as in singers, whose efforts likewise must be long sustained. It has been found that persons most susceptible to the infection of phthisis commonly have a conformation which has been called the *phthisical habitus*—viz., a long, rather narrow, and especially a shallow chest, flattened from before backward. Whether Americans exhibit this conformation oftener than those of other nations is not precisely proved, but we are inclined to think that such is the fact. Certainly the shallow chest is present in the case of many girls examined by the writer.

The second noticeable feature, the lack of bodily symmetry, is a patent fact to all physicians who have been called upon to make physical examinations of the bodies of children, and the art of the dressmaker is continually required to conceal defects of this nature. They arise partly from habits of faulty postures in school or at home during the plastic period of growth, and largely from the coincident lack of muscular vigor which is due to the absence of proper training. From twenty-five to thirty per cent of all cases examined by the writer exhibit some degree of unsymmetrical development of the body, many of these cases showing a degree of lateral curvature of the spine, more or less marked, according to the influences which have been at work. It is a noteworthy fact that children are not born deformed, and therefore most of these minor asymmetries assume special importance as being acquired mainly through faulty hygienic conditions of environment which obviously call for every counteracting influence at our command.

The third deficiency we noted in the development of our city girl is the lack of muscle. With this we are also concerned—first, because a girl who has small muscular strength is continually living below her capacity for usefulness as well as pleasure; and second, because the external muscles of the body are the natural outlets for excessive nervous energy, as well as the great stimulators of the functions of circulation, digestion, and respiration, while the internal muscles are so widely distributed in the great organs of the body that their vigorous condition is absolutely necessary for its health. We have physiological reasons for believing that internal muscular structures often partake of the same flaccidity and nervelessness as is sometimes exhibited by the external muscles; the softened heart muscle following certain diseases or a relaxed condition of the muscular coats of the stomach is capable of working serious ill, as every practitioner can testify.

That the muscle of girls is weaker than it need be we have ample proof in the statistics of our gymnasiums, which record the physical tests of strength taken at the beginning and the end of a course of physical exercise. These tests are taken with various dynamometers, and with these we find that a short course of two or three hours weekly, extending over six months, will often double the strength of the principal muscles of the body in girls from fifteen to twenty-five years of age.

Such improvement indicates that these girls were previously much below their own possibilities of development, and suggests what might have been done for them in this respect years before, had similar advantages been offered them earlier in life. The tests taken of "lung capacity" on the spirometer before and after the course, as well as measurements of the chest circumference, tell by their marked improvement the same story.

Apropos of the lack of muscular vigor in city-bred subjects, we may note that oculists believe that the very marked increase in myopia among Americans during the past few years, which is especially noticeable in city life, is partly due to muscular relaxation, which deprives the tissues of the eye of their proper support and permits the degree of bulging of the globe which is an essential condition of this disease.

But granting the fact that her physical development is not perfect, what can we say of her general health? Passing by serious diseases, it is evident that our city girl has a variety of functional complaints which should have no place in the physical history of young people. Headaches, backache, dyspepsias, neuralgias are far more common than they should be. Nervously she is not *stable*, as the increasing number of nervous difficulties, neurasthenias, etc., would indicate. The emotional strain of conventional city life, which is felt more by the society girl than by the schoolgirl, is not an ideal atmosphere in which to cultivate the perfect flower of a stable character, and those who apparently bear it well do so at some expense of strength and nerve.

This hasty glance at the features of our city girl would lead us to believe that she requires not necessarily less attention for her brain, but more for her body than has hitherto fallen to her lot. She shows the lack of influences that will grow muscle and sedate nerve and promote functional health—in a word, some definite physical training. Her functional complaints are such as the experienced physician treats with exercise and pure air, and her narrow chest and unsymmetrical body will find their only rectifiers in these same influences.

Given the limitations of a town environment, where and how shall she gain these things? All intelligent persons agree upon the necessity for exercise, the manner of taking it being perhaps the possible point of controversy. As for the amount required, physiologists have agreed that in general terms a man requires exercise equal to a walk of nine to ten miles daily, and we may therefore estimate that a woman should have not less than an equivalent of five miles to maintain her in good health. Our city girl can not run wild in the fields to obtain this exercise, or live the life of a gypsy. She must be educated mentally as well as physically, and the problem evidently resolves itself into providing some means which will give in our rather limited winter session the maximum of properly arranged exercise in the minimum of time.

First of all, every out-of-door sport that she can suitably undertake should be open to her, both in the sense of opportunity and also in that of consenting public opinion. The only two sports that are practicable during any considerable part of the city season are tennis and bicycling, for rowing is limited to too short a season to be considered, and riding is by reason of expense not open to the general public. As regards tennis, she is already possessor of the game so far as knowledge and public opinion are concerned, and, although objections have been raised to it on the score of its being too violent exercise, there appears to be nothing essential to the game which a healthy young woman may not engage in, if she is properly dressed. A girl who is delicate or who has any organic disorder should certainly consult her medical adviser before playing any very active game, but these exceptions should not be allowed to rule the game out for the large class of girls who are physically qualified to enjoy and profit by it. The old rule of moderation in all things must obtain in this exercise as elsewhere.

The mention of the bicycle for women opens a field of mild controversy which is only important because some of the objections to its use are taken from the hygienic standpoint as well as from the social. Many objectors contend that the wheel is as undesirable for women as the sewing machine, while the majority of parents seriously object to what they feel to be the unpleasant publicity of the exercise. As a matter of health, which is of the first importance, the writer has made many inquiries among women who use the wheel regarding the effects of the exercise upon them, and has failed to discover a single case of injury or poor health resulting from its use. On the contrary, the testimony to its exhilarating and healthful effect is universal. Several other American physicians, qualified to speak from experience in their practice among women, have warmly commended its use. From the standpoint of a symmetrical exercise, the position is preferable to that on a horse. The movement is unlike that of the sewing machine in several important respects: Instead of being bowed over in a cramped position which restricts the action of lungs, digestive and pelvic organs alike, the woman rider sits erect, with full opportunity for chest expansion, while the difference between the environment of the sewing woman and the riding woman as regards indoor and out-of-door life is most important.

The bicycle is one of the few out-of-door sports open to the average woman by reason of its convenience, comparative inexpensiveness, and pleasure; and if it need not be ruled out from hygienic reasons, I believe that we owe it to our girls to allow no others to interfere with its introduction. It is already used extensively in some of our largest cities, while in England it is popular with many whose word is fashion's law. It can not be contended that it is essentially unwomanly. It is only at present, in cities like New York, unusual, peculiar, and therefore unfashionable. In the interests of sound health and physical recreation for the city girl the social objection may well be set aside, with the expectation that the introduction of the wheel for women will be followed by the best of results.

But with tennis practicable only in the spring and autumn, and cycling still a matter of the future, athletics for our city girls would seem to be narrowed to slender resources. What means can they employ during the long winter months for keeping muscle, nerve, and brain in good physical order? The well-ordered, properly equipped gymnasium would appear to be the only practicable substitute in the winter months for the invigorating sports possible only to the favored few, or necessarily limited to the summer season. In such a gymnasium some definite system is important. Whether it shall be Swedish or German, class work or individual practice, will be a question to be decided separately for each place. A good teacher can arouse interest with or without apparatus, in classes or individualizing her work, as required. The requirements for the building itself are abundance of fresh air and sunshine, space, and exacting cleanliness. A physician should direct the work of each pupil, endeavoring by special prescription to overcome existing deficiencies, to stimulate the will and energy in the sluggish, and to limit nervous expenditure in those of a nervous temperament.

A young girl entering such an institution will have every safeguard against harm thrown around her. Her age, strength, previous and present health will be inquired into, and heart and lungs tested to ascertain their soundness for exertion. Any lack of symmetry, as shown in the condition of the spine, shoulders, or chest, will be noted. Her inspiratory power and muscular strength will be recorded, and the individual equation will have due weight. She will be placed in a class where the general average of strength is equal to hers, but she will be advised to avoid or increase certain exercises, according to her personal needs, and to report to the director at certain intervals for further advice.

Is there any place where the quantity and quality of a girl's exercise is as carefully supervised as in this ideal gymnasium? In such an institution the system is a progressive one, and in the hands of a good instructor always remains interesting. By easy steps the pupils are led from simple to intricate exercises, reaching the most advanced work in the course of two years' training, always provided that by preliminary exercises they have gained sufficient strength and skill.

Our young pupil at the close of her hour's exercise takes a sponge or a spray bath or none at all, according to her prescription; always a brisk rub and a complete change of underclothing are advised. The general benefits to her of such training lie in the fact, first, that it exercises the entire body in a systematic, practicable manner, as no other city exercise can do. A horse, the bicycle, or a long walk, all admirable, require fair weather for their enjoyment. The gymnasium, dry, clean, cheerful, invigorating, offers variety, companionship, and physical recreation equally in storm or shine, and this is no small consideration in arranging a programme for the physical improvement of the city girl during the winter months. The regularity of the exercise is not the least of its benefits. When one has made a financial sacrifice for the pleasure of keeping a regular engagement, she has an excellent guarantee that the engagement will be met. We are all creatures of habit, and advantage should be taken of the fact in the physical as well as in the intellectual realm, and Nature's rewards are most generous to the child of system.

The particular benefits of gymnastic and athletic work for girls have been demonstrated by exact methods more palpably than is generally known. A system of measurements and tests has been introduced in many gymnasiums, as already noted, whereby the physical proportions of the individual are taken upon entering and also at the expiration of the term of exercise, and the resulting evidence has become not only highly interesting but conclusive as to the influence of such systematic exercise upon health and development. It is not unusual for girls to gain in six months' time several pounds in weight, two inches in chest circumference, and from twenty to fifty cubic inches in inspiratory power, while the dynamometers may show an increase in muscular strength of from fifty to one hundred per cent over the original tests.

The constitutional benefits are not less marked and are by far the most important. To general inquiries regarding health the common reply is, "I feel so much better than I did in every way." In one, the chronic headache is relieved; the tendency to colds in another has been arrested; in the third, functional pain has disappeared. The body is more ready for work and more capable for it in every sense. The stimulus of muscular activity has had a profound influence upon the functioning of the whole economy. What is it, after all, that most of us need for health but better functioning? The majority of these young women have not any disease; they have simply been curtailed in their opportunities for generous lung and limb development, and they are still young enough to respond to the stimulus of well-directed exercise in this gratifying and substantial manner.

The training of the nervous system, which is the immediate result of a systematic practice of gymnastics, is recognized as one of the greatest benefits of such exercise. It is known to physiologists that every group of muscles is controlled by certain nerve centers in the brain, and it is believed that in cases where the life and habits of the individual do not call out the activity of all the muscles, the brain areas which govern those muscles to that extent fail of development. In certain lower animals, for instance, that have been born blind, it is found that the visual area in the brain has wasted away; there being no occupation for its energy, Nature has permitted it to disappear.

As illustrating the value of physical training in stimulating brain function, we have a series of observations made by Dr. Wey, Medical Director of the Elmira Reformatory, showing how dullards who took the lowest standard in scholarship, and in morals as well, became by simple but regular physical drill first more attentive, then more intelligent as to orders, less awkward (i. e., with better co-ordination of the body), and gradually, as the stimulation of the will and energy proceeded, actually better scholars, rising in some cases from the third to the first grade, and improving not only in physical appearance but in moral character. These results were entirely attributed to the awakening of mental energy through the reflex stimulation of muscular exercise.

To these benefits we may oppose the only objections we have known. The first is on the score of danger. As a matter of fact, there is little or no testimony to put upon this side that does not equally apply to many forms of exercise practiced by women, walking included. The theory that girls should not run or climb is long since exploded. Sick girls should not run or climb until they are well, but every physician knows that there would be fewer sick girls if running and climbing had always been part of a girl's early life.

Girls who have organic disease are not fit subjects for a gymnasium—there being a very few exceptions to this rule. Girls with serious spinal curvature require special exercises in the physician's office. Almost all other girls can only be benefited in a well-ordered gymnasium if they obey the rules and follow the advice offered. Any harm that can come from the so-called feats of the gymnasium arises mainly from the possibility that the pupil will not have prepared herself sufficiently for the exercises by previous preliminary training. Oversight and prescription on the part of the director obviate these difficulties. It should be understood that the special value in many of these exercises lies in their educational influence upon the nervous system. They call for a quick co-ordination of muscles, for pluck, perseverance, and self-possession, far more than for mere strength, and are legitimate training, therefore, for girls, so far as they are qualified to undertake them.

A more valid objection to the gymnasium is that the exercise must be taken indoors, but this is largely overbalanced by the advantages of system and purpose in the course, and is reduced to its minimum by the fact that a well-ordered gymnasium is cool, clean, and well ventilated. The suggestion often proffered that domestic work offers as good a field for exercise for girls is not, in the writer's opinion, tenable. An atmosphere of dust is not an ideal one for physical training, and the elements of system as well as of physical recreation are lost in this scheme, for few households could arrange their economy so as to combine the schoolgirl's leisure with their own convenience, while the drudgery of the employment would cause it to be abandoned whenever possible.

It is not our intention to claim that the gymnasium is the permanently ideal place for every sort of physical training or athletic sport for girls, but only that it does at present offer the greatest good to the greatest number of our city girls in the direction of their physical development and recreation. An out-of-door inclosure for games and sports in pleasant weather would prove a great addition to its advantages. It does not seem an impossible plan for the private schools of our city to co-operate in establishing such an out-of-door playground as this, with an instructor in games and sports, and hours arranged for each school department. Such a ground would prove a practical and useful extension of our too limited park life.

With an apparatus sensitive enough to measure changes in temperature amounting to only a millionth of a degree, Prof. S. P. Langley has located exact more than two thousand lines in the infra-red spectrum, in which two thirds of the sun's radiation is contained, and has succeeded in extending the spectrum to six times the length of the photographic spectrum. He has tested his instrument in the region of the sodium lines, and found it could not only divide these, but could detect the nickel line between them. By a special device, depending on the use of a cylindrical mirror, he was able to convert automatically the galvanometer tracings into a linear spectrum. He thought the extended spectrum would be of use in forecasting the weather, because it contained a rain band; moreover, the greater part of the lower spectrum seemed to be due to telluric causes. In the discussion of the author's paper in the British Association, the chairman of the Physical Science Section spoke of it as the most important paper that would be communicated to the section. Prof. Lockyer said that the work had done for the lower spectrum what Kirchhof had done for the visible rays. Lord Kelvin admired the marvelous precision of Prof. Langley's method, and the skillful way in which it was carried out.

RESPONSIBILITY IN CRIME FROM THE MEDICAL STANDPOINT.

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THE reason why a physician should be called upon to discuss such a subject as responsibility in crime must be because some organ or organs of the body are concerned, and he ought to know more about the structure and function of the bodily organs than other people. I believe medicine must furnish all the essential fundamental facts in the study of this subject.

According to the medical view of responsibility in crime, the mental status of the individual has to be investigated. In times past, a wide diversity of views has obtained regarding mind. Popularly expressed, some of the salient features of the view which has obtained for several centuries past have been that mind was a special endowment, bestowed by the Creator upon man, and upon no other animal. In some way not quite clearly understood, a will was also given to man, by which he was allowed a sort of freedom to choose as to whether he should allow the Creator to control his mind, or whether he should yield the management of it to an opposing power or Satan. Various manifestations on the part of the individual were regarded from time to time as evidence that either one power or the other had control, according as his conduct corresponded or not with what was commonly regarded as the best interests of the society in which he lived. The ordinary symptoms of acute mania were regarded as positive evidence that the evil one had possession, and the treatment consisted in placing upon the afflicted person charms, amulets, etc., which were regarded as obnoxious to the evil power, with the hope of making his tenancy uncomfortable, and thus inducing him to withdraw.

This view is the last survivor of those once so prevalent, which sought to explain everything of a mysterious nature by hypothecating an omnipotent personality presiding over it, and it prevailed exclusively during the early growth and development of our present criminal law.

Now, it is the proper province of modern medicine to study the construction and function of all the bodily organs, but for various reasons the brain has been the last of the larger and more important organs to be carefully studied; within the last decade, however, it has been very thoroughly investigated.

The result of that study tends to show—indeed, has demonstrated—that the functional product of the brain is mind, in precisely the same sense that bile is the functional product of the liver; that one process illustrates just as forcibly the influence of a mysterious force or power as the other.

The product of the liver, the bile, will vary according to the size, quality, and condition of the organ and the forces acting upon it; and the same is true regarding the functional product of the brain, the mind. Without liver there is no bile, and without brain there is no mind. At least the physician only investigates mind, which is a functional product of brain. The analogy, however, between brain and liver does not hold throughout, because after birth, and from that period to maturity, and indeed while

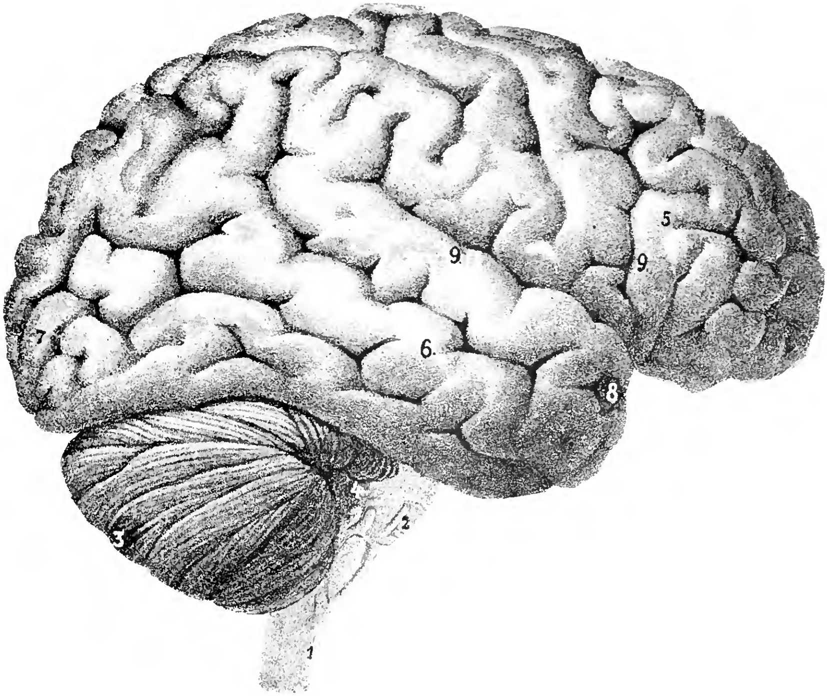

FIG. 1.

life lasts, the brain is ordinarily exposed to impressions made by an ever-changing environment, while the environment of the liver remains practically uniform.

It may be conducive to a clear understanding of the medical view of mind, and therefore of responsibility, to examine objectively the organ itself, and briefly the manner in which its functions are studied by the physician. I need hardly remind you that the brain is a double organ, and therefore only one half of it need be shown.

Figs. 1 and 2 are exact representations of the outer and mesial surfaces of the human brain.

Like many other organs of the body, its functional activity depends upon the presence of cells, the bodies of which are exclusively found upon its surface, extending to a depth varying from one eighth to one fourth of an inch, and constituting the so-called

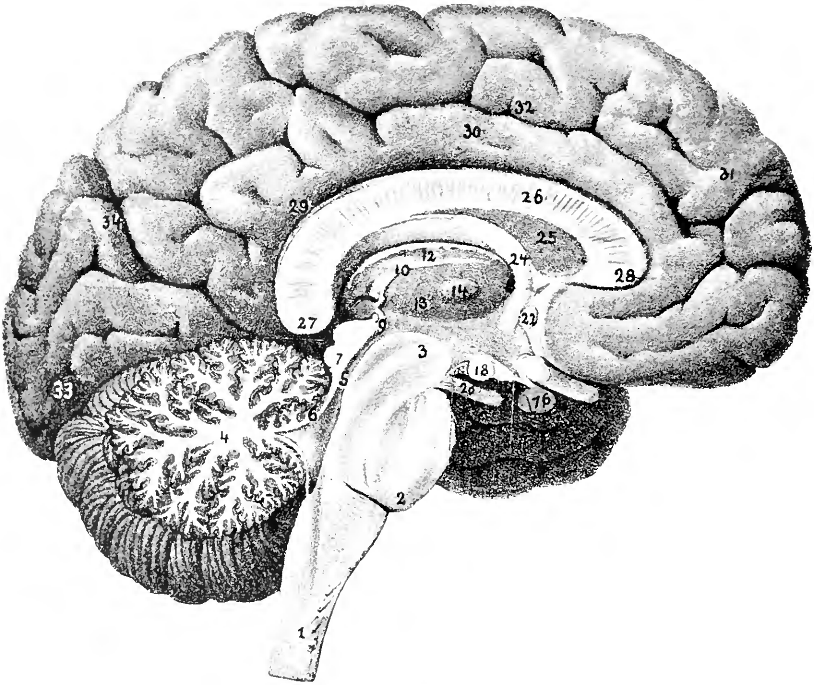

Fig. 2.

gray matter of the brain. The convoluted arrangement of the surface, as can readily be understood, more than doubles its area. Beneath the gray matter, or cortex, is found the white matter, which consists of fine fibrous processes extending from the bodies of the cells in the gray matter, and connecting those in one part of the cortex with those in another part.

Fig. 3 shows the course of the fibrous processes of the cells of the cortex of the brain as they pass from one convolution to another, connecting together the various cell bodies.

Fig. 4 shows a cell and its processes which properly constitute the essential anatomical and physiological unit of the brain, and indeed, speaking more generally, any nervous system.

Fig. 5 shows how these cells in the cortex, or gray matter of the brain, besides sending out processes as already described, also send processes to cells distributed the whole length of the spinal cord. These cells in the spinal cord in their turn send similar processes out along the nerves, to terminate in the skin, muscles, the eye, the ear, etc., all of which in neurology are called end organs; and thus a passage is afforded for impressions made upon these end organs by the environment to reach the cells in the cortex, and for impulses to return from the cells in the cortex to the end organs, perhaps producing, restraining, or regulating movements in them.

Now a few words as to methods of investigation. Figs. 6 and 7 are charts showing the areas in the brain presiding over certain functions as thereon indicated. Take, for instance, the leg center. A case is found with sudden, complete, and permanent paralysis of the leg; after a few months the person dies, and upon examination of the brain and spinal cord it is observed that a hæmorrhage has destroyed the cells in the part of the brain here indicated. Now, as might be expected when the body of a cell is destroyed, its processes perish; hence, when consecutive sections are made across a strand composed of these cell processes, the bodies of which have been destroyed, and the sections are placed in a solution of coloring matter, it is found that the fibers which have perished take a different color from those which have not, and thus their position may be determined. In this case, by this method, a large strand of fibers which have perished may be

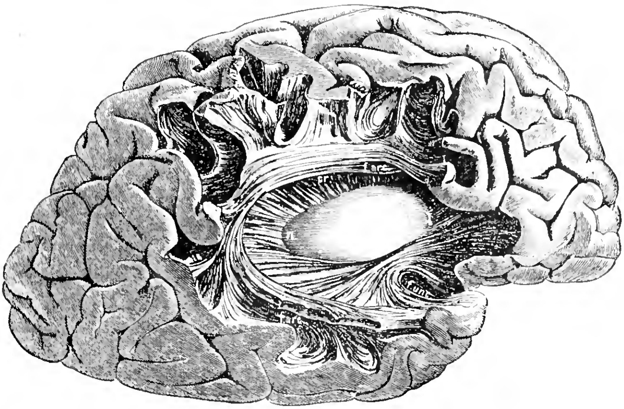

FIG. 3.

traced from the brain downward very near to the lower extremity of the spinal cord. This is known as the clinical method of study. These centers have also been removed in the course of surgical procedures, with the invariable result of producing a corresponding paralysis; and similarly they have been stimulated by electrical currents directly applied to them, and movements produced in the corresponding parts. This latter method is known as the excitation method; to this, as practiced upon the brains of monkeys some thirty years ago, we are indebted for the commencement of the study of cortical localization, and indeed for the removal of psychology from the realm of speculation to that of scientific demonstration.

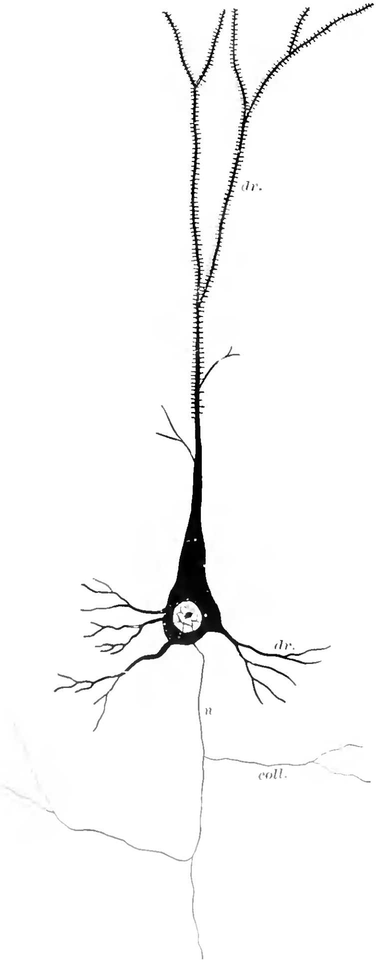

Fig. 4.

The method of removing certain cortical areas of the brain and then noting the effect is termed the extirpation method; it was by this method, practiced upon monkeys, that Prof. Schäfer, of London, and myself established the position of the center for vision in that animal. The monkey's brain is so similar to the human brain that with some modification results may be transferred from one to the other.

Fig. 8 shows the part of the monkey's brain which, when removed, produces blindness in the corresponding half of each eye, and Fig. 9 shows the parts which, when removed, produce complete and permanent blindness in both eyes. Now, while the positions of the areas for the other special senses have not been so satisfactorily demonstrated, the existence of such centers can not be doubted.

With these data, and the aid of Fig. 10, a fundamental step in the process of mental development may be investigated.

By way of the route as indicated in the figure, an impression made upon a specially constructed end organ, the eye, is transmitted along the cell process constituting the optic nerve, and so onward till it reaches a cell, or probably cells, in the occipital lobe; thence by means of the communicating fibers constituting the white matter, and previously described, the arm center is excited and a motor impulse passes out to the muscles moving the arm, and the hand is put into the flame; immediately a second impression is conveyed inward to the pain center and thence to the arm center, from which a second impulse emanates, resulting in a withdrawal of the hand. Finally, after one or more experiences of this kind, the impression produced by the pain being so much stronger than that produced by seeing the candle flame, the attempt to seize it is inhibited, and it finally comes about by means of these association fibers that the sight of flame immediately excites this inhibitory center. The cells and processes concerned transmit the impressions more readily by each repetition until the result becomes uniform; the child has learned something, and finally the desire diminishes. By the process of induc-

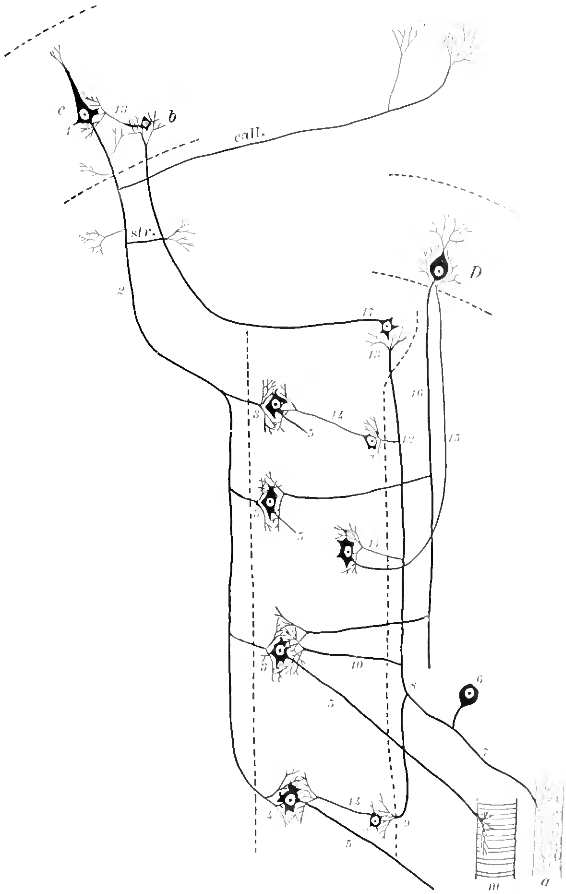

FIG. 5.—*a*, skin on the surface ot the body; *17*, a sensory cell in the medulla oblongata; *b*, sensory cell in the cortex of the brain; *c*, motor cell in the cortex of the brain; *D*, cell in the cerebellum where muscular movements are co-ordinated; *3*, motor cell in the spinal cord; *m*, muscle. The course of a stimulus at "*a*" can readily be followed to the cortex of the brain and back again to the muscle, resulting in a muscular movement.

tion from simple examples like this, those which are more complex may be explained. Here Nature inflicted the penalty in the form of bodily pain, which resulted in the establishment of a permanent inhibitory center. In a similar way society attempts, by the various influences and modes of training to which it subjects children, to establish in them permanent and sufficient inhibitory centers which shall enable them to conform to the various artificial restraints imposed by an advanced civilization. And in the latter, as in the former case, when the inhibitory impression has become well established the desire diminishes. Each successful resistance of temptation renders resistance more easy and certain.

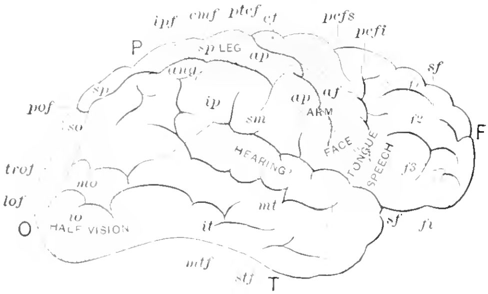

Fig. 6.

In the former as well as in the latter case the readiness with which these inhibitory impressions are received and retained depends upon the quality of the cerebral tissues, the cells.

In the lower forms of idiocy, individuals are often seen who never can be taught to refrain from putting their hands into a candle flame, and the well-recognized criminal class is largely composed of individuals whose cerebral tissues are of so inferior an order that permanent and sufficient inhibitory centers can not under any circumstances be so established as to enable them by themselves to conform to the restraints which civilization imposes.

Sound and successful training attempts to establish these centers of inhibition, and not to prevent their formation by keeping the individual in ignorance of the conditions which demand their exercise. When young people with this false training are thrown upon their own resources, great suffering is almost sure to follow.

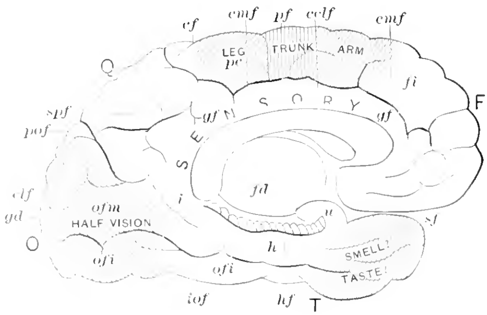

Fig. 7.

While doubtless in this country a large proportion of the individuals composing the criminal class are such by reason of defective brain tissues, it is well-nigh certain that a considerable number might never have entered it if from the start they could have had proper training.

A thorough musician may get better music from a defective instrument, with whose defects he is familiar, than a poor musician can get out of a perfect instrument.

Considered from a medical standpoint, habit may be regarded as a tendency which certain correlated brain cells have to act together from frequent repetition having rendered it easy for an impulse to pass from one to the other, with the production of a more or less uniform result. Thus we are indeed literally creatures of habit.

By the time an individual has reached maturity it is observed that he responds to the influences of his environment with more or less uniformity, and in a way peculiar to himself. The nature of this response constitutes his character. If he has strong impulses, which he uniformly inhibits in a manner favorable to the best interests of the society in which he lives, he becomes known as a man of strong character, and finally of established character, and is trusted accordingly. On the other hand, there are individuals in whom the response to their environment is so variable that they never succeed in establishing a character, and are never trusted.

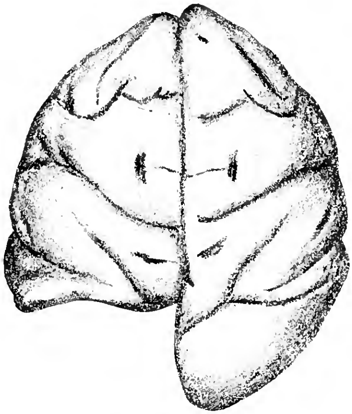

Fig. 8.

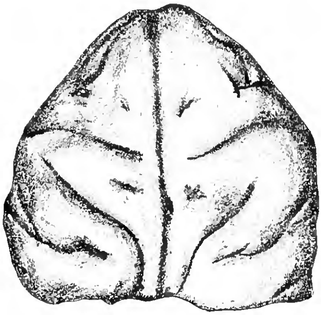

Fig. 9.

At one extreme are found individuals with cerebral tissues of so high a quality that they would establish a high character under the most unfavorable circumstances; and at the other extreme, individuals who would never establish a character under the most favorable conditions; but the great mass of individuals lies between these extremes, and with them the influences of the environment determine their status.

The social and legal penalties visited upon transgressors undoubtedly form a strong and constant stimulus to the inhibitory centers, and the more so in proportion as the individual feels sure that he can not escape from them. A strict and speedy administration of the penal laws should go hand in hand with an intelligent system of training.

It will readily be conceded that no two individuals have exactly the same degree of responsibility, but all must be held to equal responsibility under the law, until it shall be demonstrated in certain cases that a given person is by reason of defective cerebral tissues unable to support the social relation, in which case society should permanently restrain him. This decision should be reached by experts, who would carefully compare the environment to which the individual had been exposed with his mental state, or the functional product of his brain. This, I believe, has actually been done in some States by the enactment of the habitual criminal law, which provides for the perpetual restraint of these cases, without regard to the nature of the last offense.

Without at all suspecting the anatomical and physiological conditions upon which it depends, many intelligent observers, who have been intimately associated with the criminal classes in prisons, reformatories, etc., agree as to the fact that a large proportion are unable to resist the commission of crime, even under the most favorable circumstances, and a still larger proportion under the unfavorable circumstances in which their defective organization tends to force them.

A commission of experts appointed by the State to thoroughly examine the inmates of prisons, to determine their mental status, might do much, by effecting the permanent restraint of certain cases, to diminish crime and the cost and suffering it entails, with a fuller measure of justice toward all parties concerned.

A few words in regard to heredity, by way of digression. It is not disputed that the form which the aggregation of cells takes entering into the structure of a man's nose may be distinctly hereditary, and it is no less reasonable to suppose that variations in the convolutions of the brain are equally hereditary; and that, influenced by the same or a similar environment, the functional product observed in the child will be similar to what obtained in the parent—that is, practically, crime is often hereditary, and to the same extent so may be any other mental tendency.

Finally, a few words in reference to insanity and criminal responsibility. Practically the best definition of insanity is that of Dr. Maudsley, which is substantially this: Insanity is a disease of the brain, producing such a change in the mode of feeling, thinking, and acting as to render the individual unable to support the ordinary relations of life. The question of responsibility is rarely raised in well-developed cases, where the disease of the brain renders the centers inactive and the person sits and mopes in silent misery, or in the cases where the disease of the cerebral structures is so severe as to constantly stir them to irregular and unwonted activity, prompting the individual to laugh, weep, sing, shout, fight, and pray, perhaps all at the same time as nearly as possible, quite independent of the environment.

The cases of insanity in reference to which the question of responsibility arises are those whose cerebral substance is only mildly affected by disease, so that in many ways the individual still re-

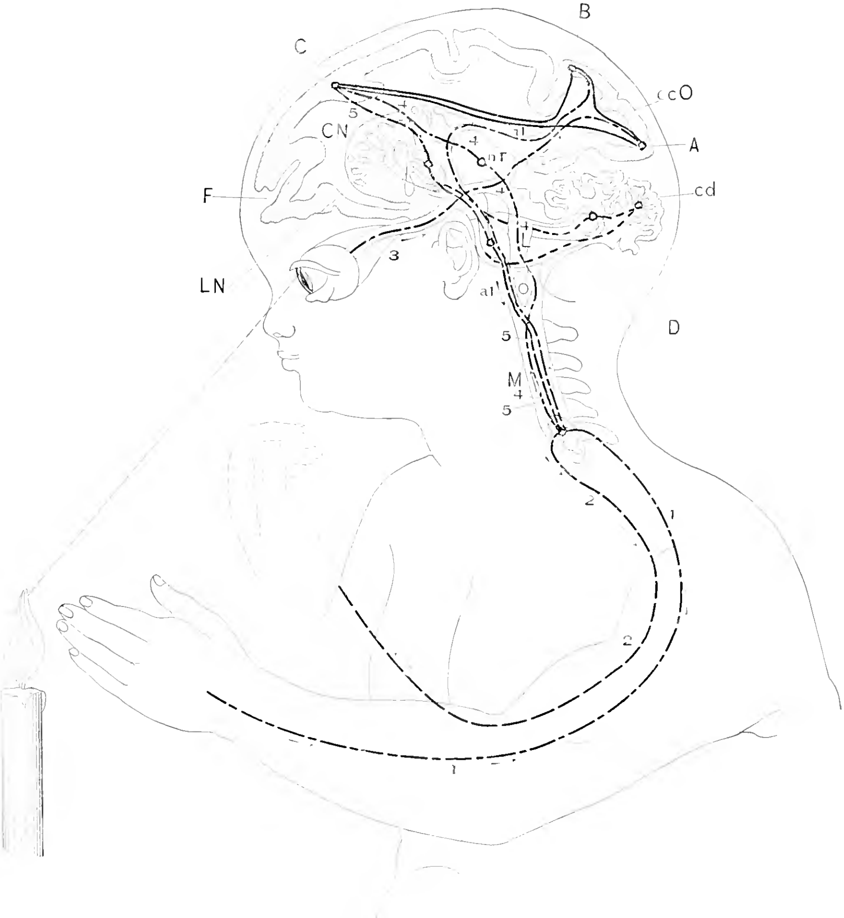

FIG. 10.—The course of the several impulses is indicated by the arrows. An explanation of the figure is facilitated by reference to Fig. 5.

acts to his environment as formerly, especially in so far as his routine duties are concerned; but in other things, where the cells concerned have been less strongly, steadily, and permanently impressed, the disease of the cerebral tissue is sufficient to effect some degree of change in the nature of his response to his environment from what had been usual to him, and it is by studying the quantity and quality of this change that the alienist determines the existence of insanity. Any specific act by itself does not necessarily afford evidence of insanity, for there is nothing an insane person can do that a sane person may not do.

The experienced alienist by thorough investigation determines as far as possible what has been the previous environment of a person alleged to be insane, and how he habitually reacted to it, and then makes a comparison between that and the manifestations which have been regarded as constituting evidence of insanity. When it is proved to the satisfaction of society that a given act was clearly the result of disease of the brain producing insanity, the individual is usually excused; but until the public becomes more generally informed regarding the bodily basis of mental manifestation, and comes to understand more clearly how and where to look for evidence of insanity, many will be held to be responsible who, according to the intention of the criminal laws, are not so; and some will be excused who are fairly responsible.

It is for physicians to determine the part played by bodily defect or disease in the commission of crime. Society in general must, with this information, determine the degree of responsibility and decide upon the punishment.

THE NEED OF EDUCATED MEN.*

By DAVID STARR JORDAN,
PRESIDENT OF LELAND STANFORD JUNIOR UNIVERSITY.

IF the experiment of government by the people is to be successful, it is its educated men and women who must make it so. The future of the republic must lie in the hands of the men and women of culture and intelligence, of self-control and of self-resource, capable of taking care of themselves and of helping others. If it falls not into such hands, the republic will have no future. Wisdom and strength must go to the making of a nation. There is no virtue in democracy as such, nothing in Americanism as such, that will save us, if we are a nation of weaklings and fools, with an aristocracy of knaves as our masters. There are some who think that this is the condition of America to-day. There are some who think that this republic, which has weathered so nobly the storms of war and of peace, will go down on the shoals of hard times; that we as a nation can not live through the headache induced by the financial sprees of ourselves and others. We are told that our civilization and our government are fit only for

* An Address to the Graduating Class in Leland Stanford Junior University.

the days of cotton and corn prosperity. We are told that our whole industrial system, and the civilization of which it forms a part, must be torn up by the roots and cast away. We are told that the days of self-control and self-sufficiency are over, and that the people of this nation are really typified by the lawless bands rushing blindly hither and thither, clamoring for laws by which those men may be made rich whom all previous laws of God and man have ordained to be poor.

In these times it is well for us to remember that we come of hardy stock. The Anglo-Saxon race, with its strength and virtues, was born of hard times. It is not easily kept down; the victims of oppression must be of some other stock. We, who live in America and who constitute the heart of this republic, are the sons and daughters of "him that overcometh." Ours is a lineage untainted by luxury, uncoddled by charity, uncorroded by vice, uncrushed by oppression. If it were not so we could not be here to-day.

When this nation was born, the days of the government of royalty and aristocracy were fast drawing to a close. Hereditary idleness had steadily done its work, and the scepter was already falling from nerveless hands. God said: "I am tired of kings; I suffer them no more." And when the kings had slipped from their tottering thrones, as there was no one else to rule, the scepter fell into the hands of the common man. It fell into our hands, ours of this passing generation, and from us it will pass on into yours. We are the common man, and you are his heir apparent. You are here to make ready for your coronation, to learn those maxims of government, those laws of human nature, without which all administrations must fail; ignorance of which is always punishable by death. If you are to hold this scepter, you must be wiser and stronger than the kings, else you too shall lose the scepter as they have lost it, and your dynasty shall pass away.

For more than a century now the common man has ruled America. How has he used his power? What does history tell us of that the common man has done? It is too soon to answer these questions. A hundred years is a time too short for the test of such gigantic experiments. Here in America we have made history already, some of it glorious, some of it ignoble; much of it made of the old stories told over again. We have learned some things that we did not expect to learn. We find that the social problems of Europe can not be kept away from us by the quarantine of democracy. We find that the dead which the dead past can not bury are thrown up on our shores. We find that weakness, misery, and crime are still with us, and that wherever weakness is there is tyranny also. The essence of tyranny we have found lies not in the strength of the strong, but in the weakness of the weak. We find that in the free air of America there are still millions who are not free—millions who can never be free under any government or under any laws, so long as they remain what they are. The remedy for oppression, then, is to bring in better men, men who can not be oppressed. This is the remedy our fathers sought; we shall find no other. The problem of life is not to make life easier, but to make men stronger, so that no problem shall be beyond their solution. It will be a sad day for the republic when life is easy for ignorance, indolence, and apathy. It is growing easier than it was; it is too easy already. There is no growth without its struggle. Nature asks of man that he use his manhood. If a man puts no part of his brain and soul into his daily work, if he feels no pride in the part he is taking in life, the sooner he leaves the world the better. His work is the work of a slave, and his life the waste of so much good oxygen. The misery he endures is Nature's testimony to his worthlessness. We can not save him from Nature's penalties. Our duty toward him may be to temper justice with mercy. This is not the matter of importance. Our duty toward his children is to see that they do not follow his path. The grown-up men and women of to-day are in a sense past saving. The best work of the republic is to save the children. The one great duty of a free nation is education—education wise, thorough, universal; the education, not of cramming, but of training; the education which no republic has ever given, and without which all republics must be in the whole or in part failures. If this generation should leave as its legacy to the next the real education, training in individual power and skill, breadth of outlook on the world and on life, the problems of the next century would take care of themselves. There can be no collective industrial problem where each man is capable of solving his own individual problem for himself.

In this direction lies, I believe, the answer to all industrial and social problems. Reforms in education are the greatest of all reforms. The ideal education must meet two demands: It must be personal, fitting a man or woman for success in life; it must be broad, giving a man or woman such an outlook on the world as that this success may be worthy. It should give to each man or woman that reserve strength without which no life can be successful because no life can be free. With this reserve the man can face difficulties, because the victor in any struggle is he who has the most staying power. With this reserve he is on the side of law and order, because only he who has nothing to lose can favor disorder or misrule. He should have a reserve of property. Thrift is a virtue. No people can long be free who are not thrifty. It is true that thrift sometimes passes beyond virtue, degenerating into the vice of greed. Because there are men who are greedy—drunk with the intoxication of wealth and power—we sometimes are told that wealth and power are criminal. There are some that hold that thrift is folly and personal ownership a crime. In the new Utopia all is to be for all, and no one can claim a monopoly, not even of himself. There may be worlds in which this shall be true. It is not true in the world into which you have been born. Nor can it be. In the world we know the free man should have a reserve of power, and this power is represented by money. If thrift ever ceases to be a virtue, it will be at a time long in the future. Before that time comes, our Anglo-Saxon race will have passed away and our civilization will be forgotten.

A man should have a reserve of skill. If he can do well something which needs doing, his place in the world will always be ready for him. He must have intelligence. If he knows enough to be good company for himself and others, he is a long way on the road toward happiness and usefulness. To meet this need our schools have been steadily broadening. The business of education is no longer to train gentlemen and clergymen as it was in England, to fit men for the professions called learned as it has been in America. It is to give wisdom and fitness to the common man. The great reforms in education have all lain in the removal of barriers. They have opened new lines of growth to the common man. This form of university extension is just beginning. The next century will see its continuance. It will see a change in educational ideals greater even than those of the revival of learning. Higher education will cease to be the badge of a caste, and no line of usefulness in life will be beyond its helping influence.

The man must have a reserve of character and purpose.

> "To the good man no harm can come, be he alive or dead."

He must have a reserve of reputation. Let others think well of us, it will help us to think well of ourselves. No man is free who has not his own good opinion. A man will wear a clean conscience as he would a clean shirt, if he knows his neighbors expect it of him. He must have a reserve of love, and this is won by the service of others. "He that brings sunshine into the lives of others can not keep it from himself." He must form the ties of family and friendship, that, having something at stake in the goodness of the world, he will do something toward making the world really good.

When every American citizen has reserves like these, he has no need to beg for special favors. All he asks of legislation is that it keep out of his way. He demands no form of special guardianship or protection. He can pay as he goes. The man who can not has no right to go. Of all forms of greed, the greed for free lunches, the desire to get something for nothing, is the most demoralizing, and in the long run most dangerous. The flag of freedom has never floated over a nation of deadheads.

Then, again, education must take the form of real patriotism —of public interest and of civic virtue. If a republic be not wisely managed, it will fail as any other corporation would; it will only succeed as it deserves success.

The problems of government are questions of right and wrong, they can be settled only in one way. They must be settled right. Whatever is settled wrong comes up for settlement again, and this when we least expect it. It comes up under harder conditions, and compound interest is charged on every wrong decision. The slavery question, you remember, was settled over and over again by each generation of compromisers. When they led John Brown to the scaffold his last words were: "You had better—all you people at the South—prepare yourselves for a settlement of this question, that must come up for settlement again sooner than you are prepared for it. You may dispose of me now very easily," he said; "I am nearly disposed of now; but this question is still to be settled—this negro question, I mean; the end of that is not yet."

This, John Brown said, and they settled the problem for the time by hanging him. But the question rose again. It was never settled until at last it was "blown hellward from the cannon's mouth." Then it was found that for every drop of negro blood drawn by the lash, a thousand drops of Saxon blood had been drawn by the sword.

Thus it is with every national question, large or small. Thus it will be with the tariff, with finance, with the civil service. Each question must be settled right, and we must pay for its settlement. It is said that fifteen per cent of the laws on the statute books of the States of the Union stand there in defiance of acknowledged laws of social and economic science. Every such statute is blood poison in the body politic. Around every such law will gather a festering sore. Every attempt to heal this sore will be resisted by the full force of the timeservers. Such statutes are steadily increasing in number, concessions by shortsighted legislatures to the arrogant monopolist, the ignorant demagogue, or the reckless agitator. This must stop. "They enslave their children's children who make compromise with sin," or with ignorance, or with recklessness. "The gods," said Marcus Aurelius, "are at the head of the administration, and will have nothing but the best."

"My will fulfilled shall be,
In daylight or in dark;
My thunderbolt has eyes to see
Its way home to the mark!"—*Emerson.*

It was the dream of the founders of this republic that each year the people should choose from their number "their wisest men to make the public laws." This was actually done in the early days, for our first leaders were natural leaders. The men who founded America were her educated men. None other could have done it. But this condition could not always last. As the country grew, ignorance came and greed developed; ignorance and greed must be represented, else ours would not be a representative government. So to our congresses our people sent, not the wisest, but the men who thought as the people did. We have come to choose, in our lawmakers, not rulers but representatives; we ask not wisdom, but watchfulness for our personal interests. So we send those whose interests are ours, those who act as our attorneys. And just as the people do this, so do the great corporations, who form a large part of the people and control a vastly larger part. And as the corporations command the best service, they often send as their attorneys abler men than the people can secure. And so it has come about that demagogues and special agents make up the body of lawmakers in this country, and this in both parties alike. They represent, not our wisdom, but our business. They are the reflex of the people they represent; no better, and certainly no worse. Those whose interest lies in the direction of good government alone, often know not which way to turn, and at last fall back on the time-honored anathema—

"A plague on both your houses!"

In this degree republican government has failed. For this failure there is again but one remedy—education. If the people are to rule us, the people must be wise. We must have in every community men trained in social and political science. We must have men with the courage of their convictions, and only the educated man has any real convictions. We must have men who know there is a right to every question as well as many wrongs. We must have men who know what this right is, or, if not knowing, who know how the right may be found. Very few men ever do that which they know and really believe to be wrong. Most wrongdoing comes from a belief that there is no right, or that right and wrong are only relative.

If representative government is ever to bring forward wisdom and patriotism, it will be because wisdom and patriotism exist and demand representation. In this direction lies one of the most important duties of the American university. Every question of public policy is a question of right and wrong. To such questions all matters of party ascendency, all matters of individual advancement must yield precedence. There is no virtue in the acts of ignorant majorities. The danger of ignorance is only intensified when rolled up in majorities. Truth is strong and error is weak, and the majorities of error melt away under the influence of a few men whose right acting is based on right thinking.

Right thinking has been your privilege: right acting is now your duty; and at no time in the history of the world has duty been more imperative than now.

THE UNIVERSITY AS A SCIENTIFIC WORKSHOP.

By Prof. Dr. FRIEDRICH PAULSEN.

THE peculiar character of the German university springs from its combining the two purposes of instruction and research. It is at once a high school and an academy, meaning by academy an institution for scientific investigation. The relation in which these two functions stand to one another corresponds with the form of the university in the different epochs of its development. The tendency now evidently prevails to give research the preference over instruction. In the estimates of the universities themselves, scientific work has the higher rating. The scientific purposes are most conspicuous in the public view; and the credit in which German universities are held abroad depends first upon their scientific achievements. The estimate is in agreement with the facts, and no wrong will be done to the German professors if we say that many among them work less in instruction than in scientific labor, that they are more academicians than teachers.

It was not always so; it has been so only for a short time. Instruction had the foremost place till in the eighteenth century, and the change that has taken place did not fairly begin till within the nineteenth century. I shall endeavor to trace this development and its causes in a short historical review.

The universities originated in the middle ages as schools. Especially were the universities in Germany, in their beginning, what their official name—*studium generale*—implies, places for general study. The professors were likewise at first called schoolmasters (*magistri regentes, sc., scholas*), and the students scholars (*scholares*). The artistical, now the philosophical faculty, which regularly comprised by far the largest proportion of the students, had wholly the character of a school. Its object was to give young men from fifteen to twenty years of age a general scientific training. It fulfilled this purpose by explaining, in what were called lectures, text-books containing the recognized material of knowledge, and practicing the students in recitations and exercises. This method still continues in English and American colleges.

No essential change from this method took place in the sixteenth century. The purpose of the philosophical faculty, as Melanchthon understood it, was quite the same, except that classical instruction was added to that in science and philosophy. Completion with a literary and philosophical course of the general scientific training, which began with the grammatical and rhetorical course in the lower schools, was the aim of the teaching which Melanchthon gave at Wittenberg for two and forty years. It was school teaching in scholastic form, so far as certain conditions permitted. So it was Melanchthon's custom to question his pupils in the lessons at the beginning of the hour. The declamations and disputations which he held were likewise pure school exercises. He boasted once in his old age of himself and his friend Camerarius, that they had spent their whole lives in the lowliness of the school, in the *vita scholastica*, in order to serve youth and fair knowledge. A change in the general constitution of the university began with a constant increase in the members of the "higher faculties"—the theological and juridical—for the completion of the university course was more and more held up as a qualification for priestly and secular office. The form, however, of the instruction was still not essentially changed from that of the philosophical faculty. It consisted in the transmission of a teaching of a still fixed substance, only that the hearers were of a greater average age. Connected with this was the dying out of the middle-age form of life; and from the scholar has been developed since the seventeenth century the student.

These conditions lasted without change into the eighteenth century. An instructive study of Kant's career as a teacher has recently appeared.* It resembled Melanchthon's in all essentials, and, like him, Kant also lectured as before him Christian Wolff lectured in Halle, upon all the philosophical sciences—on mathematics and physics, logic and metaphysics, ethics and natural law, besides anthropology and physical geography, and once on mineralogy. Like Melanchthon, Kant also had as hearers young persons, not who studied a little mathematics or physics as their special branch, but who sought chiefly at the university the completion of their general training, in order afterward to apply

* Arnoldt, Königsberg. Altpreussische Monatsschrift, vol. xxx, pp. 7, 8.

themselves to the special study of theology and jurisprudence. Like Melanchthon, Kant also taught single branches from text-books, as was the strict custom, and held recitations and disputations in addition to his lectures. It was still a schoolmaster's teaching. Only the grammatical and rhetorical branches, with the lessons in the Greek and Roman authors, which formed the principal subjects of Melanchthon's lectures, had fallen away. They were no longer among the most important departments in the universities of the eighteenth century, partly because they had become superfluous through the greater amplitude of the preparatory course in the schools, and partly because classical instruction had declined in importance and esteem.

The difference between this and the present German university instruction is apparent on a comparison of the two. The present teaching has entirely abandoned the schoolmasterly character. It aims no more at a general training, but is special, scientific. Mathematics and science are no longer taught by philosophers to hearers of all these faculties, but by specialists to specialists. The ancient writers are not read—as three hundred years ago by Melanchthon and one hundred years ago by Heyne in Göttingen and Ernesti in Leipsic—to the general hearers, for the sake of general training and cultivation, but to philological students for the purpose of inducting them into the technics of the scientific treatment of the text. The name of Fr. A. Wolf, who is given the credit of having raised ancient knowledge to an independent study, marks this revolution. The closest reminders of the old conditions are the lessons called philosophical and a few historical lectures, including the history of literature and art, at which hearers are gathered from the different faculties, and the completion and deepening of the general training is more prominently sought than induction into special studies. The tendency to a transformation is, however, visible here too plainly in History, in which the lectures and still more the accompanying exercises have already the character of professional, special instruction. Signs of the change are beginning to be visible, too, in the philosophical teaching. Psychology, especially, is tending to isolate itself as a special field of scientific investigation. It is further worthy of remark that the faculties have reversed their relation to this branch within the nineteenth century. While formerly the teaching in the philosophical faculty was mostly elementary and general, it is now divided into many branches, and is predominantly special and professional. While in the other faculties the first thing regarded is the preparation of practitioners for their calling as doctors, clergymen, and lawyers—a point that can never wholly be lost sight of—the teaching in the philosophical faculty is various, as if the training of specialists or technicalists in scientific investigation were the single object. There is nothing to indicate that the students of these faculties expect to be called to practical teaching. The difference is plainest in the seminaries and in the exercises. In the higher faculties they aim at the preparation for practice; as in the clinic course of the medical schools, in the academical exercises in the juridical faculty, more strongly prominent of late, and in the theological drill. On the other hand, the seminaries have given the philosophical faculties the character of schools of scientific investigation—philological and historical, as well as scientific and mathematical; so that the dissertations come out even from them with a peculiar predominantly scientific character; while the scholastic exercises—the old declamations and disputations—have ceased.

When we ask for the causes of this change, the most decisive of them is found to be the great change which has come over the scientific self-consciousness of the modern world since the seventeenth century. The whole scientific course of the middle ages and down to the sixteenth century was the result of the presumption that knowledge was created in antiquity and was complete. Aristotle especially was regarded as the highest authority in matters of science; he was the philosopher; his writings were the canonical text-books which were transmitted to the universities, expounded and adopted by them. The authority of Aristotle was broken down and the new method founded by Copernicus, Galileo, Kepler, Descartes, Bacon, and Harvey. Science is not now supposed to be complete at hand, but must be created by our labor.

This new method began to penetrate university instruction in the eighteenth century. The young University of Halle first recognized the novel principle of the *libertas philosophandi*. The duty of the university teacher was not to transmit the familiar scholastic philosophy, but to exercise and cultivate independent thinking. The philosophy of Christian Wolff was the first free philosophy found in this school. The scholastic philosophy was supplanted by it in the German universities in the course of the eighteenth century. Its principle is independence in thought: nothing without sufficient reason. The Kantian philosophy began to dispute with it for the mastery at the end of the eighteenth century; but Kant stands, if possible, still more distinctly on the same ground—the ground of independent thought. The view now penetrates the whole of university life that knowledge is not a gift but a duty. The calling of a professor is, in the first place, to labor to produce it; and, second, to train the rising generation to the same work; the university becomes the workshop and nursery of scientific research. This is the view which has gradually gained prevalence in Germany since the last century; and the men who advance science and form schools constitute the fame of a university. The course in England and France was different from that which matters took in Germany and the countries under German influence. To be high schools for general training has continued till the present time to be the chief end of the English universities, and it was the same in France till the Revolution destroyed the old forms. This condition is connected in part with the fact that in those centralized countries the great scientific institutions in London and Paris answer for the new work of scientific research, while in divided Germany the scientific societies are still relatively unimportant, or have been from the first only annexes of universities, as they all are in fact; and partly with the differences in the internal constitution of the universities, the philosophical faculties having in the western countries almost vanished with the public lectures, and instruction having drawn back into the colleges and assumed within them a scholastic form. Under these influences the entrance of the new philosophy was obstructed. In Germany, on the other hand, the middle-age colleges died out and the philosophical faculties remained with their public instruction, to appear now as the organs with which the new scientific and philosophical life was taken up.

The operation of this change in the scientific world by which university teaching, and especially teaching in the philosophical faculty, was divested of its scholastic features and given a purely scientific character, was supplemented by secondary causes. First among these was the development of the old Latin school into the gymnasium. This change, begun in the second half of the eighteenth century, was completed in the first two decades of the nineteenth century. The present gymnasium differs from the old Latin school by its giving, besides the linguistic and literary course, a course of considerable extent in mathematics, science, history, and geography. Thereby the philosophical faculty departed in a measure from its old work; for the entering student who now comes to the university when about twenty years old, instead of about his eighteenth year, turns at once to the study of his professional branch, with the intention of concluding the necessary scientific training with his abiturient examination. Besides this class the lectures in history, philosophy, and the history of art were heard only by the attendants of the philosophical and theological faculties and occasional guests from the other faculties.

The result was that the philosophical faculty was able and had to change its course of instruction. General and elementary teaching in languages and science was no longer demanded as before. The teacher could presume more, because the pupils brought more with them. A new scientific calling has been formed in this century — that of the gymnasial professoriate. Hitherto the teacher's office in the Latin schools had been filled entirely with theologians, and was a transition step to the priestly office. The new gymnasium demanded professionals. Its teachers are not candidates in theology with a general philosophical and philological training, but learned philologists, mathematicians, naturalists, and historians, with now professors of modern philology, geography, etc. The introduction of the examination *pro facultate docendi* in Prussia in June, 1870, marked the new demand. The special purpose of the philosophical faculty was from this time on to prepare specialists for teaching in the gymnasia. The philosophical faculty has now adapted its teaching to this new situation, and its purpose has been further so changed, in fact, that aside from the ultimate practical turning of its attendants into the teacher's office, it trains them to be merely learned scientific men. The instruction in the philological, historical, mathematical, and scientific branches is of a kind as if all who took part in it intended to devote themselves to scientific research as their only calling. Justification for this course has been sought in the consideration that recruits for scientific research are in fact found among the attendants; that gymnasium teachers have an important share in scientific work; and, finally, that the object of gymnasium teaching is really preparatory drill to scientific thought, and therefore a strict scientific training is the most important requisite of a German gymnasial teacher.

The priority, the historical course of which is sketched above, appertained to the philosophical faculty, but did not remain limited to it. The theological and juridical faculties had a part in it, and the medical faculty in particular, the course of which runs parallel with that of the philosophical, since it stands in close connection with it through the natural sciences, or as a science is strictly included in it. We are now no longer concerned with the transmission of an established doctrine, but with the search for natural or historical truth; and to approach a participation in this work is now regarded in all the faculties an essential part of the duty of an academical teacher.

When we regard the results of this development, there first appears an extraordinary prosperity of scientific investigation which proceeded in Germany chiefly from the universities. While our people in the seventeenth century stood away behind their western neighbors, they have gained, since the remodeling of the universities in the eighteenth century, a very eminent, in many instances the leading, place in all departments of scientific work. That this is due chiefly to the universities is attested by evidences both at home and abroad. Here scientific investigators have found favorable surroundings for quiet work, the necessary external means, and the no less necessary recognition of coworkers and youth. Here, again, are afforded in intercourse with academic youth, motive and opportunity to attract pupils to co-operation and to train successors in the work. The continuity in scientific labor, to which Germany owes a large part of its success in this field, certainly depends chiefly on this association of investigation and teaching at our universities.

How closely the history of science in Germany in the last century is connected with the history of the universities is made plain in the work of Lexis on the German universities, published in 1893, at the instance of the Minister of Worship. Every step forward in research and its permanent interweaving with the regular work is associated with the foundation of new chairs and new institutes at the universities. Most evident is the growth in the extension of the philosophical and medical faculties. Instead of the eight or ten chairs in the philosophical and the two or three in the medical faculty, which were regarded as sufficient in the sixteenth and seventeenth centuries, we have at the middle and smaller as well as at the larger universities three and four times as many, including the extraordinaries, and even six and eight times. The institutes of every kind nearly all date from the last century.

The German people have expended and are expending every year much on their universities. No other people proportionately devotes so large sums to the endowment of its high-school instruction. We may well say that it has not been a fruitless application of capital, and hope that it will not be in the future. The present repute of the German name among the nations of the earth has grown in no small degree out of its universities. It has sometimes been pointed out that the teaching work of the incumbents of some of the chairs—that of Oriental languages, for instance—has been very insignificant; the cost, per head, of the instruction given has been counted up and found to be high; and it has even been proposed to maintain chairs for such specialties only at two of the large universities. Such calculations are niggardly and not just. The existence of a large number of chairs is not of little importance to the permanence of the scientific achievements of the German people in these fields, even though we are not a wealthy people. The few thousand marks which are paid to the merit of men like Rückert and Bopp ought not to be regarded by any one as wasted, even though their work were substantially null. The university chair in Germany is at the same time a form of endowment for scientific labor. It is the external stimulus to strive for distinction in a kind of work which has at present no marketable value, and makes it possible to devote one's self to it permanently. If it produces work of inferior money value, in what field does not such work slip in?

When we inquire into the consequences of this situation to teaching, we begin to ask whether our universities have not declined as institutes for instruction; whether there is not danger, at least, that teaching will suffer from its combination with research; whether the professors are not disposed to neglect it in their zeal for investigation; and whether they are not too much inclined to draw their students to that side, with the result that the training for practical occupations is shortened. Are not our teachers and pastors, our jurists and officers, and even our doctors, too much devoted to theorizing and doctrine, and too little to life and reality; and do they not acquire this habit at the university? Are they not led by their teachers and by the customs into an exaggerated valuation of pure scientific work? And do not many come to regard practical work as something inferior, which they take up as a means of support only while the more distinguished career of the academy is for some cause inaccessible to them?

Fears of this kind, which are often expressed, are possibly not without ground; but I have another result to present of the association of research and teaching at our universities. I have already referred to it in an essay on the Nature of the German Universities, and content myself now with the repetition of two remarks made there: "According to the German idea the university professor is both a teacher and a scientific investigator, principally the latter, so that one may truly say that in Germany scientific investigators are at the same time the teachers of academic youth. This fixes the position of scientific men in the life of the German people. Our thinkers and investigators are known to us not merely from their writings, but face to face, as personal teachers. Men like Fichte, Schelling, Hegel, and Schleiermacher labored during their lives before the public as teachers. So Kant, Christian Wolff, Heyne, and F. A. Wolf, as personal teachers of our people, trained its leaders and teachers. . . . The relation is undoubtedly advantageous to both. The German youth, who at the university come into immediate contact with the intellectual leaders of the people, receive there the deepest and most enduring stimulus. On the other side, the relation is delightful to our scientific men. They continue young in contact with youth; the personal exchange of thought acquires something moving and vivifying through the silent but intelligent reaction of the students which is lacking to the solitary writer. And if knowledge stands nearer to the hearts of the public in Germany than with other people, that also is connected with the fact that here the great men of science have always been, too, the personal teachers of the young men."

I think there are advantages which may well compensate us for the few embarrassments and disadvantages that may arise from the combination of teaching and research. Should it occasionally really happen that an academical teacher interested in his scientific research should not pursue his teaching with due diligence, we should not therefore surrender a relation that has been developed among us by historical growth. We should not overlook the fact that in the long run the men most active in research are likewise the best teachers we can get. Exceptions may be adduced by which it may appear that some very eminent men of science have had no inclination or knack for teaching. But it is still true, on the whole, that the heart for research and the heart for teaching are intimately related, and therefore, as a rule, appear together. The testimony of history leaves no doubt that the strongest influences upon the training of youth have till now been exerted by those who have at the same time had leading positions in the scientific world. I call to mind at this moment Kant and Schleiermacher, to whose names a long list might be added from all the faculties, who would confirm the principle that scientific activity and the talent for teaching run parallel with one another.

No more, on the other hand, should we fear that an excess of scientific training is of itself dangerous to students—that is, that it will interfere with their practical career. It is rather true as to this point in general that the more fundamental the scientific training, and the greater the interest in science which any one acquires at the university, the better is he prepared for practical life. It may, indeed, happen that interest will be weakened in a profession neglected on account of engagement in scientific work. This may not rarely occur with the attendants of the philosophical faculty, and the young teacher who has been led to historical, philological, mathematical, or scientific research at the university, and has become interested in them, may feel as if he were not in his right place when he is put over a class of boys to give them elementary instruction, and the work may seem at first insignificant and beneath him. But if he is the right man he will put himself right at once, and his scientific interest will not make his school work a whit harder. On the other hand, if he has time and strength left after his school work (and he must, unless his position imposes an unreasonable burden upon him), he will soon learn how great a treasure he has in a field of occupation which lies outside of his daily routine—like a garden of flowers and herbs outside of the cornfield of his school—in which he can recruit himself after the toil and heat of the day. There is no better protection against falling into listless routine and absorption in the minute interests of the day than continuous participation in scientific work—coming back into the upper story, as a friend of mine who thus varied his daily life was accustomed to describe it. The school will likewise learn how well it is served by teachers of this sort. This is especially true of the gymnasium. The deepest and most lasting effects, as history illustrated in biographies, attests, do not proceed from teachers most eminent in drill and persistence, but from those who lead an inner, intellectual life continuously refreshed and renewed by scientific work. The pupils have a fine appreciation of their teacher and his method. Thorough scholarship and earnest participation in scientific research have assured and always will assure the teacher particular respect in the eyes of his pupils; and many a student has first been inoculated with the taste for the intellectual, inconspicuous though it may have seemed to him, by the view of such a life. It is further true in other learned professions that nothing more firmly fortifies one against the depressing moments that are strange to no calling than a steady interest in science. More than anything else, engagement with concerns of theory operates against the falling into the purely business way of viewing things which apparently threatens to degrade such professions as those of medicine and law.

Thus, we can not see harm of any kind in the direction of university instruction toward scientific research; on the contrary, the purer and deeper the theoretical interest which our students carry into life from the university the better for them and for the business they engage in.

If, however, there is danger—and I believe the fear is not without some foundation—of the power of our universities as teaching institutions declining, we may look for the cause in accompanying conditions. Among these is one existing in direct connection with scientific research—the ever-increasing division of labor and specializing. This is in itself unavoidable. Specializing is here and everywhere a condition of stimulated productiveness. We can not go back to the universality of studies which was possible in antiquity and the middle ages and down into the eighteenth century. With specializing is associated a danger. The splitting up of work into scattering, minute, and often petty study of details weakens the general human interest in science. The immediate interest in knowledge is directed to the whole, to philosophy, from which connected knowledge on all subjects, divine and human, is expected. The long labor of the mind through thousands of years, of which our research is supposed to be the continuation, began with the seeking of the Greeks for a theory of the universe. In the eighteenth century, in the age of Leibnitz, Kant, and Wolff, it was still the object; all scientific work was for a "world-wisdom"—for a view of the nature and meaning of the world and life. Many have now forgotten this, and in the pursuit of little single details have lost sight of the end. Indeed, some are proud of knowing nothing of this; they deliberately and willfully confine themselves to their special branch, boasting of their independence, and boldly despising what lies beyond their borders. Their scorn is especially expressed toward philosophy; not merely against this or that philosophy, but against philosophy itself, against the seeking for universal knowledge—knowledge of the whole.

This spirit of specialism is the danger. It tends to impede the pursuit of theory; for it is still true that science originally looked not to this or that particular, but to the whole, its nature and its significance. When science ceases to give an answer to these questions, general interest will be turned away from it. Men will then regard research with similar feelings to those with which they look at a sport, in which great exertions are made for a purpose of no value in itself. Is not this feeling sometimes manifested now, even though it is not expressed in words? What means the dissatisfaction with the present shape of our intellectual life, especially with our science, which can not achieve a whole, but wearies itself to exhaustion in endless collection and endless analysis—the indignation against the haughtiness with which the specialist rejects the assistance and even the sympathy and inquiry of the layman, the *dilettante?* In fact, narrowness readily goes with limitation, and conceit with narrowness—that special conceit which thinks itself superior to all because it can see no one in its field besides itself.

Just this spirit of specialism is now dangerous to university teaching, paralyzing the teacher's work and the interest of the learner. At the bottom it is the philosophical in every science that inspires to instructive participation. Man has an innate disposition to propagate his convictions, his view of the world, and his faith. That is the Eros which inspired Socrates to seek intercourse with his pupils. The Eros is wanting to the specialist, along with the philosophical disposition and the love of teaching. To impose a duty of teaching upon him seems to him like a robbery of his precious time. This feeling is responded to by a decline in interest on the part of his hearer. The attraction that draws him is again the philosophical, the humanly significant part of the teaching. Detail and virtuosity and exactness can not take the place of this.

Further, the more the teaching is specialized the less does it give the student what he most needs—a comprehensive survey of the whole of a field of knowledge. Take history: Instead of a lecture on universal history, or the history of the German people, five or ten lectures upon as many fragments or single sides of the subject. Excellent and thorough as they may be in themselves, they afford the beginner less than the others. He most needs the leading direction-lines for the comprehension of the whole, and these, even if the teacher can and does give them, are less plainly set forth among the mass of details and by being scattered through the hours. Or take natural science and archæology: A hundred years ago a teacher went over the whole subject in a reasonable number of lectures. Now it takes several teachers to do the work, each of whom devotes a course of lectures to a special field. It is evident that this method will make it much harder for the student to get a simple comprehension of the whole. It may easily come to pass that he is bewildered and distracted by the mass of detail, and amid the diversity of views and methods of different teachers gropes unintelligently hither and thither, and does not reach a clear understanding and free view of the whole till after many terms have been wasted. Or, if he seeks to escape this evil by attaching himself to a single teacher, he encounters the other danger of confining himself in that special field, giving himself up to the working out of a single problem, and of soon burying himself in it so deeply that he can see nothing else in heaven and earth, and of ultimately leaving the university a one-sided specialist. Another evil result that occurs to me is, that the increasing division of labor is attended with a loosening of the relation of the university teacher to practical work. This is especially evident in the juridical and theological faculties. The law professors formerly, as members of the bar, regularly took part in the administration of justice. Now they are quite outside of legal practice, and by a reflex action their teaching has become more abstract and dogmatic. The theological professors were formerly engaged also in preaching and pastoral work, and in church and school direction. In the beginning the relation was often such that the pastoral office was regarded as the chief object, and the theological professorship as a secondary work; and the instruction given to the students was a direct introduction to the duties on which they were about to enter.

It should not be forgotten that very earnest and successful efforts have been put forth during the present century to make scientific instruction more fruitful. Among the results of these are the exercises and experiments in seminaries and institutes of various kinds, of which students enjoy the advantages; the increase of means of instruction, such as the more extensive use of demonstrations with which the lectures are accompanied, and the great increase and freer use of libraries, are not to be despised.

After considering all these facts, we conclude that the association of scientific research and scientific teaching, as it has been developed in the history of the German universities, may be regarded as a happy joining, which we should by all means maintain in the future. The universities have so far devoted themselves legitimately to both purposes, and on the whole with good effect. It is true that the number of students who miss the right way or do not reach the goal is lamentably great. But there is security against this. If any one speaks of it as if it was the fault of the university, and asks it to prevent such failures by discipline, tests of diligence, and more frequent examinations, he makes an unreasonable accusation and presents a demand that can not be complied with. The university is not a school, and will not and can not be one. It is an institution for adults, who live there on their own responsibility. That all its members do not know how to make the best use of their privileges proves nothing against the institution.

Hence we find nothing of an essential character to disturb in the general organization of the university as a teaching institution. We can only endeavor to make its endowments more fruitful and to ward off the harmful tendencies as far as possible. It would indeed be a pity if the institutions which have accomplished so much, and have so illustrious names on their rolls of teachers, should, in these days of minute subdivision of labor, allow their energies to be dissipated in excessive specialization. This is not likely to happen; we may even say it will not happen. There are indications that a reaction is at hand from this tendency. If we mistake not, the one-sided exaltation of the specialist's work has passed its zenith. Long-neglected philosophy is again obtaining a footing even in the domain of scientific research—an evidence that the idea of the unity of knowledge is still vital. What philosophy gains, the university gains as a teaching institution, as the high school of general education.—*A translation, for The Popular Science Monthly, from an article in the Deutsche Rundschau.*

HELMHOLTZ'S TRIBUTE TO HEINRICH HERTZ.

THE preface to the *Prinzipien der Mechanik*, or Principles of Mechanics, of Heinrich Hertz is a testimonial by Helmholtz, who followed the author so soon in death, to his gifts and his work. Endowed with the rarest gifts of genius and character, Hertz, Helmholtz says, had gathered a fullness of fruits almost beyond anticipation, for the winning of which many of his most accomplished fellow-specialists had toiled in vain. It would have been said in classical times that he fell a victim to the envy of the gods. In him Nature and fortune seem to have favored the development of a mind that united in itself all the talents needed for the solution of the most difficult problems of science; a mind adapted alike to the highest keenness and clearness of logical thinking and to the greatest accuracy in the observation of minute phenomena. He appeared to be destined to disclose to mankind views into many hitherto hidden depths of his nature. I have keenly felt the disappointment of hope caused by his death, for Hertz was the one of my students who entered most fully into my own circle of scientific thoughts and on whom I most confidently relied for their future development. He has by his discoveries secured a permanent fame in science. Not only will his name live through his labors, but his lovely, noble traits of character, his uniform modesty, his glad recognition of the merit of others, the gratitude he felt toward his teacher, will never be forgotten by any who knew him. His only thought was for the truth, which he sought with extreme earnestness and all his might. He was never moved by ambition or self-interest. Even when he had a right to claim discoveries for himself, he was rather inclined to refrain. While usually quiet and taciturn, he could take an animated part in the social circle of his friends, and enliven the conversation by many a pertinent word. He never had a personal adversary, but he could on occasion utter a sharp judgment upon slovenly work or notoriety-seeking efforts that gave themselves out for science. How fully his thoughts embraced the widest views of science is illustrated in this book, the last monument of his earthly effort, in which he has sought to give a consecutive presentation of a system of mechanics consistent in itself, and to deduce all the special laws of that science from a single principle. Great difficulties are indeed still to be overcome in the effort to explain single sections of physics from the principles developed by Hertz. But as a whole his treatise must interest in the highest degree every reader who can enjoy a consistent system of dynamics presented in the most complete and comprehensive mathematical setting.

PITHECOID MAN.

By Prof. E. P. EVANS.

ON the 16th of February, 1894, Prof. Ernst Haeckel, the most eminent representative of natural science and the most ardent advocate of the doctrine of evolution in Germany, celebrated his sixtieth birthday and received the congratulations of numerous friends and pupils from far and near, who in many cases emphasized the expression of their good wishes by the presentation of appropriate gifts. Of these tokens of friendship and esteem perhaps the most suitable, as well as the most striking, was a painting by Gabriel Max, of Munich, entitled *Pithecanthropus europaeus alalus.* This picture, which formed one of the chief attractions of the International Art Exhibition in the Crystal Palace at Munich, represents the "missing link" and his family, or the primitive semihuman European, as he may have "lived and loved" in the Pliocene period of the Tertiary epoch.

In this connection we may premise that Prof. Gabriel Max is not only a genial artist endowed with a rare power of portraying strong passions and intense emotions of the soul—joy, sorrow, enthusiasm, the ecstasy of the saint and the heroic resignation of the martyr, especially as reflected in the features of women—but also an amateur in anthropology and comparative anatomy. Among his recent works are several remarkable studies of apes, such as In Bad Humor (an angry simian mother correcting her child by pulling its ear), Three Sages (a trio of monkeys sitting before an open book), and especially the semi-satirical group of anthropoids as art critics now in the New Pinakothek at Munich.

Unlike these paintings, which are the result of long and careful observation of living models, the representation of the Pithecanthropus is a fancy sketch based upon scientific deductions from the theory of evolution. The scene lies in the primeval forest, where the female of the pithecoid progenitors of mankind is seated at the foot of a tree, nursing her infant. The hands show a marked advance toward humanity in their differentiation from the feet. Of existing apes the gorilla comes nearest to man in this respect, and is superior to all other quadrumanes in the power of standing erect and walking on its hind feet, but as a rule it goes on all fours. The Pithecanthropus, however, no longer creeps and grovels on the ground, but assumes with ease an upright posture, and, in the words of Racine, "*élève un front noble et regarde les cieux.*" Not only does this creature lift its brow and look at the sky, but, what is perhaps of still greater importance, he puts his foot down like a man, and, if he should chance to leave any "footprints on the sands of time," they would preserve distinct traces of five toes, whereas in the impressions made by the foot of the gorilla we can discover only marks of the ball of the foot and slight indications of the great toe. The same process of development is also perceptible in the formation of the limbs and in the lines of the face. The male, as he stands near the fallen trunk of a tree, has quite straight legs—rather too straight, indeed, for *Homo primigenius*, who was undoubtedly knock-kneed—and the calves are somewhat more fully developed than we should expect to find them in this early stage of transition from ape to man. The hair on the body has become thinner and that of the head has grown longer and more luxuriant, especially in the female. The skull, too, evidently covers a bigger and better brain than that of the orang-outang or the chimpanzee, and the chest is more human in shape than that of the gibbon. But it is not so much perhaps in these physical changes as in the general cast of the countenance and the peculiar expression of the eye that the variation toward intellectuality and humanity is most clearly reflected. A single tear trembling on the mother's cheek bears witness to the awakening of a kind of consciousness and the stirrings of an emotional nature wholly foreign to the simian breast, and seems a presentiment of all the future woes and miseries of the race. The father's sterner features radiate with paternal pride mingled with a certain thoughtfulness and shadowed by vague anxiety, and, although his susceptibilities are less easily excited and his solicitudes less lively than those of his tender-hearted helpmate, he feels the burden of his responsibilities, lives in the future as well as in the past and present, and already answers to Shakespeare's definition of man as a being that "looks before and after." It is the masterly delineation of these spiritual qualities that reveals the peculiar preeminence of Max as an artist and proves the accuracy of his observations and deductions as an anthropologist. The face of the nursling is invisible, but the shapeliness of the head and the symmetrical proportions of the hands pressing the mother's breast are remarkably human and preclude the possibility of any atavistic reversion in their offspring. Nearly a century ago the German philosopher and psychologist, J. F. Herbart, stated very succinctly the superiority of man's physical structure and constitution in promoting his mental development: "He has hands, he has speech, he lives through a long, helpless infancy." The *Pithecanthropus alalus* fulfills only the first and third of these conditions, but with an additional convolution of the lobes of the brain and a slight modification of the larynx he will acquire the faculty of articulate speech, on which the rapid and progressive growth of the intellectual capacities and moral character so largely depends.

We often complain, says the report of the American University Extension Society, that the foreigners among us debauch our politics by consenting to serve as mere instruments of designing politicians; but we must remember that these same designing politicians are the only people who have been willing hitherto to give any attention whatever to the political education of these classes of our citizens. The University Extension Society claims to have made the first systematic effort toward helping our foreign-born citizens to qualify themselves for their new position. Courses have been given in quarters of the city (Philadelphia) where recent immigrants have attended them in considerable numbers. "It was pathetic" to observe the eagerness with which audiences of Russian Jews were bent on learning something of the government and institutions of their adopted country.

STUDIES OF CHILDHOOD.

IV.—THE CHILD'S THOUGHTS ABOUT NATURE.

By JAMES SULLY, M. A., LL. D.,
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WE have seen in the previous article how the child-mind behaves when brought face to face with the unknown. We will now examine some of the more interesting results of this early thought-activity, what are known as the characteristic ideas of children. There is no doubt, I think, that children do, by the help of reflection supplementing what they see or otherwise experience and what they are told by others, fashion their own ideas about Nature, death, and the rest. These ideas will probably be proved to vary considerably in the case of different children, yet to preserve throughout these variations a certain general character.

These ideas, moreover, like those of primitive civilized races, will be found to be a crude attempt at a connected system. We must not, of course, expect too much here. The earliest thought of mankind about Nature and the supernatural was very far from being elaborated into a consistent logical whole; yet we can see general forms of conception or tendencies of thought running through the whole. So in the case of this largely spontaneous child-thought. It will disclose to an unsparing critical inspection vast gaps and many unsurmounted contradictions. Thus, in the case of children, as in that of uncultured races, the supernatural realm is at first brought at most into only a very loose connection with the visible world. All the same, there is seen, in the measure of the individual child's intelligence, the endeavor to co-ordinate, and the poor little hard-pressed brain of a child will often pluckily do its best in trying to bring some connection into that congeries of disconnected worlds into which he finds himself so confusingly introduced, partly by the motley character of his own experiences, as the alternations of waking and sleeping, partly by the haphazard miscellaneous instruction, mythological, historical, theological, and the rest, with which we inconsiderately burden his mind.

As was observed in dealing with children's imaginative activity, this primitive childlore, like its prototype in folklore, is largely a product of a naïve vivid fancy. In assigning the relations of things and their reasons the child-mind does not make use of abstract conceptions. It does not talk about "relation," but pictures out the particular relation it wants to express by a figurative expression, as in apperceiving the juxtaposition of moon and star as mamma and baby. So it does not talk of abstract force, but figures some concrete form of agency, as in explaining the wind by the idea of somebody's waving a big fan somewhere. This first crude attempt of the child to envisage the world is indeed largely mythological, proceeding by the invention of concrete and highly pictorial ideas of fairies, giants, and their doings.

The element of thought comes in with the recognition of the real as such and with the application of the products of young fantasy to comprehending and explaining this reality. And here we see how this primitive child-thought, though it remains instinct with glowing imagery, differentiates itself from pure fancy. This last knows no restraint, and aims only at the delight of its spontaneous playlike movements, whereas thought is essentially the serious work of realizing and understanding what exists. The contrast is seen plainly enough if we consider first the mental attitude of the child when he is frankly romancing, giving out now and again a laugh which shows that he himself fully recognizes the absurdity of his talk; and, secondly, his attitude when in gravest of moods he is calling upon his fancy to aid reason in explaining some puzzling fact. How early this splitting of the child's imaginative activity into these two forms, the playful and the thoughtful, takes place, is not, I think, very easy to determine. Many children at least are apt at first to take all that is told them as gospel. To most children of three and four, I suspect, fairyland, if imagined at all, is as much a reality as the visible world. The disparity of its contents, the fairies, dragons, and the rest, with those of the world of sense does not trouble their mind, the two worlds not being as yet mentally juxtaposed and dovetailed one into the other. It is only later, when the desire to understand overtakes and even passes the impulse to frame bright and striking images, and, as a result of this, critical reflection applies itself to the nursery legends and detects their incongruity with the world of every-day perception, that a clear distinction comes to be drawn between reality and fiction, what exists and can (or might) be verified by sense, and what is only pictured by the mind. When this date is reached, the child's imaginative activity, losing its first *naïveté* and unconsciousness of its own worth, becomes conscious of itself; that is to say, the child, when framing his mental pictures, is aware that he is playing, pretending, or fooling; or, on the other hand, trying to understand things.

With this preliminary peep into the *modus operandi* of children's thought, let us see what sort of ideas of things they fashion.

Beginning with their ideas of natural objects we find, as has been hinted, the influence of certain predominant tendencies. Of these the more important is the impulse to think of what is far off, whether in space or time, and so unobservable as like what is near and observed. Along with this tendency, or rather as one particular development of it, there goes the disposition, already illustrated, to vivify Nature, to personify things and so to assimilate their behavior to the child's own, and to explain the origin of things by ideas of making and aiming at some purpose. Since at the same time that these tendencies are still dominant the child by his own observation and by such instruction as he gets is gaining insight into the "how," the mechanism of things, we find that his cosmology is apt to be a quaint jumble of the scientific and the mythological. The boy C—— tried to conceive of the divine creation of men as a mechanical process with well-marked stages, the fashioning of the stone men, iron men, and then real men. In many cases we can see that Nature-myth comes in to eke out the deficiencies of mechanical insight. Thus the production of thunder and other strange and inexplicable phenomena is referred, as by the savage and even by many so-called civilized men and women, to the direct interposition of a supernatural agency. The theological idea with which children are supplied shapes itself into that of a capricious and awfully clever demiurgos who not only made the world-machine, but alters its working as often as he likes: for miracle is of the essence of the child's "*Naturanschauung.*" Contradictions are not infrequent, the mythological impulse sometimes alternating with a more distinctly scientific impulse to grasp the mechanical process, as when wind is sometimes thought of as caused by a big fan, and sometimes—*e. g.*, when heard moaning in the night—endowed with life and feeling. In many cases, too, the impulses combine, as when thunder is conceived of as God's action, but effected by mechanical means, such as shooting bricks on to the floor of heaven.

I shall make no attempt to give a methodical account of children's thoughts about Nature. I suspect that a good deal more material will have to be collected before a complete description of these thoughts is possible. I shall content myself with giving a few samples of their ideas so far as my own observations and those of others have thrown light on them.

With respect to the make or substance of things, children are disposed to regard all that they see as having the resistant quality of solid material substance. Just as the infant wants to touch pictures, the reflected sunlight dancing on the wall, and the shadows of objects, so later on the child continues to attribute the resistant quality of body to clouds or other inaccessible contents of the visible scene. Air at rest is of course not perceived by the child, but when in motion as wind it seems, so far as I can ascertain, to be thought of as substantial; at least this is suggested by the following story from the Worcester collection: A girl aged nine years was looking out and seeing the wind driving the snow in the direction of a particular town, Milbury, whereupon she remarked, "I'd like to live down in Milbury." Asked why, she replied: "There must be a lot of wind down there; it's all blowing that way."

Children are, as may be seen in this story, particularly interested in the movements of things. Movement is the clearest and most impressive manifestation of life. All apparently spontaneous or self-caused movements are accordingly taken by children as by primitive man to be the sign of life, the outcome of something analogous to their own impulses. Hence, the movements of falling leaves, of running water, of feathers, and the like are especially suggestive of life. Some children in the infant department of a London Board School were asked what things in the room were alive, and they promptly replied, the smoke and the fire. Big things moving by an internal mechanism of which the child knows nothing, more especially engines, are of course endowed with life, and the author of The Invisible Playmate tells us that his little girl wanted to stroke the "dear head" of a locomotive.

What is more extraordinary, the child's impulse to give life to many things often leads him to overlook the fact that movement is caused by an external force, and this even when the force is exerted by himself. The boy C——, on finding the cushion he was sitting upon slipping from under him in consequence of his own wriggling movements, pronounced it alive. In like manner children ascribe life to their moving playthings. Thus C——'s sister when five years old stopped one day trundling her hoop, and turning to her mother exclaimed: "Ma, I do think this hoop must be alive, it is so sensible; it goes where I want it to." Another little girl, two years and a quarter old, on having a string attached to a ball put into her hand, and after swinging it round mechanically began to notice the movement of the ball, saying to herself, "Funny ball!" In both these cases, although the movement was directly caused by the child, it was certainly in the first case and apparently in the second attributed to the object. This tendency to attribute self-movement and will to toys survives in the older player. Do we not when playing billiards or bowls catch ourselves talking and thinking of the moving body as having a will of its own, and capable of carrying out our purpose if it only would, and equally capable, alas! of maliciously thwarting it?

Children are disposed, too, to form their own ideas about the mechanism of these spontaneous-looking movements. The examination of the mystery of a mechanical toy may set the young brain trying to construct a whole theory of motion. How far children apply this idea of machinery to their own movements I have not been able to ascertain. As we shall see, they seem to be mainly occupied with the mystery of our being able to move our limbs when we wish to do so. The idea has occurred to me that children's passion for pulling flowers to pieces may be prompted in part by a vague expectation of finding the mechanical secret of their growth and of the opening and shutting of their petals. Movement plays, I believe, the chief part in children's first ideas of the life of plants, though this idea grows more definite when they get knowledge of their fading and dying.

Next to movement apparently spontaneous sound appears to be a common motive for attributing life to inanimate objects. Are not movement and phonation the two great channels of utterance of the child's own impulses? A little boy assured his teacher that the wind was alive, for he heard it whistling in the night. The ascription of life to fire is greatly aided by the observation of its sputtering, crackling noises. The impulse, too, illustrated in the case given above, to endow so little organic-looking an object as a railway engine with conscious life was probably supported by the knowledge of its puffing and whistling. M. Pierre Loti, when as a child he first saw the sea, regarded it as a living monster, no doubt on the ground of its movement and its noise. The personification of the echo by the child, of which George Sand's reminiscences give an excellent example, as by uncultured man, is a signal illustration of the suggestive force of a voicelike sound.

Closely connected with this impulse to ascribe life to what older people regard as inanimate objects is the tendency to conceive them as growing. This is illustrated in the remark of the boy C—— that his stick would in time grow bigger. On the other hand, there is in the Worcester collection a curious story of a little American boy of three years, who, having climbed up into a large wagon and being asked, "How are you going to get out?" replied, "I can stay here till it gets little and then I can get out my own self." We shall see presently that shrinkage or diminution of size is sometimes attributed by the child-mind to people when getting old. So that we seem to have in each of these cases the extension to things generally of an idea first formed in connection with the observation of human life.

Children's ideas of natural objects are anthropomorphic, not merely as reflecting their own life, but as modeled after the analogy of the effects of human action. Thus I find that they are apt to extend the ideas broken and mended to objects generally. Anything which seems to have become reduced by losing a portion of itself is said to be "broken." A little boy of three years, on seeing the moon partly covered by a cloud, remarked, "The moon is broken." On the other hand, in the case of one little boy everything intact was said to be mended. We can not, of course, infer from this last that the child thought everything in the world had been broken and mended. He probably had no words for expressing the ideas "make whole" and "keep whole," and so made an analogical use of the familiar word "mend."

So far I have spoken for the most part of children's ideas about near and accessible objects. Their notions of what is distant and inaccessible are, as remarked, wont to be formed on the model of the first. Here, however, their knowledge of things will be largely dependent on others' information, so that the naïve impulse of childish intelligence has, as best it may, to work under the limitations of others' words.

It is perhaps hardly necessary to remind the reader that children's ideas of distance before they begin to travel far are necessarily very inadequate. They are disposed to localize the distant objects they see, as the sun, moon, and stars, and the places they hear about on the earth's surface, as near as possible. The tendency to approximate things, as seen in the infant's stretching out of the hand to touch the moon, lives on in the later impulse to localize the sky and heavenly bodies just beyond the furthest terrestrial object seen, as when a child thought they were just above the church spire; another, that they could be reached by tying a number of ladders together; another, that the setting sun went just behind the ridge of hills, and so forth. The stars, as so much smaller looking, seem to be located further off than the sun and moon. Similarly, when a little Londoner hears of distant places, as Calcutta, he tends to project them just beyond the furthest point known to him, say St. Paul's, to which he was once taken on a long journey from the West End. A child's standard of size and distance is, as all know who have revisited the home of their childhood after many years, very different from the adult's. To the little legs unused as yet to more than short spells of locomotion a mile seems stupendous; and then the small brain can not yet pile up the units of measurement well enough to conceive of hundreds and thousands of miles.

As all who have talked with children know and as inquiries into the contents of the little Boston minds confirm, the child thinks of the world as a circular plain, and of the sky as a sort of inverted bowl upon it—that is to say, he takes them to be what they look. In a similar manner C—— took the sun to be a great disk which could be put on the round globe to make seesaw. Heaven is localized agreeably to what has been said about the tendency to bring things as near as possible, just above the sky, which forms its floor. Some genuine thought-work is shown in the effort to adjust the various things seen and heard of respecting the celestial region into something like a connected whole. Thus the sky is apt to be thought of as *thin*, this idea being probably formed for the purpose of explaining the shining through of moon and stars. Stars are, as we know, commonly thought of by the child as holes in the sky letting through the light beyond. One Boston child ingeniously applied the idea of the thinness of the sky to explain the appearance of the moon when one half is bright and the other faintly illumined, supposing it to be halfway through the partially diaphanous floor. Others, again, prettily accounted for the waning of the moon to a crescent by saying it was half stuck or half buttoned into the sky.

As with the savage, so with the child, the heavenly bodies seem to be personified spontaneously, and quite independently of theological instruction. A little boy, two years and two months old, sitting on the floor one day in a great temper, looked up and saw the sun shining, and said angrily, "Sun not look at Hennie," and then, when he found this unavailing, "Please, sun, not look at poor Hennie."* Many children seem quite spontaneously to apperceive stars as eyes, and the moon of course as a human face.

The movements of the sun and other heavenly bodies are similarly apperceived by the help of ideas of movements of familiar terrestrial objects. Thus the sun was thought by the Boston children half mythologically, half mechanically, to roll, to fly, to be blown (like a soap bubble or balloon), and so forth. The anthropocentric form of teleological explanation is apt to creep in, as when a Boston child said charmingly that the moon comes round when people forget to light some lamps. Theological ideas, too, are pressed into this sphere of explanation, as when the disappearance of the sun is variously attributed to God's pulling it up higher out of sight, to his taking it into heaven and putting it to bed, and so forth. These ideas are pretty obviously not those of a country child with a horizon. There is rather more of Nature-observation in the idea of another child that the sun after setting lies under the trees, where angels mind it. But I confess that many of these answers of the Boston children look to me more like attempts of vacuous minds to invent something smart on the spur of the moment than spontaneous growths pre-existing before the questioner appears on the scene.

The impressive phenomena of thunder and lightning give rise in the case of the child, as in that of the Nature-man, to some fine myth-making. The American children, as already observed, have different mechanical illustrations for setting forth the *modus* of the supernatural action here, thunder being thought of now as God groaning, now as his walking loud on the floor of heaven (cf. the old Norse idea that thunder is caused by the rolling of Thor's chariot), now as his hammering, now as

* See note by E. M. Stevens, Mind, vol. xi, p. 150.

his having coals run in—ideas which show how naïvely the child-mind envisages the Deity, making him a respectable citizen with a house and a coal cellar. In like manner the lightning is attributed to God's burning the gas quick, striking many matches at once, or other familiar human device for getting a brilliant light suddenly. So rain is let down by God from a cistern by a hose, or, better, through a sieve or a dipper with holes.*

Throughout the whole region of mysterious unexplained and exceptional phenomena we have illustrations of the anthropocentric tendency to regard what takes place as designed for us poor mortals. The little girl of whom Mr. Canton writes thought "the wind and the rain and the moon 'walking' came out to see *her*, and the flowers wake up with the same laudable object." † When frightened by the crash of the thunder a child instinctively thinks that it is all done to vex his little soul. One of the funniest examples of the application of this idea I have met with is in the Worcester collection. Two children, D—— and K——, aged ten and five respectively, live in a small American town. D——, who is reading about an earthquake, addresses his mother thus: "Oh, isn't it dreadful, mamma? Do you suppose we will ever have one here?" K—— (intervening), with the characteristic impulse of the young child to correct its elders, "Why, no, D——, they don't have earthquakes in little towns like this." There is much to unravel in this delightful childish observation. It looks, to my mind, as if the earthquake were envisaged by the little five-year-old as a show, God being presumably the traveling showman, who takes care to display his fearful wonders only where there is an adequate body of spectators.

Finally, the same impulse to understand the new and strange by assimilating it to the familiar is, so far as I can gather, seen in children's first ideas about those puzzling semblances of visible objects which are due to subjective sensations. To judge from C——'s case, the bright spectra or after-images caused by looking at the sun are instinctively objective—that is, regarded as things external to his body. Here is a pretty full account of a child's thought about these subjective optical phenomena: A little boy of five years, in rather poor health at the time, "constantly imagined he saw angels, and said they were not white, that was a mistake, they were little colored things, light and beautiful, and they went into the toy basket and played with his toys." Here we have not only objectifying but myth-building. A year later he re-

* I am greatly indebted here as in other places to Dr. Stanley Hall's well-known article on The Contents of Children's Minds, published in the Princeton Review.

† The Invisible Playmate, pp. 27, 28.

turned to the subject. "He stood at the window at B——, looking out at a sea mist thoughtfully, and said suddenly: 'Mamma, do you remember I told you that I had seen angels? Well, I want now to say they were not angels, though I thought they were. I have seen it often lately, I see it now: it is bright stars, small bright stars moving by. I see it in the mist before that tree. I see it oftenest in the misty days. . . . Perhaps by and by I shall think it is something in my own eyes." Here we see a long and painstaking attempt of a child's brain to read a meaning into the "flying spots" which many of us know, though we hardly give them a moment's attention.

What are children's first thoughts about their dreams like? I have not been able to collect much evidence on this head. What seems certain is that to the naïve intelligence of the child these counterfeits of ordinary sense-presentations are real external things. The crudest manifestation of this thought-tendency is seen in taking the dream apparition to be actually present in the bedroom. A boy in an elementary school in London, aged five years, said one day, "Teacher, I saw an old woman one night against my bed." Another child, a little girl, in the same school, told her mother that she had seen a funeral last night, and on being asked "Where?" answered quaintly, "I saw it in my pillow." A little boy, whom I know, once asked his mother not to put him to bed in a certain room "because there were so many dreams in the room." In thus materializing the dream and localizing it in the actual surroundings, the child but reflects the early thought of the race which starts from the supposition that the man or animal which appears in a dream actually approaches the sleeper.

The Nature-man, as we know from Prof. Tylor's researches, goes on to explain dreams by his theory of souls or "doubles" ("animism"). Children do not often find their way to so subtle a line of thought. Much more commonly they pass from the first stage of naïve acceptance of objects as present here and now to the identification of dreamland with fairyland or the other and invisible world. There is little doubt that the imaginative child firmly believes in the existence of this invisible world, keeps it carefully apart from this one, even though at times he may give it a definite locality in this—e. g., in C——'s case, in the wall of his bedroom. He gets access to it by shutting out the real world, as when he closes his eyes tightly and "thinks." With such a child dreams get taken up into the invisible world. Going to sleep is now recognized as the surest way of passing into this region. The varying color of his dreams, now bright and dazzling in their beauty, now black and terrifying, is explained by a reference to the division of that fairy world into princes and good fairies, on the one hand, and cruel giants, witches, and the like, on the other hand.

We may now pass to some of children's characteristic ideas about living things, more particularly human beings and the familiar domestic animals. The most interesting of these, I think, are those respecting growth and birth.

As already mentioned, growth is one of the most stimulating of childish puzzles. A child finds that things are in general made bigger by additions from without, and his earliest conception of growth is, I think, that of such addition. Thus plants are made to grow—that is, swell out—by the rain. The idea that the growth or expansion of animals comes from eating is easily reached by the childish intelligence, and, as we know, nurses and parents have a way of recommending the less attractive sorts of diet by telling children that they will make them grow. The idea that the sun makes us grow, often suggested by parents (who may be ignorant of the fact that growth is more rapid in the summer than in the winter), is probably interpreted by the analogy of an infusion of something into the body.

In carrying out my inquiries into this region of childish ideas I lighted quite unexpectedly on the queer notion that toward the end of life there is a reverse process of shrinkage. Old people are supposed to become little again. The first instance of this was supplied me by the Worcester collections of Thoughts. A little girl of three once said to her mother, "When I am a big girl, and you are a little girl, I shall whip you just as you whipped me now." At first one is almost disposed to think that this child must have heard of Mr. Anstey's amusing story Vice Versa. Yet this idea seems too improbable, and I have since found that she is not by any means the only one who has entertained this idea. A little boy that I know, when about three years and a half old, used often to say to his mother with perfect seriousness of manner, "When I am big then you will be little; then I will carry you about and dress you and put you to sleep."

I happened to mention this fact at a meeting of mothers and teachers, when I received further evidence of this tendency of child-thought. One lady whom I know could recollect quite clearly that when a little girl she was promised by her aunt some valuables—trinkets, I fancy—when she grew up, and that she at once turned to her aunt and promised her that she would then give her in exchange all her dolls, as by that time she (the aunt) would be a little girl. Another case narrated was that of a little girl of three years and a half who, when her elder brother and sister spoke to her about her getting big, rejoined, "What will you do when you are little?" A third case mentioned was that of a child asking about some old person of her acquaintance, "When will she begin to get small?" I have since obtained corroboratory instances from parents and teachers of infant classes.

Here we seem to have to do with a pure product of the childish brain. What does it mean? By what quaint zigzag movement of child-thought, by the use of what far-fetched analogy, was the idea excogitated? I can not learn that there is any idea like it in primitive folklore. This at once suggests that it is the result of the activity of the little brain as employed in deciphering the words of older people. It has been suggested to me that the playful way a nurse will sometimes adopt of speaking to the child when she wants it to do something—e. g., "When I'm a little girl I shall be good and not mess my clothes"—may be taken literally by the serious mind of the child. I do not, however, think that this will account for the frequency of the phenomenon. It seems probable that other processes of childish interpretation assist. Children often hear old people talked about as weak and silly. Now, if there is one proposition of which the child is sure it is that grown people are always able to do things and awfully knowing. C——'s belief in the preternatural calculating powers of Goliath shows how strongly the child-mind associates size and intelligence. Consequently, it is a shock to a child to overhear his mother talking about grown people as stupid, just as it is a shock to him to hear her characterizing them as bad or wicked. The creed of infancy is that all such defects will disappear with completion of growth. Hence it may be that children who are in the way of hearing old people spoken of as losing power and intelligence carry over the thought of littleness, and imagine that they must be getting small again. This tendency would, of course, be greatly strengthened if the child happened to hear an old person talked about as getting childish or passing into second childhood. Indeed, I am disposed to think, from the frequency of the appearance of the belief, that this reference to the childish condition of old age is probably always co-operant in bringing the tendency to the definiteness of a theory of senility. However the idea arises, it is a curious and striking illustration of the fact that with all our attempts to supply the young brain with our own ideas, it manages to substitute a good many new and thoroughly original ones.

The origin of babies and young animals furnishes, as we know, the child's brain with much food for speculation. Here the little thinker is not often left to excogitate a theory for himself. His inconvenient questionings in this direction have to be firmly checked, and various and truly wonderful are the ways in which the nurse and the mother are wont to do this. Any fiction is supposed to be good enough for the purpose. Divine action is commonly called in, the questioner being told that the baby has been sent down from heaven in the arms of an angel, etc. Fairy stories with their pretty conceits, as that of the child Thumbkin growing out of a flower, in Andersen's book, contribute their suggestions, and so there arises a mass of child lore about babies in which we can see that the main ideas are supplied by others, though now and then we catch a glimpse of the child's own contributions. Thus, according to Dr. Stanley Hall's report, the Boston children said, among other things, that God makes babies in heaven, lets them down or drops them for the women and doctors to catch them, or that he brings them down a wooden ladder backward and pulls it up again, or that mamma and nurse or doctor goes up and fetches them in a balloon. They are said by some to grow in cabbages, or to be placed by God in water, perhaps in the sewer, where they are found by the doctor, who takes them to sick folks that want them. Here we have delicious touches of child fancy, quaint adaptations of fairy and Bible lore, as in the use of Jacob's ladder and of the legend of Moses placed among the bulrushes, this last being enriched by a thorough master stroke of child genius—the idea of the dark, mysterious, wonder-producing sewer. In spite, too, of all that others do to impress the traditional notions of the nursery here, we find that a child will now and again think out the whole subject for himself. The little boy C—— is not the only one, I find, who is of the opinion that babies are got at a shop. Another little boy, I am informed, once asked his mamma, in the abrupt, childish manner, "Mamma, vere did Tommy (his one name) tum (come) from?" and then, with the equally childish way of sparing you the trouble of answering his question, himself answered it quite to his own satisfaction, "Mamma did tie (buy) Tommy in a s'op (shop)." This looks like a real childish idea. To the young imagination the shop is a veritable wonderland, an El Dorado of valuables; and it appears quite reasonable to the childish intelligence that babies, like dolls and other treasures, should be procurable there.

The ideas, partly communicated by others, partly thought out for themselves, are carried over into the beginnings of animal life. Thus, as we have seen, one little boy supposed that God "helps pussy to have 'ickle kitties, seeing that she hasn't any kitties in eggs given her to sit upon."

Enumerating the climatic influences of forests, Prof. I. B. Balfour showed, in the British Association, that they improve the soil drainage and modify miasmatic conditions. Trees, like green plants, assimilate carbon and purify the air, but it is not established that forests increase ozone. They stop air currents laden with dust particles and germs; they prevent extremes of temperature; they increase humidity, precipitate rain, and control waterflow.

THE ECONOMIC THEORY OF WOMAN'S DRESS.

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IN human apparel the element of dress is readily distinguishable from that of clothing. The two functions—of dress and of clothing the person—are to a great extent subserved by the same material goods, although the extent to which the same material serves both purposes will appear very much slighter on second thought than it does at first glance. A differentiation of materials has long been going on, by virtue of which many things that are worn for the one purpose no longer serve, and are no longer expected to serve, the other. The differentiation is by no means complete. Much of human apparel is worn both for physical comfort and for dress; still more of it is worn ostensibly for both purposes. But the differentiation is already very considerable and is visibly progressing.

But, however united in the same object, however the two purposes may be served by the same material goods, the purpose of physical comfort and that of a reputable appearance are not to be confounded by the meanest understanding. The elements of clothing and of dress are distinct; not only that, but they even verge on incompatibility; the purpose of either is frequently best subserved by special means which are adapted to perform only a single line of duty. It is often true, here as elsewhere, that the most efficient tool is the most highly specialized tool.

Of these two elements of apparel dress came first in order of development, and it continues to hold the primacy to this day. The element of clothing, the quality of affording comfort, was from the beginning, and to a great extent it continues to be, in some sort an afterthought.

The origin of dress is sought in the principle of adornment. This is a well-accepted fact of social evolution. But that principle furnished the point of departure for the evolution of dress rather than the norm of its development. It is true of dress, as of so much else of the apparatus of life, that its initial purpose has not remained its sole or dominant purpose throughout the course of its later growth. It may be stated broadly that adornment, in the *naïve* æsthetic sense, is a factor of relatively slight importance in modern dress.

The line of progress during the initial stage of the evolution of apparel was from the simple concept of adornment of the person by supplementary accessions from without, to the complex concept of an adornment that should render the person pleasing, or of an enviable presence, and at the same time serve to indicate the possession of other virtues than that of a well-favored person only. In this latter direction lies what was to evolve into dress. By the time dress emerged from the primitive efforts of the savage to beautify himself with gaudy additions to his person, it was already an economic factor of some importance. The change from a purely æsthetic character (ornament) to a mixture of the æsthetic and economic took place before the progress had been achieved from pigments and trinkets to what is commonly understood by apparel. Ornament is not properly an economic category, although the trinkets which serve the purpose of ornament may also do duty as an economic factor, and in so far be assimilated to dress. What constitutes dress an economic fact, properly falling within the scope of economic theory, is its function as an index of the wealth of its wearer—or, to be more precise, of its owner, for the wearer and owner are not necessarily the same person. It will hold with respect to more than one half the values currently recognized as "dress," especially that portion with which this paper is immediately concerned—woman's dress—that the wearer and the owner are different persons. But while they need not be united in the same person, they must be organic members of the same economic unit; and the dress is the index of the wealth of the economic unit which the wearer represents.

Under the patriarchal organization of society, where the social unit was the man (with his dependents), the dress of the women was an exponent of the wealth of the man whose chattels they were. In modern society, where the unit is the household, the woman's dress sets forth the wealth of the household to which she belongs. Still, even to-day, in spite of the nominal and somewhat celebrated demise of the patriarchal idea, there is that about the dress of women which suggests that the wearer is something in the nature of a chattel; indeed, the theory of woman's dress quite plainly involves the implication that the woman is a chattel. In this respect the dress of women differs from that of men. With this exception, which is not of first-rate importance, the essential principles of woman's dress are not different from those which govern the dress of men; but even apart from this added characteristic the element of dress is to be seen in a more unhampered development in the apparel of women. A discussion of the theory of dress in general will gain in brevity and conciseness by keeping in view the concrete facts of the highest manifestation of the principles with which it has to deal, and this highest manifestation of dress is unquestionably seen in the apparel of the women of the most advanced modern communities.

The basis of the award of social rank and popular respect is the success, or more precisely the efficiency, of the social unit, as evidenced by its visible success. When efficiency eventuates in possessions, in pecuniary strength, as it eminently does in the social system of our time, the basis of the award of social consideration becomes the visible pecuniary strength of the social unit. The immediate and obvious index of pecuniary strength is the visible ability to spend, to consume unproductively; and men early learned to put in evidence their ability to spend by displaying costly goods that afford no return to their owner, either in comfort or in gain. Almost as early did a differentiation set in, whereby it became the function of woman, in a peculiar degree, to exhibit the pecuniary strength of her social unit by means of a conspicuously unproductive consumption of valuable goods.

Reputability is in the last analysis, and especially in the long run, pretty fairly coincident with the pecuniary strength of the social unit in question. Woman, primarily, originally because she was herself a pecuniary possession, has become in a peculiar way the exponent of the pecuniary strength of her social group; and with the progress of specialization of functions in the social organism this duty tends to devolve more and more entirely upon the woman. The best, most advanced, most highly developed societies of our time have reached the point in their evolution where it has (ideally) become the great, peculiar, and almost the sole function of woman in the social system to put in evidence her economic unit's ability to pay. That is to say, woman's place (according to the ideal scheme of our social system) has come to be that of a means of conspicuously unproductive expenditure.

The admissible evidence of the woman's expensiveness has considerable range in respect of form and method, but in substance it is always the same. It may take the form of manners, breeding, and accomplishments that are, *prima facie*, impossible to acquire or maintain without such leisure as bespeaks a considerable and relatively long-continued possession of wealth. It may also express itself in a peculiar manner of life, on the same grounds and with much the same purpose. But the method in vogue always and everywhere, alone or in conjunction with other methods, is that of dress. "Dress," therefore, from the economic point of view, comes pretty near being synonymous with "display of wasteful expenditure."

The extra portion of butter, or other unguent, with which the wives of the magnates of the African interior anoint their persons, beyond what comfort requires, is a form of this kind of expenditure lying on the border between primitive personal embellishment and incipient dress. So also the brass-wire bracelets, anklets, etc., at times aggregating some thirty pounds in weight, worn by the same class of persons, as well as, to a less extent, by the male population of the same countries. So also the pelt of the arctic fur seal, which the women of civilized countries prefer to fabrics that are preferable to it in all respects but that of expense. So also the ostrich plumes and the many curious effigies of plants and animals that are dealt in by the milliners. The list is inexhaustible, for there is scarcely an article of apparel of male or female, civilized or uncivilized, that does not partake largely of this element, and very many may be said, in point of economic principle, to consist of virtually nothing else.

It is not that the wearers or the buyers of these wasteful goods desire the waste. They desire to make manifest their ability to pay. What is sought is not the *de facto* waste, but the appearance of waste. Hence there is a constant effort on the part of the consumers of these goods to obtain them at as good a bargain as may be; and hence also a constant effort on the part of the producers of these goods to lower the cost of their production, and consequently to lower the price. But as fast as the price of the goods declines to such a figure that their consumption is no longer *prima facie* evidence of a considerable ability to pay, the particular goods in question fall out of favor, and consumption is diverted to something which more adequately manifests the wearer's ability to afford wasteful consumption.

This fact, that the object sought is not the waste but the display of waste, develops into a principle of pseudo-economy in the use of material; so that it has come to be recognized as a canon of good form that apparel should not show lavish expenditure simply. The material used must be chosen so as to give evidence of the wearer's (owner's) capacity for making it go as far in the way of display as may be; otherwise it would suggest incapacity on the part of the owner, and so partially defeat the main purpose of the display. But what is more to the point is that such a mere display of crude waste would also suggest that the means of display had been acquired so recently as not to have permitted that long-continued waste of time and effort required for mastering the most effective methods of display. It would argue recent acquisition of means; and we are still near enough to the tradition of pedigree and aristocracy of birth to make long-continued possession of means second in point of desirability only to the possession of large means. The greatness of the means possessed is manifested by the volume of display; the length of possession is, in some degree, evidenced by the manifestation of a thorough habituation to the methods of display. Evidence of a knowledge and habit of good form in dress (as in manners) is chiefly to be valued because it argues that much time has been spent in the acquisition of this accomplishment; and as the accomplishment is in no wise of direct economic value, it argues pecuniary ability to waste time and labor. Such accomplishment, therefore, when possessed in a high degree, is evidence of a life (or of more than one life) spent to no useful purpose; which, for purposes of respectability, goes as far as a very considerable unproductive consumption of goods. The offensiveness of crude taste and vulgar display in matters of dress is, in the last analysis, due to the fact that they argue the absence of ability to afford a reputable amount of waste of time and effort.

Effective use of the means at hand may, further, be taken to argue efficiency in the person making the display; and the display of efficiency, so long as it does not manifestly result in pecuniary gain or increased personal comfort, is a great social desideratum. Hence it happens that, surprising as it may seem at first glance, a principle of pseudo-economy in the use of materials has come to hold a well-secured though pretty narrowly circumscribed place in the theory of dress, as that theory expresses itself in the facts of life. This principle, acting in concert with certain other requirements of dress, produces some curious and otherwise inexplicable results, which will be spoken of in their place.

The first principle of dress, therefore, is conspicuous expensiveness. As a corollary under this principle, but of such magnificent scope and consequence as to claim rank as a second fundamental principle, there is the evidence of expenditure afforded by a constant supersession of one wasteful garment or trinket by a new one. This principle inculcates the desirability, amounting to a necessity wherever circumstances allow, of wearing nothing that is out of date. In the most advanced communities of our time, and so far as concerns the highest manifestations of dress—e. g., in ball dress and the apparel worn on similar ceremonial occasions, when the canons of dress rule unhampered by extraneous considerations—this principle expresses itself in the maxim that no outer garment may be worn more than once.

This requirement of novelty is the underlying principle of the whole of the difficult and interesting domain of fashion. Fashion does not demand continual flux and change simply because that way of doing is foolish; flux and change and novelty are demanded by the central principle of all dress—conspicuous waste.

This principle of novelty, acting in concert with the motive of pseudo-economy already spoken of, is answerable for that system of shams that figures so largely, openly and aboveboard, in the accepted code of dress. The motive of economy, or effective use of material, furnishes the point of departure, and this being given, the requirement of novelty acts to develop a complex and extensive system of pretenses, ever varying and transient in point of detail, but each imperative during its allotted time—facings, edgings, and the many (pseudo) deceptive contrivances that will occur to any one that is at all familiar with the technique of dress. This pretense of deception is often developed into a pathetic, childlike make-believe. The realities which it simulates, or rather symbolizes, could not be tolerated. They would be in some cases too crudely expensive, in others inexpensive and more nearly adapted to minister to personal comfort than to visible expense; and either alternative is obnoxious to the canons of good form.

But apart from the exhibition of pecuniary strength afforded by an aggressive wasteful expenditure, the same purpose may also be served by conspicuous abstention from useful effort. The woman is, by virtue of the specialization of social functions, the exponent of the economic unit's pecuniary strength, and it consequently also devolves on her to exhibit the unit's capacity to endure this passive form of pecuniary damage. She can do this by putting in evidence the fact (often a fiction) that she leads a useless life. Dress is her chief means of doing so. The ideal of dress, on this head, is to demonstrate to all observers, and to compel observation of the fact, that the wearer is manifestly incapable of doing anything that is of any use. The modern civilized woman's dress attempts this demonstration of habitual idleness, and succeeds measurably.

Herein lies the secret of the persistence, in modern dress, of the skirt and of all the cumbrous and otherwise meaningless drapery which the skirt typifies. The skirt persists because it is cumbrous. It hampers the movements of the wearer and disables her, in great measure, for any useful occupation. So it serves as an advertisement (often disingenuous) that the wearer is backed by sufficient means to be able to afford the idleness, or impaired efficiency, which the skirt implies. The like is true of the high heel, and in less degree of several other features of modern dress.

Herein is also to be sought the ground of the persistence (probably not the origin) of the one great mutilation practiced by civilized Occidental womankind—the constricted waist, as well as of the analogous practice of the abortive foot among their Chinese sisters. This modern mutilation of woman is perhaps not to be classed strictly under the category of dress; but it is scarcely possible to draw the line so as to exclude it from the theory, and it is so closely coincident with that category in point of principle that an outline of the theory would be incomplete without reference to it.

A corollary of some significance follows from this general principle. The fact that voluntarily accepted physical incapacity argues the possession of wealth practically establishes the futility of any attempted reform of woman's dress in the direction of convenience, comfort, or health. It is of the essence of dress that it should (appear to) hamper, incommode, and injure the wearer, for in so doing it proclaims the wearer's pecuniary ability to endure idleness and physical incapacity.

It may be noted, by the way, that this requirement, that women must appear to be idle in order to be respectable, is an unfortunate circumstance for women who are compelled to provide their own livelihood. They have to supply not only the means of living, but also the means of advertising the fiction that they live without any gainful occupation; and they have to do all this while encumbered with garments specially designed to hamper their movements and decrease their industrial efficiency.

The cardinal principles of the theory of woman's dress, then, are these three:

1. Expensiveness: Considered with respect to its effectiveness as clothing, apparel must be uneconomical. It must afford evidence of the ability of the wearer's economic group to pay for things that are in themselves of no use to any one concerned—to pay without getting an equivalent in comfort or in gain. From this principle there is no exception.

2. Novelty: Woman's apparel must afford *prima facie* evidence of having been worn but for a relatively short time, as well as, with respect to many articles, evidence of inability to withstand any appreciable amount of wear. Exceptions from this rule are such things as are of sufficient permanence to become heirlooms, and of such surpassing expensiveness as normally to be possessed only by persons of superior (pecuniary) rank. The possession of an heirloom is to be commended because it argues the practice of waste through more than one generation.

3. Ineptitude: It must afford *prima facie* evidence of incapacitating the wearer for any gainful occupation; and it should also make it apparent that she is permanently unfit for any useful effort, even after the restraint of the apparel is removed. From this rule there is no exception.

Besides these three, the principle of adornment, in the æsthetic sense, plays some part in dress. It has a certain degree of economic importance, and applies with a good deal of generality; but it is by no means imperatively present, and when it is present its application is closely circumscribed by the three principles already laid down. Indeed, the office of the principle of adornment in dress is that of handmaid to the principle of novelty, rather than that of an independent or co-ordinate factor. There are, further, minor principles that may or may not be present, some of which are derivatives of the great central requisite of conspicuous waste; others are of alien origin, but all are none the less subject to the controlling presence of the three cardinal principles enumerated above. These three are essential and constitute the substantial norm of woman's dress, and no exigency can permanently set them aside so long as the chance of rivalry between persons in respect of wealth remains. Given the possibility of a difference in wealth, and the sway of this norm of dress is inevitable. Some spasm of sense, or sentiment, or what not, may from time to time create a temporary and local diversion in woman's apparel; but the great norm of "conspicuous waste" can not be set aside or appreciably qualified so long as this its economic ground remains.

To single out an example of the temporary effect of a given drift of sentiment, there has, within the past few years, come, and very nearly gone, a recrudescence of the element of physical comfort of the wearer, as one of the usual requirements of good form in dress. The meaning of this proposition, of course, is not what appears on its face; that seldom happens in matters of dress. It was the show of personal comfort that was lately imperative, and the show was often attained only at the sacrifice of the substance. This development, by the way, seems to have been due to a ramification of the sentimental athleticism (flesh-worship) that has been dominant of late; and now that the crest of this wave of sentiment has passed, this alien motive in dress is also receding.

The theory of which an outline has now been given is claimed to apply in full force only to modern woman's dress. It is obvious that if the principles arrived at are to be applied as all-deciding criteria, "woman's dress" will include the apparel of a large class of persons who, in the crude biological sense, are men. This feature does not act to invalidate the theory. A classification for the purpose of economic theory must be made on economic grounds alone, and can not permit considerations whose validity does not extend beyond the narrower domain of the natural sciences to mar its symmetry so far as to exclude this genial volunteer contingent from the ranks of womankind.

There is also a second, very analogous class of persons, whose apparel likewise, though to a less degree, conforms to the canons of woman's dress. This class is made up of the children of civilized society. The children, with some slight reservation of course, are, for the purpose of the theory, to be regarded as ancillary material serving to round out the great function of civilized womankind as the conspicuous consumers of goods. The child in the hands of civilized woman is an accessory organ of conspicuous consumption, much as any tool in the hands of a laborer is an accessory organ of productive efficiency.

Experiments to determine whether air when dried became electrified, reported upon by Lord Kelvin in the British Association, were interpreted as indicating that the effect was really due, not to bubbling or other motion that might cause friction, but to true electrification of the vapor in the air.

SHINTŌ, THE OLD RELIGION OF JAPAN.

By NOBUTA KISHIMOTO, M. A.

DURING the last twenty years there has been considerable discussion in Japan, both among native and foreign scholars, concerning the real nature of Shintō, the old religion of that country, and this discussion seems to have revolved around two central questions, namely, whether Shintō is a religion or not, and whether it was native to Japan or not. Different answers have been given, and diverse views have been expressed. However, the question whether Shintō was native to Japan or not largely depends upon what do we mean by Shintō, just as the question whether Shintō is a religion or not, depends upon just what we mean by religion. Shintō can not be a religion in the sense that Buddhism, Christianity, and Mohammedanism are, for it has neither code of morals nor system of beliefs, as these systems have. But if we are justified in saying that the rude Hebrews of the pre-Mosaic ages had their religion, and the wandering Arabs of the ante-Mohammedan centuries also had theirs, in this sense at least there can be nothing improper in the statement that our early forefathers too had their own religion, known later in history as Shintō.

What is Shintō, then? one may ask. What does its name mean? How old is it? What is its history? Is the present Shintō different from its primitive form? What will be the best method for investigating it? To answer all these questions with any degree of fullness is not the intention of the present writing—indeed, is not possible in such a paper as this. But the writer will venture to answer some of the above questions by presenting certain results of his personal experiences and investigations regarding this old and yet living religion of his native country.

The name Shintō consists of the two Chinese words *shin* and *tō*. The word *shin* may be either a noun or an adjective, as many *Chinese* words are. As a noun it means *god* or *gods*, and as an adjective it means *divine*. The word *tō* is the same word with the *taou* of Taouism, and means primarily *way* or *path*, and secondarily *teaching* or *doctrine*. This is the word by which the *Logos* of the Gospel according to St. John is rendered in both the Chinese and Japanese versions of the New Testament. Thus, taken by itself, the name Shintō may mean several different things, but as it is applied to the old religion of Japan its meaning is quite definite, and can not but be the "way of the gods." We know that the term *shin* is plural from the fact that the gods of Shintō are very numerous, and also we know the term *tō* is singular from the fact that Shintō as a religion is but one.

Some writers spell the name *Shintō*, as it is spelled here, and others spell it without *h* and write *Sintō*. Either form is practically good, but strictly speaking neither is correct, for the Japanese tongue does not distinguish the two syllables *shi* and *si*, its corresponding sound being something halfway between the two. By some writers this word is written also Shintō*ism*. The addition of the suffix *ism* has this practical advantage—it gives a clew to the category to which the thing denoted by the word belongs. On the other hand, it makes the word tautological, and hence is not used here. One may ask, Then, is the name Taou*ism* tautological? Certainly not, for there the word *taóu* or *tō* is used in that particular sense which is well known to those who are familiar with the teaching of the founder of that system.

I have just said that the name Shintō consists of two *Chinese* —not *Japanese*—words, and hence the origin of this name can not be regarded as native to Japan. But here let me emphasize—because I know there are some foreign scholars who have made the mistake—the fact that the Chinese origin of the *name* Shintō by no means implies the Chinese origin of the *thing* indicated by it. Buddhism had already existed for some time before it received its name. Christianity existed before it began to be called by its name. So, after these analogies, we might just as well say that there was the thing Shintō existing before its name was applied to it. The earliest mention of the name Shintō, so far as I know, is found in the *Nihongi*, the Chronicles of Japan, which was completed in the year 720 A. D. Before the introduction of Confucianism and Buddhism the religion of Japan had no need of being called by any name. But when these foreign systems made their appearance and began to spread, there came, it seems, the necessity of calling the native faith by a particular name by way of distinction. In Japan, Buddhism was called *Butsu-dō*, the "way of the Buddhas," and Confucianism, *Ju-dō*, the "way of the sages." To contrast with these, the native religion probably began to be called *Shin-tō*, the "way of the gods," the *dō* of the two former names being the same word with the *tō* of the last, only differently pronounced for euphony. At what particular time this happened we have no means of knowing. The name is not found in the oldest extant book of the Japanese language, called *Kojiki*, the Records of Ancient Matters, which was completed eight years before the Nihongi—that is, 712 A. D.; but as we have already in the Constitution of Prince Shōtoku a passage where Shintō, Confucianism, and Buddhism are called the "three systems," by their respective names, "Shin, Ju, Butsu," and as this Constitution was drawn up by the prince in the reign of the Empress Suiko (A. D. 593–628), we may suppose that the name Shintō was already known toward the close of the sixth century, although its express mention, as far as I know, first occurs in the Nihongi of 720 A. D.

One fact which, although indispensable to the real understanding of this religion, is commonly overlooked, is this, that Shintō has a long history, for it has come down to us from the prehistoric ages of its native land, and during this long history it has experienced different fortunes and undergone different interpretations. Even at our own time there are at least nine distinct sects, which all go by the name Shintō, but are more or less different from one another, both theoretically and practically. The study of these present sects, their origin and characteristics, will be one of the interesting and instructive subjects of investigation. But for those who intend to study Shintō historically it will be quite convenient to divide the whole history of Shintō into three general periods—ancient, mediæval, and modern.

The *ancient period*, as I call it, commences with the beginning of the Japanese people, coming down to the close of the sixth century of the Christian era, when the influence of the foreign systems of religion and philosophy began to be strongly felt. This is the period during which Shintō remained almost in the state of original purity, and hence the period may be termed the "period of pure Shintō." The *mediæval period* of the history of Shintō begins with the seventh century and comes down to the latter half of the seventeenth century. It was during this period that Shintō lost its original purity and became alloyed with the philosophies and religions of China and India. Indeed, we know from history that during this period several attempts were made to amalgamate, in various proportions, these different elements from foreign as well as native sources, and the result was the appearance of diverse compounds thus made. "Ryōbu-Shintō" in the ninth century, "Yūitsu-Shintō" in the fifteenth century, and "Deguchi-Shintō" and "Suiga-Shintō" in the latter half of the seventeenth century, are some examples of these compounds. In fact, this period was not only the period during which Shintō lost its pristine purity, but also the period during which it was made to withdraw itself into the background, leaving the field to its foreign competitors. Its simple and *naïve* content could never be any match for the learned and orderly teachings of Buddhism and Confucianism. Hence this mediæval period may be called the "period of adulteration and decline of Shintō." The third and last period is the *modern period*, which covers the present century and the whole of the last. Toward the close of the seventeenth century, several circumstances which I can not enter upon here made a strong reaction against the foreign influences to set in, and the interest in the things primitive and purely Japanese was revived. In the next—

that is, the eighteenth—century, this reactionary tendency culminated in what is sometimes called the "Japanese renaissance of the eighteenth century." The scholars like Mabuchi, Motoöri, and Hirata then appeared in succession, whose far-reaching influence must be regarded at least as one of the main causes of the "restoration of 1868," when an end was put to the Shōgunate and the emperor was restored to his proper power and authority. Hence this modern period may be called the "period of the revival of pure Shintō."

It is true that revolution never goes backward. The revived Shintō of this modern period is not that simple and *naïve* Shintō of the ancient period. In the writings of the chief exponents of this revival we find that speculative or allegorizing spirit which is altogether foreign to the old Shintō; and, moreover, the reason why these men were able to become such exponents was because they were well versed in—not to name other things—the Buddhistic philosophy or the Chinese literature, or both. However, this modern period is the one in which the cry "Return to the things purely Japanese" is emphasized and felt. Especially since the "restoration of 1868" the interest in those things purely Japanese has steadily increased, although not without some temporary hindrances and disturbances.

This knowledge of the fact that Shintō has met these different fortunes and different interpretations, from time to time, is a necessary condition—I might almost say *the* necessary condition—for a proper understanding of its real nature, and one must keep this fact always before his eyes. Without doing so he is apt to make a big blunder. Sometimes, when one is expected to be talking about Shintō in its primitive state, he is really nothing more than describing its present condition. At other times, and that more often, when one is understood to be explaining the essential nature of Shintō, he is found, even to his own surprise, to be busying himself with the modified Shintō of the mediæval or modern period. The little carelessness of a writer results in the great mistake of many a reader, and such seems to be especially the case with numerous writings of those foreigners who with a positive air sketch in a few strokes "such and such is the real nature of Shintō," notwithstanding the fact that their conclusions are hasty ones based on scanty materials which are gathered from distant and doubtful sources.

As I am very anxious to avoid any such blunder, and yet as I can not, in this short paper, follow through the whole history of Shintō from its beginning to our own times, I will content myself with a brief sketch of the most important characteristics of this old religion—those characteristics which are common not only to the Shintō of all its different sects, but also to the Shintō of all ages. The first characteristic I have in my mind is about the *objects* of Shintō worship. The second is the fact that Shintō is a religion of *purity*. The third and last characteristic I have to mention is about *merrymaking*, which plays so prominent a part in Shintō worship of all ages.

The objects which our forefathers worshiped or held in reverence were of different kinds. Among these objects ancestors were most important and are to be mentioned first. Then certain natural phenomena and objects are to be noticed, for certain natural powers, objects, and even animals were called deities and were held in reverence.

The fact that our forefathers worshiped these different kinds of objects is consistent with the meaning of the Japanese word for god—namely, *kami*. This word primarily means *high* or *above*, and is generally used in this primary sense. The upper half of the human body is called *kami*, in contrast to its lower half, which is called *shimo*. In our feudal times the governor of a province or district was called *kami*, being the head of the province or district. Even at the present time the local or central government is often called *o-kami* in the mouth of a country farmer. No doubt, when the term was applied to a god or gods, it was used in the same sense, meaning something standing high above human beings and possessing powers more than human. Thus a *kami* is simply an object of worship, and almost anything was regarded by our forefathers as an object of worship, in so far as it was mysterious and suggestive of good or evil influence. To them all their ancestors, who were wise in council or brave in war or even quick in temper, were suggestive of help or harm, and became the centers of myths and legends. To them the sun, which is the source of light and life; the moon, which does "wax and wane as if it were alive"; the fire, which is prone to anger and can consume everything in an instant; the thunder, which peals and roars, often striking men and beast to death; the mysterious principle of life, which propagates itself through and is represented by the organs of reproduction, and the like, are all wonderful and fear-inspiring. The cunning fox, which is peculiarly famous in Japan, was no doubt an object of fear and respect, while the mysterious serpent that "walks without feet" must have been a god also. Thus our forefathers could not help seeing an impressive object almost everywhere, and each one of these objects was called *kami* and was worshiped.

This fact is still more plainly seen in the absence in Shintō of any tendency toward idolatry—the tendency, I mean, to assimilate and embody the objects of worship in the visible form of man or beast. This tendency is absolutely lacking in Shintō. I freely admit that in the *Koziki*, the oldest book of Shintō, there is a very strong tendency to identify most of the objects of Shintō worship with the ancestors of the imperial and other great families; but at the same time I firmly assert that among the Japanese of all ages there seems to have been no tendency to represent their objects of worship in the visible form of man or beast. Even the idea that an object of worship must be embodied or represented visibly is unknown to the Japanese mind. If any such idea or tendency is found at present, it is doubtless due to foreign influences, especially that of Buddhism. To the pure Japanese mind, an idol—a simulacrum of god—was unnecessary. Whether the absence of this tendency speaks favorably or unfavorably as to the place of Shintō in the development of religious consciousness in general, is not the point I am aiming at. My point is this: This absence of the tendency toward idolatry in Shintō indicates the absence therein of a more general tendency to assimilate the different kinds of the objects of worship into one type or one kind of objects. To the Japanese mind it was not incongruous or inconsistent to worship all sorts of objects. If certain animals were called *kami*, certain trees were also called *kami*, and both were worshiped. If certain ancestors were called *kami*, the sun and the moon were also called *kami*, and both were worshiped. Just as the meaning of the word *kami* is vague and comprehensive, so the objects of Shintō worship were diverse and heterogeneous.

As to the worship of "Heaven" in the sense of *one active and benevolent principle of Nature*, which has been said to be the essence of Shintō, there is no proof of its existence in our old historical records, the earliest of which was compiled in the beginning of the eighth century of the Christian era. Such an abstract and refined conception of Nature and its God no one can expect from any of the primitive peoples of the world. However, even in the "ancient period" of Shintō there was not wanting a certain tendency to make one deity—specially Amaterasu, the sun-goddess—supreme over all other deities. Later, when Chinese philosophy made its way to Japan and began to assert its influence, our forefathers probably for the first time came to have some conception of Heaven as the all-present and all-seeing, and as the punisher of the wicked and the rewarder of the good.

The physical purity or cleanliness of the Japanese people is unique and almost proverbial. The reason for this fact is found in the very nature of Shintō, which is a *religion of purity*, and which demands the utmost physical purity and cleanliness of its believers. Its rites and ceremonies for avoiding all sorts of uncleanness are numerous. For example, blood was considered to be unclean, and so anything stained with blood was also unclean. Thus the woman in her monthly courses or for some time before and after a childbirth, was regarded as unclean. Uncleanness in these cases means liability to dangers. Thus the woman just before a childbirth was confined to a "parturition house," in order to keep her separate from the rest of the family to avoid the spread of danger by contagion. More than birth, death was feared because of its accompanying uncleanness. The dead body and anything which came in contact with it were regarded as unclean and dangerous. How much the uncleanness of death was feared is plain from a very singular custom among the early Japanese of abandoning the old house together with the dead body whenever a death occurred in it. This explains the reason why coffin-carriers, grave-diggers, as well as butchers, were classed among the outcasts and were called "not-men."

The reason why the idea of uncleanness was associated with the idea of dangerousness was, in my opinion, because uncleanness was thought to be the enemy of the gods, and the gods can not be where any uncleanness exists. The gods are clean and pure, and those who are not clean and pure can not but forfeit the protection of the gods. Those who are not protected by the gods can easily be attacked and injured by the evil and unclean spirits, and hence the idea of danger came to be associated with the idea of uncleanness. This is perhaps made plainer by some concrete case. When I was a young boy, the custom of eating beef began to spread. As blood was regarded as unclean, and also as Japan had been a strong agricultural country, there was a very deep-rooted disinclination to eat beef. In this, of course, one has also to recognize the influence of the vegetarian principle of Buddhism. But to anybody who had ever tasted beef, it was so delicious that he could hardly control his natural appetite by his religious scruple. My father was one of those who knew its taste, and so now and then we used to treat ourselves to beef. But where did we eat it? We did not eat it inside of the house. We cooked and ate it in the open air, and in cooking and in eating we did not use the ordinary utensils but used the special ones kept for the purpose. Why all these things? Because beef was unclean, and we did not like to spread this uncleanness into our house wherein the "gods-shelf" is kept, and into our ordinary utensils which might be used in making offerings to the gods. The day when we ate beef my father did not offer lights to the gods nor say evening prayers to them, as he did usually, for he knew he was unclean and could not approach the gods. Then my mother, who did not and could not eat beef till very recently, did these things; and I, who used to partake of the new dainty dish, often went to bed feeling as if I was unclean and subject to dangers.

As the gods hate uncleanness, temples, temple utensils, and all other things which were connected with the gods were carefully kept clean—that is, away from any unclean things. For this purpose the *shimé-nawa,* or clean rice-straw rope, is used in many cases to mark off the sacred objects. If one travel in Japan even at present he will find many things thus marked off, especially in temple precincts. Here he may find an old tree with the *shimé-nawa* around its trunk. There he may see an old well marked off in the same manner. Thus, if he find anything with the *shimé-nawa,* he never does wrong to conclude that some kind of superstition, fear, or reverence is entertained by the people toward that object. Especially the unclean people are afraid of coming in contact with any object thus distinguished, because they believe they may thus incur some evil or punishment for defiling the sacred object.

In many cases, however, men can not avoid coming in contact with unclean things, and hence there are several means of purification in Shintō. Purification by washing with water is the commonest method. Sprinkling salt is another common method, and purification by fire is also common. Purification is performed at any time when it is necessary, either privately or publicly. The length of the time required for purification differs in different cases and degrees of uncleanness. Often one purifies himself, but sometimes he asks the help and intercession of the priest. There are two semiannual national acts of purification—one on the last day of the sixth month and the other on the last day of the twelfth month—when all the sins committed and impurities incurred by the whole nation during the past half year are purged away. These are called the "Great Purifications," and even now are performed at the great temples of Ise by the Emperor in deputy.

To the Shintōist the essential character of sin is impurity or uncleanness, and it has more of a physical than of a moral nature; for with the early Japanese, as with any primitive people, morality, if there was any, was more external than internal, more physical than spiritual. Many an act was regarded as unclean, not because it was morally and intrinsically wrong, but more because it caused physical uncleanness and made the parties concerned liable to the anger and curse of the gods. If anything is meritorious in Shintō, this strong emphasis of physical purity and cleanliness is one; and there can be no doubt that this Shintō teaching of physical cleanliness has had much influence upon the progress of moral cleanliness of the Japanese nation.

How the meaning of purity and cleanliness passed from external or physical to internal or spiritual, and how strong the practical influence of such a transference of the meaning was, can be seen from many facts. The great Shintō scholar Motoöri, who lived during the latter half of the last century and was one of the leaders of the Japanese renaissance of the eighteenth century, boldly asserts: "Human beings, having been produced by the spirit of the two creative deities, are *naturally* endowed with the knowledge of what they ought to do and what they ought to refrain from. It is unnecessary for them to trouble their heads with systems of morality. If a system of morals were necessary, men would be inferior to animals, all of whom are endowed with the knowledge of what they ought to do, only in an inferior degree to men." Hence he concludes that, as the Japanese have and need no system of morals, they are superior to the Chinese, who have and need such a system. Some eight hundred years earlier than Motoöri there flourished another great exponent of Shintō, whose name was Michizané. Michizané was a patriot, statesman, scholar, and poet, and even at present he is one of the most extensively worshiped gods of Shintō. This hero has a short poem which is expressive of the old religious spirit of the Japanese nation, and which, being helped by the influence of his strong and noble personality, has had a very marked influence among our countrymen. The poem, if I may venture to translate it, is this:

"Only if our inner heart is
In harmony with the true way,
The gods will protect us,
Even though we do not pray."

The meaning of these lines is unmistakable. According to Michizané, religion can have no real existence apart from morality; but, on the contrary, if one live a pure and divine life, there is already in his life the reality of religion. If his heart is not in harmony with the heavenly way, and if he does not live his prayer in his life, mere verbal prayer is of no account, because the gods care more for the real purity of our heart than for the empty prayer of our mouth.

The other important characteristic of Shintō is that this system is a *religion of naïve optimism*. Our early forefathers seem to have been remarkably happy and cheerful in their temperament. "To live happy with gods and men" seems to have been the long and short of their religion as well as of their life. If any misfortune happened, they ascribed it to the anger and curse of the gods, and by offerings and festivals they tried to appease the gods and to restore their favor. If everything went well, and especially when the annual produce of the soil was plentiful, again they ascribed this to the favor and mercies of the gods, and by offerings and festivals they praised the gods and rejoiced themselves. Thus there are numerous festivals of the Shintō gods all over the country. These festivals may be classified as public and private, and also as regular and occasional. The greatest annual festivals naturally come in autumn—that is, our harvest time. It is in these festivals that the *saké*, the "Japanese rice beer," that "cheereth gods and men," plays such an important part that no festival can be complete without it. The *kagura* is also indispensable in these festivals. It is a theatrical performance, where music and dancing come together to entertain the gods as well as men. Many other religious dances of both comical and dignified natures are also performed. The wrestling too was at first a part of a religious festival. Of course, during these festivals many and generous offerings are made to the gods to show gratitude, while at the same time alms and gifts are very freely given to the poor. Thus it is plain that in the mind of the early Japanese the gods were not very different from them nor very far from them. The gods and their worshipers lived together, enjoying each other's company. The festivals were as much for gods as for men. The offerings were not for the poor, as in Christianity, but they were real and actual offerings to the gods themselves. The music was not merely to praise the gods, but was mainly for the purpose of pleasing them.

Thus, Shintō is a religion of merrymaking, a religion of enjoying this life to its utmost extent. I say "this life," but this does by no means imply that Shintō denies the future existence of the soul. Surely it implies the belief in such an existence. On this point a great mistake was made by some. No error can be more superficial than this, but, strange to say, even some missionaries fell into it! Plainly enough Shintō does not expressly teach the eternal existence of the soul or the doctrine of eternal punishment. It does not know the immortality of the soul, as we have it in Christianity. Such a dogma is foreign to Shintō, as the Buddhist doctrine of transmigration is foreign to it. But the fact that Shintō implies and even teaches some kind of future existence is indisputable from the very fact of ancestor worship, which necessarily implies the belief in the existence of the now deceased ancestors somewhere.

This belief, however, must have been very vague and indefinite. Our early forefathers did not believe their religion in order to be saved from tortures in the next life. To them religion was something of more immediate concern. They did not care much for the next world. All that they cared was to enjoy this present life as best they might. To this end they did what they could, and were happy and satisfied. But they were mortals and could not help dying. No doubt death was not pleasant to them, and they did not like it. Yet to them death did not have any associations of a hideous nature, such as going to hell, eternal torments, and the like. They thought probably that after death one will continue to live somewhere else than here on this earth.

Even there was a custom of the retainers following their deceased master to the grave, being buried alive. This indicates the *naïveté* of their thought, and at the same time the recognition of some sort of future existence. They also thought that the deceased have some interest in the affairs of their friends and relatives who are still living on this earth. This belief is still quite common among the Japanese, even among the educated classes; and who can say that it has nothing rational and helpful in it?

The fact that the early Japanese were remarkably optimistic in their temperaments and dispositions is to be properly emphasized. Here, in conclusion, I will cite only two facts which confirm this statement. In the first place, it is true that Buddhism pessimized Japan, but at the same time it is also true that Japan optimized Buddhism. This is, of course, too big a subject here to enter in any detail. However, if any one carefully compares the Japanese Buddhism with Buddhism of any other country, he will surely find out that our Buddhism is more optimistic than that of anywhere else. The cause of this, it seems to me, lies in the natural tendency of the Japanese mind to see the bright side of things. The hare in the moon, instead of pounding drugs as a punishment, as a Hindu legend has it, is described in a Japanese legend as making *mochi* or rice pastry—the national cake of Japan—which represents the joy and happiness of the new year. The other fact is this: Some time ago an American lady who was in Japan for many years told me the following incident, which is almost an everyday occurrence in Japan. While the lady was in that country, one of her Japanese friends, who had recently married, died. So the lady made a call to condole the family deprived of its head, when she was surprised by the young widow, who thanked the American lady, expressing her sentiments by words like these: "I am sure that my husband must be glad to have your company here to-day, and be thankful for your kindness." This was quite a new experience to the American lady, who never expected such cheerful words from a bereaved young widow, and who never had happened to see the belief in the future life from such a point of view.

Thus, to the Japanese, especially to their early ancestors, the utmost enjoyment of this earthly life—that is, to be happy with gods and men—was the final object of their existence. To them religion was nothing but the very means of accomplishing this end. This is evident from the fact that in our olden times all festivals were religious, there being no distinction between religious and secular. By eating, drinking, singing, and dancing, which form the main elements of these festivals, they wanted to be happy with gods and with men. Therefore I say that Shintō may be defined, from this aspect, as a *religion of merrymaking*.

THE ANCIENT OUTLET OF LAKE MICHIGAN.

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THE reports of several of our State Geological Surveys contain references to former outlets of the Great Lakes, when their waters were for some reason turned from their present lines of discharge. A brief mention of the ancient overflow of Lake Michigan across the flat divide at Chicago and down by the Desplaines and Illinois Rivers to the Mississippi appears as long ago as 1868 in the account of the geology of Cook County, Illinois, by Bannister, in the third volume of the Geological Survey of that State; and of this more below.

A more explicit description of the ancient Maumee-Wabash outlet of Lake Erie was given more than twenty years ago by G. K. Gilbert in the first volume of the Geological Survey of Ohio. The region is very flat, with a faint divide separating the eastern and western slopes; across this divide the old channel is "not less than a mile and a half broad, and has an average depth of twenty feet, with sides and bottom of drift. For twenty-five miles this character continues, and there is no notable fall." To the northeast, the channel opens out on the even floor of an ancient lake, whose shore lines diverge to the outlet. In the southwest the channel touches bed rock at Huntington, and then descends more rapidly. Most of the flat passage from the lake outlet to the sill of rocks is now "occupied by a marsh, over which meanders the Little River, an insignificant stream, whose only claim to the title of river seems to lie in the magnitude of the deserted channel of which it is the sole occupant. At Huntington the Wabash emerges from a narrow cleft of its own carving, and takes possession of the broad trough, to which it was once but a humble tributary." Mr. Gilbert's further account of the peculiar river courses of that district is extremely interesting, and illustrates to perfection how much meaning can be given by intelligent study to a country as flat and apparently monotonous as northwestern Ohio. It is noticeable that the explanation which Mr. Gilbert then suggested for the reversal of the present overflow of Lake Erie was an uplift of the land to the northeast; but Prof. Newberry, director of the State Survey, calls attention in a footnote to the possibility that the overflow resulted from an ice barrier in the valley of the St. Lawrence; and to this conclusion nothing has lent stronger support than Mr. Gilbert's subsequent observations of marked lacustrine shore lines in New York, from which we know that the land was depressed and not raised in the northeast at the time of this and other similar overflows.

The broad channel now followed by the Minnesota River is analogous to that across the Maumee-Wabash divide, although the lake from which the river flowed to cut the channel has shrunk away so far as to withdraw its waters beyond our northern boundary. The former occupation of the Minnesota channel by a large river was first pointed out by General G. K. Warren, in the Annual Report of the Chief of Engineers, 1868, page 307; and a fuller account of it was published in the American Journal of Science for December, 1878. Warren looked to a northward elevation of the land as a reason for the former southward direction of drainage, as Gilbert had done in Ohio; and this view generally obtained until the region was carefully studied out by Warren Upham, whose reports are found in the annual volumes of the Minnesota Geological Survey, and by whom a special account of the valley is given in the Proceedings of the American Association for 1883. Here the name of river Warren is proposed for the ancient stream by which this great trough was excavated: in earlier papers Upham had given the name of Agassiz to the lake from which the river issued. Further account of the ancient lake and river is found in the first two volumes of the final report on the Geology of Minnesota, now in progress.

The same observer has described a southwest overflow from Lake Superior, when the greater part of its basin was presumably occupied by retreating ice, and its waters rose about five hundred feet above their present level. The overflow took place across the pass between the valleys of the Bois Brulé and the St. Croix Rivers in northwestern Wisconsin; the channel across the pass being about a thousand feet wide and nearly a hundred feet deep, although its depth is now somewhat decreased by a marshy filling from which the headwaters of the Bois Brulé run back to the present lake (Geological and Natural History Survey of Minnesota, ii, 1888, p. 642). The lower course of the St. Croix follows a "great valley," whose fuller history is deferred to later volumes of the Minnesota Survey; its lakelike expansion above its confluence with the Mississippi is said to be due to alluvial obstruction by tributaries (ibid., pp. 377, 643). These studies by Upham in the Northwest were only continuations of the work that he had begun in New Hampshire several years before, where he recognized the shore lines of a small glacial lake in the southern part of the north-sloping Contoocook Valley, with an overflow to the southeast at Greenfield, N. H. (Geological Survey of New Hampshire, iii, 1878, pp. 116–119). A few years ago, in company with Mr. C. L. Whittle, I traced out a number of deltas and shore lines on the slopes of this picturesque valley, but have not since then been able to complete the attractive study of mapping and restoring the old lake.

Upham's observations on the shore lines of Lake Agassiz have fully demonstrated that in northern Minnesota and Dakota, and in Manitoba farther north, the land was depressed, not elevated, at the time of the overflow of river Warren from Lake Agassiz; and hence, there as in the St. Lawrence Valley, the cause of overflow must be looked for in the retreating front of the Pleistocene ice sheet. In the Bulletin of the Geological Society of America (vol. ii, 1891, pp. 243–276) Upham has described a number of glacial lakes associated with large river channels, north of our boundary in Canada. The channels are now deserted by the great streams that carved them, and are occupied only by smaller streams, which are frequently "laked" by the alluvial deposits brought in by lateral tributaries, as will be referred to again further on.

In 1885 Gilbert traced out the shore lines of the expanded waters of Lake Ontario, afterward named Lake Iroquois by Spencer, and showed that they converged to the southeast, and at Rome, N. Y., an outlet was found through what is now called the valley of the Mohawk. Only a brief mention of the attractive problem offered by this locality has yet been published. Spencer has called attention to the probable former discharge of Lake Huron and Georgian Bay across the province of Ontario by way of the river Trent (Proceedings of American Association, xxxvii, 1888, p. 198); and Gilbert has suggested that at an earlier stage there was another outlet farther north, by way of Lake Nipissing and the Ottawa River—the account of this being found in his excellent History of the Niagara River, published by the Commissioners of the State Reservation at Niagara, in their sixth annual report. The reading of this history will greatly increase the pleasure of an intelligent visit to the great cataract. It was of the outlet by way of the Ottawa River that Wright gave an account in the New York Nation for September 22, 1892.

The abandoned channel of overflow of the ancient Lake Bonneville at Red Rock Pass in northern Utah, and the "old river bed" leading from Sevier Desert to Great Salt Lake, well known from Gilbert's monograph, are analogous to the old channels here considered, although the overflows there were not produced by glacial barriers.

All these abandoned channels have certain features in common. At their upper end, where they trench across a divide of greater or less distinctness, they open out upon lacustrine plains of greater or less extent and distinctness, whose converging shore lines may be traced to the point of discharge. The breadth of the abandoned channel is relatively constant throughout a great part of its length; from which we may infer that the volume of water received from the lake at its head was large in comparison with that received from the tributaries lower down in its course. None of the deserted channels are cut to a great depth; but, whatever their depth, they are inclosed by banks or bluffs that are still distinct and comparatively steep; thus showing that relatively short periods of time elapsed both during and since their occupation by large rivers. The rock-cutting done by Niagara in post-glacial time seems to be a much greater piece of work than that accomplished by any of the temporary lake outlets during the closing phases of the Glacial period; but none of them, as far as I have read, had an opportunity for active work equal to that of Niagara.* They are nearly all comparatively shallow; but an exception to this rule has been pointed out to me by Mr. Gilbert, to which a paragraph may be devoted.

Emmons, the geologist of the second district of New York, long ago described what he took to be fissures in the Potsdam sandstone of northern New York, but which to modern interpretation appear to be gorges or chasms cut by rivers, presumably constrained into that position by drift or ice obstruction. The Ausable chasm is a well-known instance of these "fissures," but one of the examples described by Emmons has no river running through it. It lies close to the Canadian boundary in Clinton County, sixteen miles west of Lake Champlain, and is thus described in Emmons's report (Geology of the Second District, New York, 1842, pp. 309, 310): "The fissure or gulf, as it is called, is three hundred feet deep and about sixteen rods wide. Its walls of sandstone or conglomerate are perpendicular at the deepest part. The small lake at the bottom is said to be one hundred and fifty feet deep. The direction of this fracture is north, seventy degrees west, and the rock dips at a small angle from each side of it. . . . At Keeseville and Cadysville large rivers, the Ausable at the former and Saranac at the latter, still occupy these gorges as their channels, and have sufficient force and power to sweep out, especially in the time of high water, all rocks of an ordinary size. At this place there is merely a small rill discharging itself from a small lake of dead water, insufficient in itself to accomplish any perceptible change. To account for the present condition of this rock, we have therefore to go back to a period when some current swept through this gorge with great force and power; for by no other means could the materials which once filled the space between the present walls of the gulf be removed."

Returning to the general features of the abandoned channels,

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* Russell's Geological Reconnaissance in Central Washington gives an account of a temporary displacement of the Columbia River when its valley was obstructed by ice and its waters ran through the Grand Coulée: a basin was then excavated beneath a cataract in the course of the river, and the basin now holds a lake, although the river and the cataract have disappeared (Bulletin 108, United States Geological Survey, pp. 91, 92).

it is next to be noted that the small lateral streams which now enter the old river course find it much too large for their volume. This is especially true near the divide across which the old channel was cut. It is only at some distance down the channel that enough water has entered through lateral streams to form a considerable river; yet all along the channel maintains about the same width. Evidently, therefore, it was not cut out by the existing drainage. In consequence of the small volume of the longitudinal streams now occupying old channels, they are frequently more or less obstructed by the alluvial fans built at the entrance of lateral tributaries; thus swamps or long, narrow, lakelike expansions of the rivers are produced up stream from the fans. This was first noticed by Warren, and since then the list of examples has been greatly increased by Upham and others. In the last of Upham's papers referred to above, he describes a number of lakes of this kind on the Qu'appelle and Pembina Rivers and elsewhere. Long Lake in Assiniboia is about fifty miles in length, but only one or two miles wide. Lac qui Parle and Lake Traverse, in the old channel at the head of the Minnesota River, are of this kind. The sluggishness of the Minnesota and of the Illinois Rivers just above their junctions with the Mississippi has been attributed to the same cause, and this would indicate that at the time when the channels of the Minnesota and the Illinois were occupied by the large rivers which once flowed through them, these held the place of main streams, while the Mississippi came into them with smaller volume as a tributary.

There is on this account a curious contrast to be noted between the excavation of the late glacial channels that were cut out during the closing stages of the Glacial period by the overflow from glacial lakes, and the clogging of the preglacial valleys that were commonly filled with sands and gravels by streams that came directly from the retreating ice front without delay and filtering in lakes, as in southeastern Ohio. Both of these kinds of valleys mark the courses of "constrained" drainage near the end of the Glacial period. At the ice front the water supply in both cases was doubtless surcharged with detritus; but the waters that had to accumulate in lakes marginal to the ice front before flowing away as rivers must have been nicely filtered, so that they issued clear and blue from the lake outlets; while the others had to carry their detritus down stream for many miles, and must have been of gray and turbid color for long distances. The plentiful clear waters of the streams of the first class ran down the valleys that led from the lowest pass in the lake rims and cut down their channels to a moderate grade, oftentimes so moderate that the present river occupants of the valley are unable to keep them clear of the alluvium that is brought in by tributaries;

hence they are frequently characterized by swamps or linear lakes, especially near their heads. On the other hand, the streams of the second class, surcharged with detritus from the ice, frequently demanded a steeper grade than they found, and therefore deposited much of their load, filling up their valleys with broad flood plains of sand and gravel, such as are now growing in front of the Greenland and Malaspina glaciers; and sometimes they may have transformed side streams into lakes, such as now characterize the side streams of the Red River of Louisiana.

The record of the latter feature is truly a rarity in the past, but it has been deciphered by Andrews as perceptible in some of the lateral tributaries of the gravel-filled valleys of Ohio. The following is Andrews's account. After describing the terraces of sand and gravel derived from the glacial drift and occurring along those streams whose sources lie in the "area of the general drift," he says: "There is in the second district [southeastern Ohio] another and very distinct system of terraces, found on streams emptying into the larger streams bordered by true drift terraces. They may be called backwater terraces. When in the Ohio, Muskingum, Hocking, etc., rivers, the water in the drift era stood eighty or ninety feet higher than at present, the backwater would set back up all the tributaries. In this still water the sand and sediment brought down these tributaries were deposited; or, in other words, the still-water areas were silted up, as mill ponds often are. When afterward the main streams fell to their present level these affluents cut through the backwater beds and carried away much of the soft materials, but left in many places fringing terraces which tell very plainly how they were formed. In these backwater terraces we find no true drift sand or gravel. The beds are entirely of home origin. Such terraces I have seen in the Little Scioto River, above its junction with the Ohio at Sciotoville, on Duck Creek, and on the Little Muskingum River in Washington County, and on Sunday Creek in Athens County. I have no doubt they are to be found on a large number of streams." (Geology of Ohio, ii, 1874, p. 444.) This record shows a delicacy of observation and a skill in physical interpretation that have impressed me as exceptional and admirable.

Taking up again the comparison of the two classes of constrained streams, it is seen that the channels of the first class were cut down to so gentle a grade by the filtered glacial streams that they are now not infrequently found to be filling up, and lakes are forming in them; but the valleys of the second class were filled so high by the gravels deposited from the surcharged glacial streams that they are now being terraced, and the lakes that were formed on their lateral tributaries are now discharged by the cleaning out of the clogged valleys. A pretty contrast for our geographical lessons!

It is noticeable that the abandoned channels of the glacial lakes are now generally utilized as natural paths of communication. The Indians easily passed from the head of the Minnesota to the Red River of the North; and indeed at times of high water they paddled their canoes over the flat divide. The Chicago outlet of Lake Michigan was naturally chosen for the path of the Illinois and Michigan Canal, and now two railroads follow the same well-graded course. More important still is the broad channel into which the Mohawk flows from the Adirondacks, and which we therefore call the Mohawk Valley. This well-opened passage determined the location of the Erie Canal; and that, taken with the drowning of the Hudson River, by which navigable tidewater is carried up to Albany, has undoubtedly been the determining cause in the development of New York city as our greatest seaport.

As a good number of these abandoned channels have been described, and as it is very probable that others will be found, it seems to me worth while to recognize them as constituting a special group of river-made forms of brief and peculiar history, deserving recognition and representation in our study of physiography. In this connection a particular interest attaches to the former outlet of Lake Michigan, because it is the only one of the old outlets that is now mapped with any approach to accuracy. Twelve sheets prepared by the United States Geological Survey —namely, the Chicago, Riverside, Calumet, Desplaines, Joliet, Wilmington, Morris, Ottawa, Marseilles, Lasalle, Hennepin, and Lacon sheets—already represent a length of over a hundred miles of the former lake outlet, and give an effective illustration of its peculiar features.

Before speaking of the old channel, I must turn from that theme to give the maps a fuller introduction, for they seem as yet to be very little known to our teachers and scholars. They are constructed to serve as the topographical basis for the geological map which our national survey is charged to prepare. No suitable map existing, Major Powell, director of the survey, organized a topographical corps in 1882, under the charge of Mr. Henry Gannett, to whom the mapping of the country was intrusted. The progress of the work has manifestly been embarrassed by the expense of the survey over so vast a country, by the need of comparatively rapid progress, and by the difficulty of securing experienced topographers; but all considerations of distribution, scale, cost, and time have been duly discussed, and as a result we have already several hundred map sheets of areas distributed over many States, on which the topographic features of our land are represented to us as they never have been before. The scale employed varies from one to four miles to an inch on the maps thus far issued, but in future only the larger scale of a mile to an inch will be used. Relief is indicated by brown contour lines at intervals varying from five to fifty or more feet, according to the scale of the map and the character of the surface. Water is printed in blue; names, roads, boundaries, etc., in black. The accuracy of the work is not so great as many geographers and geologists would like to see. The expense of more accurate work would perhaps prevent its execution; but it may be justly said that a great increase of knowledge is made by the publication of these maps. Some of the sheets are better than others, and some of the poorer ones have been severely criticised by those who know the ground; but, as far as I have been able to observe, the character of the work is rising, and the interest in it is increasing. A sympathetic popular support and an intelligent criticism of this great undertaking will go far toward securing its improvement and extension. The study of geography will be greatly advanced when these maps are properly distributed to schools, as they soon should be, so that every high school at least would have not only its own district represented, but would possess also a collection of typical maps of other districts.* At the same time the demand for more and better maps will be increased. In my own teaching, I find these maps simply invaluable. It is not only the younger students who learn lessons from them. Many a problem is effectively introduced and illustrated by the maps that would otherwise remain out of reach to teachers as well as scholars. The case which I am about to describe illustrates this point very clearly.

On noticing, a year or more ago, that the topographic sheets thus far issued for Illinois included a good part of the old Michigan outlet, I resolved to have a look over the ground at the first opportunity. A visit to the World's Fair was therefore arranged to include a trip down the Illinois valley, maps in hand, and in the good company of several friends from the Chicago University. The assistance given by the maps in gaining an appreciation of the form of the country raised the high estimate that I had previously formed of their educational value. They are simply indispensable in geographical study.

* It may be noted that the conference on geography held in Chicago in the winter of 1892-'93—one of several conferences held under the auspices of the National Educational Association—appointed a subcommittee to prepare a list of these and other governmental maps of use in teaching. This list has been published, with explanatory notes, under the title of Governmental Maps for Use in Schools, by Messrs. Henry Holt & Co., New York. Many of the maps can be obtained free of cost from the governmental bureaus, and others can be had for a merely nominal cost.

Lake Michigan is inclosed at Chicago by the contour line of five hundred and eighty-five feet above sea level; and the lacustrine plain on which Chicago is built lies mostly under the contour of six hundred and ten, the western suburbs rising to six hundred and thirty feet. In the southern part of the city, near the World's Fair grounds, several faint sandy lake ridges may be traced, rising three or four feet above the dark soil of the plain. The Desplaines River comes from the north on the western part of this plain, ten miles from the lake; its narrow channel, with comparatively steep banks to the water's edge, being sunk ten or twenty feet below the plain. Opposite Summit Station, on the Chicago and Alton Railroad, the river enters a broad, swampy trough, which it follows to the southwest. It is this trough that was briefly described as the lake outlet by Bannister twenty-six years ago; and from his rather casual mention of it I infer that its meaning was then generally appreciated by those who were familiar with the ground. Since then it has been frequently mentioned in a general way in geological literature. The trough is about a mile wide and lies just below the contour of five hundred and ninety feet. Its banks become better defined as it enters the rising ground farther west. From the entrance of the Desplaines eastward to the lake there is no perceptible divide. The canal by which the South Branch of the Chicago River is connected with the Desplaines joins the channel in the western part of the city; and it is by deepening the river channel farther down stream (southwest) that a sufficient volume of lake water is to be diverted through Chicago, thus returning, in a measure, to glacial conditions of drainage, and purifying what is now a very turbid stream.

In addition to this chief passage across the flat divide, there is another one, also mentioned by Bannister, about twelve miles farther south at the village of Blue Island, on the southern end of Washington Heights (six hundred and fifty feet). Here is a long, shallow, swampy trough, again at a level of five hundred and ninety feet, running west from the lacustrine plain through the rising land, and joining the Desplaines at Sag Station, Chicago and Alton Railroad, nine miles below Summit. The Calumet River runs toward the trough from the southeast, but turns abruptly eastward near Blue Island and flows to Lake Michigan. The western end of this southern trough is drained into the Desplaines by a little stream called the Feeder. The swampy part of the trough, between the Calumet and the Feeder, is probably inclosed by faint alluvial fans, swept down by brooks from the higher ground on the south; indeed, it is quite possible that the abrupt turn in the course of the Calumet at Blue Island results from the obstruction of a former westward course in this manner.

The plain west of Lake Michigan, for a distance of twelve or fifteen miles, appears to have been under the lake waters during the greater time of the westward overflow. Its level surface, its fine, dark soil, and the occasional sandy ridges that traverse it have already been mentioned. Its western boundary, at the point where the Rock Island Railroad gradually ascends to higher ground, is rather distinctly defined by a low but definite bank, apparently an old shore line of the lake, the base being near the contour of six hundred and twenty feet.

Farther west there is a belt of higher ground, whose contours reach seven hundred or seven hundred and fifty feet. On the topographic maps this belt appears to be a plateau-like swell, well dissected by streams; but on the ground it has the appearance of a faintly marked moraine, and it is so represented on the soil map of Illinois, prepared by Mr. F. Leverett and exhibited in the Illinois State Building in the World's Fair. Its morainic form is indicated by numerous faint mounds and small hollows, and the railroad cuts show it to be composed largely of drift. The spurs and valleys, apparently of simple drainage development as indicated on the map, do not justly represent the expression of the surface at this point. A more appreciative drawing of the contour lines is required to express this faint morainic topography; but I do not think it should escape representation on a scale of 1 : 62,500. It would be interesting to compare a careful contouring of a small portion of this belt with its generalized portrayal on the survey sheets.

The old channel, now occupied by the Desplaines, crosses this belt of higher ground in a well-marked trough. The breadth of the flat bottom of the trough is almost constant at a measure of a mile; its depth below the immediately adjacent upland is about seventy-five feet. This is partly cut in horizontal Niagara limestone, and the descent into the flat-bottomed trough is accomplished on steep sloping bluffs, somewhat dissected by narrow, short, and steep-sided ravines. This may be called the Lemont channel, from the village of that name at its middle, where quarrying is now going on in the limestone in order to increase the westward discharge from Lake Michigan, as stated above.

The morainic belt has a width of fifteen or twenty miles on the Desplaines and Joliet sheets. Joliet lies near its western base. Farther west there is a second belt of higher country, also represented as a morainic belt on Leverett's map, of which further mention will be made below. Between the two belts there is a strip of lower country, about twenty-five miles wide, whose elevation at and below the junction of the Desplaines and Kankakee Rivers varies from six hundred to five hundred and fifty or less. This I shall call the Morris basin, from a town of that name near its middle. On entering the basin, the old channel is less distinctly defined than before, chiefly because of the smaller depth to which it could be cut in the lower ground. The bluffs are only about fifty feet high at Joliet, while at Morris, eight miles below the entrance of the Kankakee, they are hardly perceptible. Through this district the floor of the old channel is generally rocky, and in the floor the Desplaines River—or the Illinois, as it is called below the entrance of the Kankakee—has cut a narrow and shallow trench. Occasionally heavy gravel beds were seen, but their origin could not be determined in our rapid excursion.

A peculiar feature of the northeastern part of this district is the subdivision of the old channel into several courses, as if a number of almost equally good lines of escape had been originally offered to the lake overflow, along all of which the waters ran for a time, but into one of which they were gradually collected, that one being the channel now followed by the Desplaines past Joliet. Two of these temporary branching channels are represented on the Joliet sheet, a short distance above that city, in the form of swampy passages connecting the Desplaines with the Dupage River. A third is seen southwest of Joliet, and is now utilized by the Illinois and Michigan Canal.

The second belt of higher ground again reaches a level of seven hundred and fifty feet north and south of the town of Marseilles, after which it may be named; and through this belt the old channel again appears as a depressed linear plain, now about a mile and a half wide at an altitude near four hundred and ninety feet. It is inclosed by steep bluffs, a hundred or more feet in height. Back from the bluffs, narrow and steep-sided ravines dissect the rolling upland for a distance of from two to four miles. There are flat alluvial fans in front of some of these ravines, and it may be for this reason that several small lateral streams in the neighborhood of Marseilles enter the river by direct courses instead of first running a distance down the valley, as is so often the habit of side streams while traversing the flood plain of their master. The contour lines of the maps do not indicate the occurrence of any fans, the lines being concave toward the mouth of the streams; but I think some of them should be slightly convex in that direction. It is possible that small matters of this kind may have escaped the attention of the topographers, although the scale of the maps is large enough to show them clearly if they really exist. As in the Morris basin, the present river about Marseilles is sunk in a narrow trench, twenty or thirty feet below the broad plain of the old channel bottom.

West of the Marseilles morainic belt—the second belt of higher ground—there is a broad stretch of even country at a height of about six hundred and fifty feet. The city of Ottawa is located in the old channel where it traverses this even upland; the in-closing bluffs here vary from seventy-five to a hundred feet in height, being frequently cut back by ravines, as already described. The level of the Illinois River at this point is a little under four hundred and fifty feet. The floor of the old channel stands at four hundred and seventy feet. Its descent from Summit Station is therefore one hundred and twenty feet in about seventy miles; but it must be remembered that part of this slope may be due to post-glacial elevation of the land to the northward.

The entrance of the Fox River from the north at Ottawa was one of the special features that I wished to see. It runs near the western base of the Marseilles morainic belt, and its trench below the general upland is as deep as the old channel; but it is narrow and steep-sided, like the many side ravines of the old-channel bluffs, although in volume the Fox is at least half as great as the Illinois. It has a flood plain of slight width where its banks are of fire clay, as at Dayton, three miles from Ottawa; but farther up and down stream, where it is inclosed by sandstones, the rocks rise directly from the water's edge, and steep bluffs rise above the rocks to the upland. The descent of the river bed is relatively rapid, amounting to about sixty feet in the first ten miles above its mouth.

The other rivers that enter the old channel present the same peculiarity as the Fox, but as they come in over lower ground their valleys are less deep, and therefore less noticeable. The Desplaines has already been described as flowing in a narrow trench in the plain west of Chicago, until it abruptly enters the swampy bed of the old channel. The Kankakee has a similar narrow valley when it joins the Desplaines, from the southeast, in the Morris basin, the two rivers forming the Illinois. Next is the Fox, and below this is the Vermilion, with a steep-sided, narrow valley like those of its fellows. The contrast between the narrow valleys of the side streams and the broad channel followed by the Illinois is strongly marked.

This is all plain enough on the ground; it is distinctly shown on the maps; but it should also be represented by photographs. If any readers of this article happen to have views illustrative of the district here described, I beg that they will communicate with me. There should, indeed, be a photographic exchange established by a union of our professional and amateur photographers, in which good views might be selected under certain conditions for purchase or exchange. At present it is a very difficult matter to find views of the simpler landscapes of our country, however well represented the greater mountains may be.

When all these features are considered together, there is good warrant in the old belief of the southwestward overflow of Lake Michigan. The considerable breadth of the old channel, in which the Illinois is cutting a narrow trench, must be due to the great volume of the old lake outlet which once filled the channel from bluff to bluff, just as the present tributary rivers fill their valleys. The old outlet river fitted its broad valley as well as the existing rivers fit their narrow valleys. It must have been large compared with its tributaries, because the breadth of its channel increases so slowly in a distance of nearly a hundred miles. Like the Niagara below Buffalo and the St. Lawrence among the Thousand Isles, the old outlet near Joliet split up into a more or less complicated network of channels, and its discharge seems to have continued just about long enough for the selection of one of these as the survivor. But it is manifest that the old outlet, like all its fellows from other expanded lakes of the close of the Glacial period, did not exist long enough to broaden its channel by lateral meanderings. The special phases of climatic periods by which these constrained river courses were determined were too short-lived to allow the development of meandering rivers—far too brief to measure so long a part of a river's history. The old outlet of Michigan endured long enough to clear off the drift from its path, and to make a beginning of cutting its channel down into the underlying rock; but it does not seem to have cut the rock down as deep as it might have done if more time had been allowed, for even the smaller rivers of to-day have trenched the floor of the old channel since the outflow of the lake has been turned over another path. To be sure, something of the ability to do this may be ascribed to the change in the attitude of the land, a presumable elevation to the north since the ice went away; but we have no definite measures of the amount of this elevation in the district here considered.

The good fortune of having maps of this interesting district should bring it clearly before many students who may not see it on the ground. It appears to have so many features common to the other examples of its class that it may well be taken as their type. As other similar channels are mapped, it will be interesting to see how far their essential features are merely repetitions of those so clearly shown on the maps of the old outlet of Lake Michigan.

WITH reference to Croll's and Ball's theories of ice ages and genial ages, Mr. Edward P. Culverwell has shown, on the basis of calculations of the daily distribution of solar heat on different latitudes at the present time and in the supposed glacial and genial ages, that the winter temperature of Great Britain in the glacial age, as dependent on sun heat, would be no lower than that from Yorkshire to the Shetlands, and similarly that, from 40° to 80° of north latitude, the shift of the winter isothermals would be only about 4° of latitude, a result wholly inadequate to produce an ice age. The shift of isothermals in the genial age was found to be still smaller.

THE CHEMISTRY OF SLEEP.

By HENRY WURTZ, Ph. D.

WE do not comprehend the mystery of wakeful consciousness; and therefore that of temporary unconsciousness, including sleep of all kinds, is equally beyond our understanding. To say that sleep is a suspension of our control over our thoughts and our motor nerves and voluntary muscles is a mere substitution of other classes of mysteries equally inscrutable.

The same should be frankly admitted as to all our so-called explanations of natural phenomena, which consist mainly of generalizations, expressing in few words the laws that rule and connect, so far as we can discover, the infinity of cosmical facts and transformations. Such generalizations—whose surpassing importance and value are nevertheless undeniable—imply, as essential preliminaries, the laborious classification of the facts in any field of investigation that we have in hand.

But in the field of which we are now to attempt a brief and necessarily superficial survey it must be conceded that such classification is as yet highly imperfect. The forms and modifications of existence varying in cause or origin, nature, and degree which may be called by the general name of sleep have not yet been subjected to the exact and critical experimental research needed for scientific classification. Little can now be done except to point out wherein our knowledge is defective, and to indicate some more or less tentative arrangement of the facts under different heads as a provisional guide to the study of this condition of existence, in which mos persons expend one third of their terms of life. Such heads may be as follows:

An attempt at a *definition* of normal healthy slumber, which only is entitled to be called—

"Tired Nature's sweet restorer, balmy sleep."

Such a definition must be sufficiently well founded on the conditions presented in natural sleep to admit of drawing lines of parallelism with and of divergence from other species of lethargy or unconsciousness, or modified consciousness, that arise from abnormal or morbid conditions, mental and nervous disorders, drugs, anæsthetics, cold, heat, exhaustion, partial asphyxiation by drowning or otherwise, etc.

A statement of our present narrow range of facts and observations relative to the chemical, physical, and physiological changes of the organs of the body, and of their functions, during normal sleep.

A consideration of the mental, moral, and emotional phenomena presented in natural and in artificial sleep, including its morbid forms, with those forms in which the mind sleeps with the body awake, and those in which the body may sleep with the mind more or less awake.

Anæsthesia in general, inclusive of its widely differing successive stages, as that of exaltation of some mental faculties, with or without full consciousness, or one of the waking dream conditions (see further on)—that of extinction of full consciousness with the muscular system still awake—and, finally, that of complete lethargy of the mind and body with extinction of all sensation.

An attempt, which must needs yet be quite crude, to generalize something useful from the sparse and scattered array of facts thus found to be available.

As to a definition of natural sleep, it may be interesting to go back a century and examine the views then held. Having at hand the second edition of the Encyclopædia Britannica, published from 1778 to 1783, the writer finds therein an article on Sleep, in the tenth volume, which article is brief, being but supplementary to that on Dreams, in the fourth volume. To this latter subject we shall return further on. Under Dreams, the following meager definition of sleep is given: "Sleep is a state in which all communication is cut off between our sentient principle and this visible world." By this, taken literally, a blind man would be asleep. But, of course, the word visible was intended to imply the whole world of the senses. Still, allowing such latitude, the definition is both inaccurate and inadequate. As to the asserted complete cutting off of external impressions from the senses in true sleep: were this so, a sleeping person could not be awakened by the usual means—namely, a forcible external impression upon one or more of the senses.

Its inadequacy may be briefly illustrated by pointing out that it takes no note of one of the most salient phenomena of sleep—that the *will,* though not at all *suspended* therein, being easily recognized in dreams, altogether loses its rationality and its *control* over the workings of the mind as well as over those of the body.

The following may be set forth as an attempt at a reasonable and comprehensive definition, or rather description, of the conditions we find in sleep: Sleep is a state in which the impressions of external objects on the senses are *dulled,* but not annulled or suspended; in which the emotions, the imagination, the memory, and the will are but partially or even not at all suspended, and may even be intensified, while the *control* of the will over the emotions, the imagination, and the memory is wholly annulled, together with its conscious control over the nerves of the voluntary muscular system. Reasoning power is annulled, but involuntary and instinctive muscular motions, and those arising from habit, still continue. Memory is certainly not annulled, or we should never dream of the past, of which we do dream largely.

The consciousness of Duration—that deepest of all mysteries—is not absent in sleep, but also passes wholly out of the control of the reason and the memory, and loses all relation to the conditions of waking experience, being often exaggerated or exalted far beyond these. Unconsciousness of duration occurs during the waking dream state, being here suspended at times, so that lapses of time remain unnoticed. Those subject to intense mental occupation, or to reverie, which is a species of waking dream, will attest this. Strong emotions also influence our consciousness and perception of duration.

It may be objected that the above description of sleep does not cover a species that general readers have been taught to consider typical—what is called "dreamless sleep." This, however, is probably a literary fiction. Even the "dreamless sleep of infancy" is not always realized, for healthy infants often present indications of dreaming. Sleep so deep as to be dreamless is probably not of the most natural kind, but rather the result of nervous, mental, or muscular exhaustion, or of drugs, being thus a more or less morbid lethargy.

No one would claim that natural dreams are symptomatic of morbid conditions, though of course certain kinds of dreams—as those from opium, of delirium tremens, dyspeptic nightmares, etc.—are such. These, moreover, are often a kind of waking dream, in which the body remains more or less awake while the mind is lethargic or deliriously excited.

It thus appears that sleep is far from being the simple affair it was held to be in the last century. On the contrary, it is a highly complex phenomenon, involving all the functions—mental, moral, and physical, and doubtless also physiological—of that most complex of all organisms, man. Hence, it must be worthy of far closer scientific study than it has yet received.

As to the physiological and chemical phenomena that accompany sleep in the animal economy: Of this—the most essential branch of the investigation—it must be stated that its cultivation has been very imperfect and inadequate. Still, enough is known to convince the present generation of *chemical* thinkers that sleep is by no means a subject for the psychologist alone, but will turn out to be physiological and chemical—that is, accompanied, and even almost altogether ruled, by chemical agencies and transformations. We have here a strong and sound basis for the hope of arriving at a control of natural sleep itself and at modes of influencing and promoting its production without danger or detriment to general health. The few facts we have so far may be stated as follows: In healthful sleep the blood circulates more slowly; hence kidney action and perspiration diminish. The breathing is slower, and the exhalations of moisture and carbon dioxide from the lungs are less. Hence, these are doubtless produced in smaller amount, as they should be, from the diminution of muscular work and of combustion of animal fiber. And it is highly probable, though not yet fully tested by experiment, that certain gaseous, vaporous, or other products of the transformation of the muscles, nerves, and other tissues, partially stored up in the blood during working hours, are eliminated during sleep by the lungs, skin, and kidneys. The digestion is stated to be more active during normal sleep, and the temperature in the vital organs at least is stated by some authorities to remain at its normal point, though in the limbs it probably falls. This may be due to a tendency of the blood to the internal digestive organs. It is known, as was proved independently by Hammond and Durham, that the *volume* of the brain diminishes during natural sleep.

Returning to the old edition of the Encyclopædia Britannica (1779) before quoted, a few sentences possessing interest may be further taken from the article on Sleep. Referring back to the article on Dreams, it is here added: "Sleep we have shown to arise immediately from the communication between our sentient principle *and external objects being cut off*, in consequence of which memory is also lost, and the person becomes insensible of existence. This state may be induced either by such causes as affect the brain, the nervous system, or the blood, though it probably depends in most cases on the state of the vital fluid." This "vital fluid" or "vital spirit," as it is elsewhere denominated, is apparently not the blood itself, but an agent or influence then unknown, believed to reside therein. If we were now—with our present chemical knowledge—to substitute for "vital fluid" oxygen of oxyhæmoglobin of the arterial blood, this part of the citation would become rational. Oxygen, however, had then been discovered but four years previously, and its functions must have been yet but vaguely understood. The Italics have been introduced into the above excerpt to emphasize certain notions about sleep whose fallacy has been previously pointed out.

Dr. Hammond suggests that in the most profound natural slumber the spinal cord, with its nervous ganglia, remains awake, though not quite so much so possibly as when the brain itself is wholly conscious. Of course, the involuntary muscles, as those which operate the heart, the respiratory organs, etc., governed by ganglia of the spinal cord, never slumber. Their slumber is the last sleep of all. But Dr. Hammond cites proof independent of this. The position of the sleeping person is often changed unconsciously when uneasy, and the feet, when chilled, will be drawn under the bedclothes. He mentions still more impressive facts, such as sleeping on horseback, without danger of losing seat, once the habit is acquired. We may add that men sleep leaning against a wall or a tree, or even astride of a limb, without serious risk of falling. Monkeys, opossums, and other animals sleep hung up by helices formed of their tails. Somnambulism may be referred to the same class of facts.

Prof. Michael Foster, of the University of Cambridge, England, a very eminent physiologist, says, in a work published in 1891, that although the phenomena of sleep are largely confined to the central nervous system, and especially to the hemispheres of the brain, the whole body shares in the condition. "The pulse and breathing are slower. The intake of oxygen and the output of carbon dioxide, especially the latter, are lessened. Indeed, the whole *metabolism*" (by which term he designates generally the chemical transformations in the living organism) "and the dependent temperature of the body are lowered." (The latter statement is not in accord with other authors.) "We can not say as yet how far these are the indirect results of the condition of the nervous system, or how far they indicate a partial slumbering of the several tissues." Prof. Foster distinctly declines to enter into what he calls "the psychology of sleep and dreams." But to ignore dreams and their essential relations to natural sleep suggests to the present writer the play of Hamlet with the Prince of Denmark left out.

Foster points out the fact, as the result of all experience, that the recumbent posture is highly promotive of natural sleep, and connects it with the reduction of energy consumed in the circulation, especially with the large diminution of work that falls upon the heart. The most remarkable and significant statements made by this high authority are that "during sleep the pupil is constricted, during deep sleep exceedingly so, and dilatation, often unaccompanied by any visible movements of the limbs or body, takes place when any sensitive surface is stimulated; and on awaking, the pupils also dilate." He adds that this "contraction of the pupils is worthy of notice, since it shows that the condition of sleep is not merely the simple and direct result of the falling away of afferent" (external) "impulses. When the eyes are closed in slumber, the pupils ought, since the retina is then quiescent, to dilate; that they are constricted, the more so the deeper the sleep, shows that important actions in the brain are taking place." In other words, as we have already set forth, certain inherent functions of the brain, also of the nervous system, emotional and imaginative processes, among others, independent of what he calls "afferent" impulses from without, are still fulfilled. The nerves which govern the muscles of the iris must be so affected by the imagination (or by some unknown agent acting only during sleep) as to contract, as if light still fell upon them. This does not seem, however, to concur with the generally accepted view that the muscular fibers that control the iris are involuntary. Until these extraordinary phenomena are understood, we shall doubtless not arrive at a complete theory of sleep. The study of dream phenomena will in this connection (in spite of Prof. Foster) constitute an essential aid.

The collateral phenomena accompanying and related to sleep, though not confined to natural sleep—or, for that matter, to any kind of sleep that suspends the bodily functions—are several. Dreams are the most important and significant; but we can give space only to some partial consideration of the two species of dreams—namely, sleeping and waking dreams. Our encyclopædia of 1778 discusses several views then entertained regarding dreams; among them the curious one presented by the famous Richard Baxter, in his book on the Immateriality of the Human Soul, to the effect that dreams are due "to the action of some immaterial beings upon our souls." Objection is made to this on the ground that the existence of such immaterial beings is incapable of proof. This spiritualistic side of the discussion we must omit.

The most important suggestion regarding dreams made by this encyclopedist of 1778 is that *mania* and hypochondriasis are conditions under which the subjects dream while otherwise wide awake. That this is so appears incontrovertible, and we learn thence that the dream state does not necessarily arise from sleep, of the body at least. Mania may probably be defined as a dreamy slumber of the mind, without the participation of the body. Similar conditions are abundantly brought on temporarily by the abuse of certain powerful agents that destroy the rule of the will and reason over the mental functions, leaving the individual to be swayed altogether by the animal emotions. When the mania is chronic, accounts agree that in time the demoralization becomes, in most cases, so complete as to really give color to the views in ancient books, including our scriptural writings (and, moreover, in the works of some modern writers), that many if not most maniacs are under demoniacal possession. Waking dreams and reveries are known also to attack many persons in whose minds imagination is a predominating element. And even such as do not belong to this class, may become, when under the influence of great distress, fear, privation, or hardship, subject to such waking visions. Starvation or thirst, or both, have often produced the most remarkable illusions. One interesting example may be cited which is historical. It is found in the Journal of Strain's Exploration of the Isthmus of Darien in 1854,* many of the members of which perished slowly and horribly from sheer hunger (thirst not being a factor in this case). The following paragraph is given as an illustration:

"From the time that food became scarce to the close, and just in proportion as famine increased, they did not gloat over visions of homely fare, but reveled in gorgeous dinners. So strangely and strongly did this whim get possession of their minds, that the hour of halting, when they could indulge undisturbed in these rich reveries, became an object of the deepest interest. While, hewing their way through the jungles, and wearied and overcome, they were ready to sink, they would cheer each other up by saying, 'Never mind, when we go into camp we'll have a splendid supper,' meaning, of course, the imaginary one they designed to enjoy. Truxton and Maury would pass hours in spreading tables loaded with every luxury they had ever seen or heard of. Over this imaginary feast they would gloat with the pleasure of a gourmand, apparently never perceiving the incongruity of the thing. They would talk this over while within hearing of the moans of the men, and on one occasion discussed the propriety of giving up in future all stimulating drink, as they had been informed it weakened the appetite. As hereafter they designed, if they ever got out, to devote themselves entirely and exclusively for the rest of their lives to eating, they soberly concluded that it would be wrong to do anything to lessen its pleasures or amount."

"Absence of mind," of the results of which such remarkable stories are current, must be cited also as an example of a transient waking dream or species of reverie state.

Under the next head a few words may first be expended upon the class of lethargies or comatose sleeps arising from certain diseases, such as apoplexies, epilepsy, paralysis, catalepsy, etc. These have but remote analogies with natural sleep. In most of them the brain, instead of being in the collapsed condition, partly drained of blood, which occurs in real sleep, is overloaded and congested with blood, and the resulting stupor is mostly absolute and dreamless. Syncope or fainting has one point of analogy with sleep—namely, that it is accompanied by cephalic anæmia, or loss of blood from the brain; but this goes so much further than in sleep, and the other symptoms, of decrease of general circulation and of respiration, are so great, that there is no further analogy. The insensibility of every sort during syncope is often absolute. Paralysis may in some forms be regarded as a death-

* A great part of this journal may be found in Harper's Magazine in 1881 (or thereabouts).

like slumber of the body while the mind remains awake. The sleep from the action of excessive cold, which precedes death, is due, of course, to general retardation of the circulation, which in due time affects the brain, but probably has but a partial analogy with natural sleep. It has not been sufficiently examined to determine whether dreams accompany it at any stage. The delusions from the abuse of opiates and those of delirium tremens are of the class of waking dreams. Death by drowning is asserted to be preceded by extraordinary waking dreams, sometimes rather pleasurable than otherwise.

The most important of all species of sleep for our present purposes of comparison are those produced by anæsthetic agents. The general use of these is now but about half a century old, though it has been shown that the principle of anæsthesia and its use in surgery, etc., is about as old as the Christian era. Dioscorides describes the use of the *mandragora* root, steeped in wine, as an anæsthetic drink to produce a sleep in which painless amputations and other surgical operations could be effected. Pliny and Apuleius (author of the famous Golden Ass) each make similar statements. Sir B. W. Richardson announced, in 1875, that he had experimented with mandragora, and had largely confirmed the ancient stories about it. The moderns have a great number of anæsthetic agents, some of which are permanent gases, others volatile liquids, which are mostly administered by inhalation; but we yet know very little, in exact scientific detail, about most of them. Some, when given in properly graduated doses, furnish us with conditions approaching closely to those of natural sleep, generally of a dreamless kind; but others, if given in small doses, furnish us examples of sleep of the will power and reasoning functions, accompanied by emotional dreams and hallucinations. In the case of *nitrous oxide* (laughing gas), especially when given in moderate doses, mixed with air or oxygen, emotional excitements of the most remarkable kind result. The subject will often fly into an energetic rage, manifesting a violent and ludicrous pugnacity toward those about him. Others will *declaim* in an oratorical manner, sometimes sensibly and coherently. Of such occurrences the subject often retains vague memories, like those of natural dreams. Thus memory persists during the action of this agent, as in true sleep; and, as in sleep, the will-control is wanting. The natural instincts, no longer restrained, rise up and assert themselves. "*In vino veritas.*" Ordinary alcoholic intoxication, indeed, is but one kind of anæsthesia, and passes in its progress through the same characteristic stages or phases that have been previously defined.

The generalization remaining to be brought forward is as follows: It has already been indicated that of all the known artificial forms of lethargy, the premonitory stages of anæsthesia only are approximate in character to normal sleep. Nitrous oxide, with oxygen, is now largely administered to the point of insensibility, by distinguished physicians, to produce vicarious sleep, in cases of obstinate insomnia, and is regarded as a priceless remedy. But the lethargy thus produced is dreamless, and therefore not normal sleep. The mental and moral natures of the individual are in a condition of suspended animation, which, from what has been previously set forth, is an abnormally torpid condition of life. Further, it has been shown that *complete* anæsthesia itself differs essentially from natural sleep; for in the latter the senses are only dulled, and still remain more or less susceptible to strong external impressions, by dint of which wakefulness is readily brought about.

The question now arises, Is there any agent which exerts in small doses a sedative effect on both body and mind, an effect that increases with the dose or with the period of action, until entire insensibility finally results, and which, like nitrous oxide, works no permanent harm? The answer is that we have one such agent, *carbon dioxide* gas; itself a constant and copious *product* of normal animal life.

It is placed by Richardson, an eminent specialist on this subject, among anæsthetics, and this place is generally conceded to it. Even in the day of Pliny, its outward effects were familiarly known, as at the *Grotta del Cane*, near Naples. Popularly it is deemed a deadly poison, but many chemists have held that it is not so. In mines and deep wells it is usually unmixed with air, and the result of inhalation is, of course, speedy suffocation. Berzelius long ago stated that air containing five per cent can be breathed without serious injury. Dr. Angus Smith found, nevertheless, that one twenty-fifth of this proportion produced a slow diminution of the circulation, such as we have seen accompanies natural sleep. We have one experiment made by a commission on coal mines of the British Association, in which an animal exposed to carbon dioxide and air, *half and half*, a small jet of air being, however, continuously introduced to maintain a supply of free oxygen, lived "for a long time"—how long not stated. Here, plainly, rapid poisonous action is shown to be absent.*

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* New facts have appeared since the above was written that add great strength to the positions taken here against the generally assumed highly toxical qualities of carbon dioxide —a body always present in the lungs and blood of men and animals. The experiments of Berzelius above cited—like all others of that unparalleled chemical genius—as to the toleration of animal life for important amounts of this supposed poison, stand now as being much more than verified. To wit, among others, an English experimenter, Mr. T. H. Wilson, has found that rabbits are uninjured by breathing for an hour air containing twenty-five per cent of the much-dreaded gas. At the last meeting of the British Association, Dr. J. S.

We have seen that during natural sleep the carbon dioxide expired (during wakefulness between three and four volumes per hundred of air from the lungs) diminishes as the circulation diminishes. Many claim that a succession of rapid but long-drawn respirations will quickly bring on drowsiness, and often sleep even ensues. This can be attributed only to a small over-charging of the circulation with carbonic acid. It must be recalled also that carbonic-acid waters and effervescent drinks generally produce with many a decided though transient sedative effect. But in this way doubtless none of the gas reaches the blood, except the little thrown off from the stomach by eructation, this being incidentally and partially inhaled. The gases contained in arterial and venous blood appear to vary somewhat. Several authorities agree, however, that the amount of free carbonic acid in arterial is much smaller than in venous blood, while the oxygen in the former (combined mainly with the hæmoglobin) is much larger. Pflüger made the free carbon dioxide, mostly in solution, in red arterial blood of a dog thirty-four volumes and a half per hundred, while in the blue venous blood it rose as high as fifty, or half the volume of the blood.

The generalization referred to is simply that normal sleep and sleepiness, or drowsiness, are due to a small increase over the average of the carbonic acid in solution in the blood, arising through its overproduction from the greater amount of muscular and other tissue that undergoes oxidation during the waking hours. During the sleeping hours this overload of the anæsthetic gas is gradually discharged until wakefulness results.

In this brief discussion no room has been occupied with what are called hypnotism, clairvoyance, trance, mind-reading, etc. These are outside of our scope—being, if authentic, not natural but supernatural phenomena, pertaining to the realms not of law but of miracle.

Experiments, continued through many years, by Dr. S. Rideal, show that the chemical activity of sunlight during winter on the high Alps is much greater than at lower levels, and enormously greater than in large towns at the same season. This increased activity may contribute importantly to the beneficial effects of health of residence in such regions.

Haldane discussed the subject of the fatality to miners of "after-damp," hitherto believed to owe its effects to carbon dioxide. He shows that *absence of oxygen* is the real cause of death in these cases. He introduces the novel and highly rational suggestion that all parts of mines should be provided with reservoirs of highly compressed oxygen. A pint of this, he shows, would keep a man alive for an hour. Doubtless, with our present means and knowledge, oxygen could be stored in mines and elsewhere, in its *liquefied* form, for this and other valuable uses.—H. W.

THE GEOLOGY OF NATURAL SCENERY.

By FREDERICK J. H. MERRILL, Ph. D.

IN this age of scientific progress, poets and prose writers may no longer tell us of "eternal hills" and streams which "flow on forever." The science of earth-knowledge shows that the mountains are but creatures of yesterday in geologic time, and to-morrow may be cast into the sea through the agency of that wondrous source of power, the sun. Moreover, as the study of Nature advances, the veil of superstition is torn aside and the mystery is dispelled in which ignorance involves the causes of natural phenomena; so that to the mind a broader field of view is opened, while the knowledge of the changes which have occurred and are taking place about us on the earth adds much to the inspiration which beautiful scenery gives, without detracting from the poetic quality of the feelings it excites.

Foremost among the minds which have felt this inspiration and expressed their pleasure in the English tongue are those of Byron and Sir Walter Scott. But, in their time, truth in description of natural phenomena was not expected. The poet interpreted at will the scenes which impressed him, and the reader, charmed with the rhythmic cadence of the lines, was content to admire the beautiful clothing of the writer's thought, little caring whether the phenomena were truthfully described or properly explained. But from the writers of the future we must expect a reconciliation between scientific truth and poetic fancy.

It is fallacious to claim that natural science bridles too closely the poetic mind. Science is but truth, and what is not true has no part in science. Surely, in the presence of the most famous works of man the knowledge of their history in no way detracts from the interest which they inspire. Mountain and valley, hill and plain, river, lake, and sea, have each their history for the observer to read; and instead of imagining convulsions of Nature and picturing speculative catastrophes, the mind may dwell on the action of simple and familiar agents working through long ages and bringing about by slow degrees that beauty and grandeur of terrestrial form which is never caused by cataclysms.

To instance this hypothesis we need not journey far; our own land is rich in scenery unsurpassed, and whether we seek our illustrations in Rhineland or the valley of the Hudson, among the Alps or the Sierras, we are only turning the pages of one great book. But though the turning of those pages might go on forever, and though the most earnest student can never know their number, the history which they contain is intelligible to all who would know it, infinite in the variety of its expression and charming in the simplicity of its style.

Among the varied scenes which charm the eye there are none so pleasing as those which combine both land and water; and the vicinity of New York city, with its varied and rich combination of water and landscape, will serve as a fitting example to introduce the subject.

In order to consider the origin and history of this scenery, it is necessary to look backward a short distance in geologic time. Ten thousand years or more ago the continental glacier extended from the highlands of British America southward to Long Island, and at its margin, where it may have been a thousand feet or more in thickness, accumulated a mass of rock *débris* brought in part from northern New York and New England. When the advent of a warmer climate caused the ice sheet to retreat, its terminal mass of *débris*, called by geologists the *moraine*, formed a range of lofty hills, locally known on Long Island as the "backbone," and which crosses Staten Island, northern New Jersey, Pennsylvania, and Ohio, continuing northwestward far beyond the Mississippi.

The land was then much depressed to the northward, and the waters of the ocean communicated with New York Bay through the valleys of the St. Lawrence, Lake Champlain, and the Hudson. In place of Lake Champlain was a great estuary, its surface four hundred feet above the present tide level, stretching from the foothills of the Adirondacks on the west to the Green Mountains on the east, and of which the beaches with their sea shells may still be found. Into the estuary which occupied the valley of the Hudson the streams from the surrounding country brought their sediment, gradually forming deposits of clay and sand, while on the outer shores of Staten and Long Islands the ocean waves broke sixty feet or more above their present level. Gradually the continent rose from its submergence, the elevation of the land caused the ocean to retreat, and the Hudson, the Mohawk, and their tributaries sought an outlet southward to the sea. The rivers thus revived cut a channel in their seaward journey deeper and deeper through the sand and clay deposited in the Hudson Valley, and near the end of their united course carved through the moraine a passage which we call the Narrows.

When Long Island Sound is viewed from the Westchester shore the lofty hills of the moraine form a most picturesque background to the blue waters of that beautiful estuary which but for the advent of the ice sheet would probably have been separated from the ocean only by a low, sandy plain. From the summit of the moraine in Prospect Park, Brooklyn; from Harbor Hill, or from any of the numerous eminences on Long

Island, the widespread view of sea and land impresses itself upon the observer, and in every way in which this range of hills is brought to our notice we are unconsciously led to appreciate the scenic importance of this legacy of the continental ice sheet.

From the scenery of Long Island Sound and the moraine one may turn to that of the Hudson River.

On the east shore of this noble stream is a terrace, picturesquely dotted with handsome country seats, which extends almost continuously from New York to Peekskill, and, after a brief interruption where the steep slopes of Anthony's Nose and the Dunderberg form the lower gate of the Highlands, reappears at Garrison's and Cold Spring and forms the plain upon which the Military Academy is located. at West Point. This terrace is about seventy-five feet above tide at the Riverside Park in New York city, and increases in height northward to about one hundred and twenty feet at the State Camp near Peekskill and one hundred and eighty feet at West Point. North of the Highlands the remnants of terraces may be seen on both shores of the river as far as Troy and throughout the valley of Lake Champlain, increasing in height northward to the St. Lawrence River, where, in the vicinity of Montreal, they have an altitude of over five hundred feet.

In these terraces is recorded ineffaceably the history of the continental submergence previously mentioned. They are the remnants of the deposit of sand and clay formed in the Hudson and Champlain Valleys when submerged, and the surface of the highest terrace indicates approximately the old sea level.

These terraces, relics of Quaternary subsidence, are not, however, the only interesting geological phenomena to be seen along the valley of the Hudson. The bold, precipitous Palisades, known as widely as the river which they overlook, call our attention to a period of volcanic activity in Mesozoic time. These lofty cliffs form the margin of a sheet of trap or igneous rock, three hundred to four hundred feet in thickness, which was forced to the surface in a molten state between the beds of red Triassic sandstone which form the eastern border of northern New Jersey and of Rockland County, New York.

Throughout most of its extent the Palisade range has been leveled off by wave action at some remote period of subsidence, while immediately west and north of Nyack a portion which has escaped erosion rises in high peaks with irregular outlines.

Leaving the Palisades behind us, we enter the gorge of the Highlands. The rocks which form these rugged steeps are of the oldest and hardest in our State. Though they have yielded to the cutting of the river current in past ages, they resist the degrading influences of the atmosphere and rear their summits far above the surrounding country.

When Storm King is passed in our northward course, the scenery changes completely. The gneiss hills of Westchester County, abruptly rolling to the east, the craggy Palisades and the Highland mountains give way to a region of moderate elevation and gently rolling surface, abruptly notched by the river valley. This is a belt of slate and limestone territory extending from Vermont to Alabama, and of world-wide fame in its fertility, known in Pennsylvania as the Great Valley, and in Virginia as the Valley of the Shenandoah.

From Cornwall to Troy the scenery of the Hudson shows but little variation, as the geology does not change materially except where the hard Catskill sandstones and conglomerates rear their lofty pile, furrowed, channeled, and notched so deeply and widely that of the original plateau only the present mountain remnants may be seen.

As a geological map of the Hudson Valley would tell what variety of scenery might be expected, so one may forecast the scenic pleasures of the Rhineland without entering its territory.

From Basle to Mainz the Rhine flows through a low plain of Quaternary age. In this portion of the valley the natural scenery is monotonous, varied only by distant views of hill country. From Biebrich to Bingen the river skirts the foot of the Rheingau, which affords on the right bank the picturesque scenery of that famous vine-clad slope. From Bingen northward the river has abruptly cut its channel through the Devonian rocks which extend from Bingen nearly to Bonn, and, in meandering through the defiles of its valley, exhibits to the traveler a variety of imposing scenery which in remote centuries as well as in recent times has inspired the poet and the minstrel, and in the richness of its historic associations and its relics of the feudal system is unsurpassed and probably unequaled by any other valley in the world. From Bonn to the sea the country bordering the river is of more recent origin and proportionately deficient in relief and scenic variety.

In connection with these instances may be stated a general principle of the relation of scenery to geology: the older the formation, the higher its relief and the more striking its scenery.

To exemplify this principle in its broadest form let the reader compare the topography of some of the newest and oldest formations. For instance, compare the London basin with the Scottish Highlands, or Dover Cliffs with Mount Snowdon, or the drift hills of Long Island with the Adirondack peaks, or the sand plains of Florida, Georgia, and the Carolinas with the mountain region about Asheville. The most inexperienced observer can not fail to note the contrasts.

To this rule, as to all others, there are exceptions. Some of the highest mountains of the world are composed of Tertiary rocks, and volcanic cones, which vary greatly in age, are characterized by similarity of form.

The dependence of scenic contrast on geologic age may well be exemplified along another well-beaten line of travel.

If we journey from Paris to Lausanne we find the Tertiary plain of France comparatively monotonous; but in crossing the Jurassic rocks between Tonnerre and Dijon we find them deeply incised by valleys, adding much to the picturesqueness of their scenery by their high relief. At Dijon we are on the western margin of the valley of the Saone, a basin filled with Tertiary and Quaternary sediments and comparatively uniform in surface. Crossing the Saone Valley we ascend the slope of the Jura Mountains, pass their summit, and when we descend their eastern flank, from the southeast there bursts upon the eye a vision of serried mountain peaks, lofty, abrupt in outline, and in most cases capped with snow, looking like curling breakers in a stormy sea. This is the Bernese Oberland. Of this well-known Alpine chain the highest peaks are formed of rocks very old in geologic time. Passing southward beyond the valley of the Rhone we may cross the Pennine Alps by the Simplon Pass and descend to the Quaternary plain of northern Italy. Here the contrast is abrupt and easily observed, as is the change from the mountain region of Tyrol to the plain of Bavaria about Munich.

To multiply these instances is unnecessary; the writer's object is only to explain these scenic contrasts which have been seen by every intelligent observer. In our own country the Atlantic coast plain and the flat sedimentary plains of the Mississippi basin differentiate themselves from the Appalachian mountain region, and the plutonic masses of the Adirondack chain stand out in bold contrast to the glacial and post-glacial deposits of the western portion of this interesting wilderness. So in the Rocky Mountain region the central masses of Archæan rocks stand out in strong relief above the later formations which border them.

To elaborate this subject in detail would be to write the geology of the whole world, a task from which the writer refrains.

From the fact manifest in the Alps that glaciers rarely form till the mean annual temperature falls below 27° Fahr., Prof. T. G. Bonney estimates that a fall of 20° Fahr. would produce large glaciers in the hill districts of Britain; one of from this to about 12° Fahr. would bring them back in the various districts on the globe where traces of them have been observed, and in some of these the small size of the vanished glaciers shows that the fall can not have exceeded about 15° Fahr.

GEOLOGIES AND DELUGES.*

By Prof. W. T. SOLLAS, F. R. S.

IN the days when geology was young, now some two hundred years ago, it found a careful foster-mother in theology, who watched over its early growth with anxious solicitude, and stored its receptive mind with the most beautiful stories, which the young science never tired of transforming into curious fancies of its own, which it usually styled "theories of the earth."

Of these, one of the most famous in its day and generation was that of Thomas Burnett, published in 1684, in a work of great learning and eloquence. Samuel Pepys, of diary fame, is said to have found great delight in it, and it is still possible to turn to it with interest when jaded with the more romantic fiction of our own day.

It was the fashion to commence these theories with chaos, and chaos, according to Burnett, was a disorderly mixture of particles of earth, air, and water, floating in space; it was without form, yet not without a center, a center indeed of gravity, toward which the scattered particles began to fall, but the grosser, on account of "their more lumpish nature," fell more quickly than the rest, and reaching the center first accumulated about it in a growing heap, a heap, as we might now express it, of fallen meteorites; the lighter particles, which form fluids, followed the heavier in their descent and collected around the solid kernel to form a deep ocean. This was at first a kind of emulsion, like milk, formed of oily and watery particles commingled, and, just as in the case of milk, there separated on standing a thick, creamy upper layer, which floated on the "skim milk" below. That this really happened, the good Burnett bravely remarks, "we can not doubt." The finest dust of chaos was the last to fall, and it did not descend till the cream had risen; with which it mingled to form, under the heat of the sun, the earth's first crust, an excellent but fragile pastry, consisting of fine earth mixed with a benign juice, which formed a fertile nidus for the origin of living things. Outside nothing now was left but the lightest and most active particles of all, and these "flying ever on the wing, play in the open spaces" about the earth, and constitute the atmosphere of air.

Such was the earth when first it formed the abode of unfallen man—perfect in form and beauty, for it was a true sphere, smooth as an egg; undisfigured by mountains, and unwasted by the sea. It was unfortunately but too like an egg, since its fra-

* British Association address to workingmen.

gile shell rested on the treacherous waters of the interior abyss, "the waters under the earth," and the sun overroasting, finally cracked and burst it; the broken fragments of the ruined world fell downward into the abyss, and the subterranean waters rushed out in a mighty flood to remain as our present seas and oceans, from which the broken crust protrudes as continents and islands. As might naturally be anticipated, the bursting out of the abyss corresponds to the Noachian deluge, which we thus perceive to have been profounder in its origin and wider reaching in its effects than we might previously have supposed. This, for distinction, we may call Burnett's deluge; of his geology we may say that it is cosmological, since it endeavors to trace the history of the earth backward to its origin in chaos; that it is catastrophic, because it attempts to account for all the great features of the earth by a single event which occurred suddenly and with violence; and that it is theologic, since it owes its inspiration to Holy Writ.

As geology grew older it went to school: what was the name of the school is not quite certain; some have called it "Science falsely so called," others more briefly, "Inductive Science." However this may be, the immediate effect on the manners of young geology was very distressing. It grew contradictory, and was frank in the expression of obnoxious opinions. One of its most irritating remarks was that the world was not made in a week, and it would appear that at this time the relations of child and foster-parent became not a little strained. Still, geology proved an apt scholar, and its progress was rapid. One of the most important lessons it learned was that if we want to know how the world was made, the first essential is to study the earth itself, to investigate with patient drudgery every detail that it presents, and particularly the structures that can be seen in river banks, sea cliffs, quarries, pits, and mines. Thus it discovered that the solid land beneath our feet is to a large extent composed of layers of sediment which were once deposited more or less quietly at the bottom of ancient seas, and certain curious bodies known as fossils it concluded to be the remains of plants and animals, sea-shells and the like, which were once the living denizens of these seas.

It discovered that these deposits lie so regularly, one upon another, that it compared them to a pile of books, or to a slanting row of books lying cover to cover; and that in some cases, at least, the simile was not strained, will appear if we trace the structure of England from Oxford westward toward Bristol. We then find that the thick bed of clay upon which Oxford stands lies evenly on a series of gently sloping beds known as the lower Oölites; these in like manner repose on those thin seams of limestone and clay called the Lias, and these in their turn upon the red beds of the Trias. It might perhaps have been expected that this uniform arrangement would continue through the whole thickness of the stratified rocks, but it was discovered, and the importance of the discovery was recognized so early as 1670 by Bishop Steno, a man of great genius, that the regularity of the successions is liable to interruption at intervals. Thus as we approach Bristol we encounter those beds of limestone which are associated with our coal-bearing strata, and which are consequently called "carboniferous"; but these are by no means related to the beds we have just passed over in the same manner as they are to one another—we do not find the highest bed of the carboniferous series offering its upper surface as a gently sloping platform on which the trias may rest; on the contrary, the carboniferous beds are seen to lie in great rolling folds, with the tops of the rising folds absent, as it were sliced off, and it is on the edges, not on the surface, of these beds that the red trias layers are seen to be spread out. This sudden change in disposition may well be called a break in the succession of the rocks, and, as if to emphasize it and compel attention to it, we find it accompanied by a complete change in the character of the fossils, those occurring in the carboniferous rocks being of entirely different kinds from those which are found in the overlying beds.

Evidently the carboniferous beds could not have been laid down in the sea in the steeply folded form they now present; at first they must have been spread out in nearly horizontal layers, and the folded form must have been subsequently impressed upon them, no doubt by the action of some stupendously powerful force. Subsequent also must have been the removal of the upper parts of the folds and the general planing down which they appear to have undergone.

To the young geology all this might seem perfectly clear, but in its impulsive explanations it assumed that Nature must have frequently acted in a great and terrible hurry: thus the folding of the rocks was supposed to have been produced suddenly and violently by a single mighty convulsion, which simultaneously changed sea floors into mountain chains, split open the land in wide-gaping chasms—our present river valleys—and with the same blow destroyed every living inhabitant in the world.

But the discordance between two sets of rocks is met with not once only, but several times, in the stratified rocks of the earth's crust, and for every discordance there must have occurred a corresponding catastrophe.

These catastrophes were as wonderful as Burnett's, and there were more of them, so that at this stage of its existence geology was appropriately designated "catastrophic." It had completely severed the apron-string, and ceased to be theologic, but it still to its credit remained cosmologic. It traced the earth from chaos up to a stage when islands and continents rose out of a primeval ocean, the waters of which were boiling; saw it peopled with strange and various forms of life, and watched it run its course, rejoicing in the sun, "cheerful, fresh, and full of joyance glad," then pictured it overtaken with disasters, shaken with earthquakes, overwhelmed by floods, and agonizing in the labors of a new birth. Calm followed after storm, and life rejoiced afresh in a remade world to be again destroyed. Thus, through alternations of peace and strife, the earth moved on its changeful way, to the crowning creation of man, who was himself a living witness of the last great catastrophe of all, the Noachian deluge. Its waters covered the whole earth, to the tops of the highest mountains under heaven, and on their retreat they left behind, as a standing witness to their extension, great sheets of sediment, supposed to be spread out over the entire surface of the globe, and appropriately named the "diluvium." The diluvium may be seen in most parts of the British Isles, except in the south of England; it consists of clays and sands, containing vast numbers of curiously scratched stones.

As the powers of geology matured it became increasingly able to dispense with catastrophes. The very diluvium itself was shown to be local in its distribution, and glacial in its origin; masses of moving ice, like that which buries the greater part of Greenland out of sight, covered a large part of the temperate regions, and this it was that produced the curious scratched stones; and the deposits containing them, which are consequently no longer called "diluvial" but "glacial." More important yet, land could be shown to be still actually rising from the sea, and mountains growing into the air, but so slowly that the fact was not established without much dispute, which is hardly yet over. Valleys could be shown to result, not from any bodily fracturing of the land, but from the slow wearing action of the rivers which flow through them, and the waves of the sea were shown to be capable of cutting down cliffs and of reducing the land to a plain.

From these facts the discordance in the succession of stratified rocks found an easy solution. Recurring to the instance of the carboniferous rocks and their relations to the trias, we no longer need suppose that the stupendous force which folded the carboniferous rocks and raised them into the air acted suddenly or even very rapidly; judging from the rate at which mountains rise now, their upheaval may have proceeded slowly; a few feet in a century would suffice. If we allow but one foot in a century, it would only require two million years to produce a mountain range twenty thousand feet in height. The movement might naturally be expected to be accompanied by earthquakes, but there is nothing to lead us to suppose that these would be on a much grander scale than those of the present. During its slow elevation, the mountain range would be exposed to wind and weather, rain and rivers would carve it out into ridges and valleys, and frost would splinter its peaks into spires and pinnacles. Subsequently it would sink beneath the sea, and the waves of the sea, as they battered down its cliffs, would remove the last remnants which had escaped the rain and rivers, and roll over an unbroken plain. On this plain, as it continued slowly to subside beneath the sea, the immense deposits of the trias, lias, lower oölites, and Oxford clay would be piled up.

If the rise of the sea floor into the Bristol Alps took place slowly, and involved a great lapse of time, so equally did the sinking of the land to form the sea floor afresh, and in this long interval time was afforded for great changes in the organic world; and thus we reach an explanation of the great and striking differences which distinguish the fossils of the carboniferous rocks from those of later date.

There is no insuperable difficulty in this explanation; its great merit lies in its accordance with the course of Nature as we observe it at the present day; and henceforward it became the motto of geology that the processes of the present furnish the key to the interpretation of the past. The changes in which the life of the earth is manifest are not only slow and gradual now, but they have ever been the same. The earthquakes, which in ancient times shook the land, were no more violent than those of which we have lately read in the daily newspapers; the ancient volcanoes were not more terrible in their outbursts than Krakatoa; floods were not more appalling than those which still from time to time sweep away tens or even hundreds of thousands of human beings from the Ganges plain, and the earth, instead of falling into convulsions every now and then, proceeds on the even tenor of her way, without haste and without rest, preserving a uniformity in her progress which impresses us with its solemn grandeur, but which sometimes seems a trifle monotonous. From its belief that an unbroken uniformity in the operations of Nature extends from the present into the most remote past, geology now came to be called "uniformitarian." It was no longer theologic, no longer catastrophic, and, I am sorry to add, no longer cosmologic. It persistently refused to inquire into the early history of our planet, and restricting its study to the accessible parts of the earth's crust, it abdicated its regal position as the science of the earth, and became as it were a mere petty chieftain, dealing only with rocks and the fossils they contain; the fossils, by the way, not rightly belonging to its province at all.

And it was because it passed from being a science of the earth to become a mere study of rocks and fossils that Hutton was able to make his famous declaration that as a result of his inquiries into the system of Nature he could discover "no vestige of a beginning, no prospect of an end." Apart from this, however, and in its self-limited career, geology pursued a luminous advance, and as it did so the Noachian deluge began to sink into an oblivion which it might be thought to have scarcely merited. For if the biblical account is to be taken literally, it furnishes us with a catastrophe of the first order; and since it is said to have occurred comparatively recently, or at least in historic time, the uniformitarian, by his own principles, would have been compelled to infer, as the catastrophist had done, that such deluges form a part of the orderly scheme of the world. The universality of the deluge had, however, for various reasons, been denied, not only by geologists, but by writers of other schools of thought, and toward the middle of the century belief in it among the learned was gradually expiring; such a number and variety of convincing arguments as converged against it could indeed but lead to that result; and that the deluge, so far from being universal, was a local and very local phenomenon, became an article of belief so settled among all good geologists—and I think I may add theologists—that it may be said to have finally fallen into the deep slumber of a decided opinion, from which I for one have no desire to arouse it.

Thus the deluge, so far from shaking the uniformitarian position, was rather itself submerged by uniformitarian views, and growing geology was in danger of taking the uniformitarian formula for an infallible dogma. It was saved from this by physics, a clever brother of its own, which had now discovered the famous principle of the "conservation of energy," and another equally famous, "the dissipation of energy." From these it was deducible that the duration of the earth as a living planet must be strictly limited in time. It must have had a beginning, and at the beginning was furnished with a store of energy, which it has ever since been spending. In this spending of energy its life consists, and when the store is at length exhausted its life will cease, and it will become numbered among the dead planets.

A good deal of this uniformitarian geology might perhaps itself have guessed, had it extended its views beyond rocks and fossils to the stars and other shining bodies which people the vast realms of space. The present, then, strange to say, will still afford a key to the past. We have but to turn to the sun, our nearest luminary, though still more than ninety millions of miles away from us, and in that great orb we find much to suggest the state of our planet some ninety millions of years ago or more.

It is scarcely necessary to remind you of the fact that the sun is a body so hot that the most refractory substances known to us on the earth exist in it in a state of gas or vapor; tongues of glowing gas shoot from it like flames; the clouds which emit its brilliant light are probably clouds of carbon or silicon, which have momentarily condensed from a gaseous state; and rain, if rain ever occurs, must be a rain of molten metals, such as iron, which will be dissipated in gas before it has fallen very far.

If we proceed to the more remote nebulæ, largely composed of glowing masses of gas, we find a suggestion of a stage more embryonic still, when the earth had as yet no separate existence, but formed, with its sister planets and the sun, a single shining cloud. On the other hand, if we turn our gaze on our nearest relative—offspring possibly—that dead planet, the moon, we may read in its pallid disk the sad reminder, "Such as I am, you, too, some day will be."

But this was not all that was contained in the admonition of physics; it showed not only that the earth is mortal, but that its span of life, as measured in years, or millions of years, is brief compared to the almost unlimited periods which geology had been in the habit of postulating. If catastrophic geology had at times pushed Nature to almost indecent extremes of haste, uniformitarian geology, on the other hand, had erred in the opposite direction, and pictured Nature, when she was "young and wantoned in her prime," as moving with the tame sedateness of advanced middle age. It became necessary, therefore, as Dr. Haughton expresses it, "to hurry up the phenomena."

With its uniformitarianism thus moderated, geology has again become cosmologic, and, neglecting no study that can throw light on any question connected with our planet, has regained its position as the science of the earth: it is henceforth known as evolutional geology.

The change has not taken place without occasional relapses into catastrophism. Some indications of this can, I fancy, be perceived in the writings of that eminently great geologist Suess, who, among other suggestions savoring of heresy, has lately recalled attention to the "Deluge," and endeavored to show that though certainly local, and indeed confined to the Mesopotamian Valley, it was on a grander scale than we had been accustomed to suppose, or, in plain language, a genuine historic catastrophe.

A local flood must have had a locality, and the clew to this is furnished by Genesis itself, which informs us that Abraham, the founder of the Hebrew race, left his ancestral city, "Ur of the Chaldees," at a time long subsequent to the flood; it is, therefore, rather in the land of the Chaldees than in Palestine that we should be led to seek the scene of this momentous tragedy.

This land is no other than the famous and once beautiful valley of Mesopotamia, through which the great Euphrates and arrow-swift Tigris flow to empty themselves into the Persian Gulf. Almost lost sight of for a while, interest in it was reawakened some seventy years ago by the investigations commenced by Mr. Rich, and followed up with such wonderful results by Botta, Place, Layard, George Smith, and others. Their discoveries have revealed to us in unexpected fullness the details of a complex and advanced civilization almost if not quite as ancient as the Egyptian, and far more profoundly interesting, for the ancient nations of Mesopotamia are the intellectual forefathers of the modern world. The learning of the Chaldees was the heritage of the Jews and Greeks; from these the torch was handed on to the Romans, and Jew and Greek and Roman inspired, and still inspire, for good and evil, the civilization of the nineteenth century. There is much more of the Chaldean in every one of us than we are given to imagine.

The people whom we find in possession at the dawn of history were Semites, the parent stock from which the Jews subsequently branched off; and one has but to glance at their faces and forms, as portrayed in their statues and pictures, to recognize the strong family likeness, while the emphasis with which muscular development is expressed in parts of the human figure suggests that the remarkable assertion, "The pride of a young man is in his legs," was a Semitic opinion long before the time of Solomon.

Just as Egypt is the gift of the Nile, so is Mesopotamia equally the gift of the Tigris and Euphrates, for it is built up of the mud brought down from the mountains by these two streams into the Persian Gulf, which is thus in process of obliteration. So long as the two great rivers were not regulated, they produced terrible floods in the wet season; and one of the earliest works of the Chaldeans was to control their flow by great dams, and by diverting a part of their water into canals. These canals covèred the country like a network, and served not merely to ease the rivers, but also to irrigate the land, which, thus richly supplied by water, became, under the hot sun, so fat and fruitful that corn is said to have borne three hundred fold. Groves of palms, orchards, with grapes and many other luscious fruits, were cultivated, while the pastures supported abundant flocks and herds. It was a true garden of Eden, and differed chiefly from the biblical paradise, which Delitsch thinks was actually situated within this garden, in the fact that even here man had still to earn his bread in the sweat of his brow. This the Turks, who now possess the country, have no inclination to do, and consequently it is rapidly returning to its primitive desolation. Were England as enterprising as she was in the time of Elizabeth, we should rent this land from the Porte, run a railway through it, and thus shorten our route to India by a thousand miles, farm it, and thus provide ourselves with one of the richest granaries in the world.

In a land so favored, it is nothing wonderful that the inhabitants teemed in millions, villages were everywhere dotted about, and in their midst great and flourishing cities arose—Ur, the City of the Moon-god; Erech, the City of Books; Nippur, and, most famous of all, proud Babylon, "the Gate of God," which stood on the left bank of the Euphrates, some two hundred and eighty miles above its present mouth. In early times, probably about 2300 B. C., the Jews left this beautiful land for some unknown reason, and after various vicissitudes settled in Palestine. Another branch of the Chaldean stock migrated in later times to the northern part of the Tigris Valley, where they built many mighty cities, and founded the warlike kingdom of Assyria. Of their cities it is sufficient to mention Assur, which gave its name to the kingdom, and Nineveh, which afterward became the capital.

The Mesopotamian plain, owing to the way in which it has been produced, is an almost dead flat, and offers no natural elevations for building; the Chaldees, therefore, to raise the foundations of their palaces, temples, and houses above the reach of floods and fever, and for better defense against their enemies, constructed, with incredible labor, great mounds, by piling together quantities of sun-dried bricks and rubbish, and building round this a thick wall of burned bricks, well cemented together. Some of these mounds, as that of Kojundjik at Nineveh, are as much as sixty feet in height, and it has been computed that this mound alone would have required the labor of twenty thousand men for six years in its construction. But there was never any difficulty in obtaining all the labor that was wanted. Prisoners of war were compelled to work under the stick, and the building of mounds was one of the wholesome occupations to which the Jews were set during their captivity in Assyria.

On the mound of Kojundjik stood two great palaces, one of them that of King Assurbanipal. It was evidently not merely a royal residence, for one of its chambers at least was devoted to public purposes; this was the king's library, to which the citizens, who were taught in their early years to read and write, had free access. Whether any of the books were written on papyrus is uncertain; all that have survived the conflagration, in which the palace was destroyed, are on tablets of kiln-made brick. Of such tablets many thousands have been recovered, not only from Nineveh, but from other towns, and many of them are now preserved in the British Museum. Thus within the last fifty years modern Europe has obtained a glimpse, and more than a glimpse, into the literature of a civilization that perished just as the Roman was coming into existence; for, as Sir Walter Raleigh puts it, "In Alexander's time learning and greatness had not traveled so far west as Rome, Alexander esteeming of Italy but as a barbarous country, and of Rome as but a village. But it was Babylon that stood in his eyes, and the fame of the East pierced his ears."

The recovered literature covers a vast field of human interest, in science, as in astronomy and mathematics, particularly in astronomy, for the Chaldeans were famous star-watchers, and had already named the stars and constellations, associating them with the deeds and mighty works of their heroes and demigods, so that the starlit sky became a pictured dome, and the zodiac a frieze to the Assyrian, reminding him of history or fable, like the sculptures and paintings which adorned the king's palaces; in religion and poetry, and in commerce, many of the tablets recording business contracts, and revealing a system of mortgage and banking, money being frequently lent at from thirteen to twenty per cent, which was moderate; for the advantages of cent per cent were already known and appreciated by these simple Semitic folk.

It was among the tablets from King Assurbanipal's library at Nineveh that George Smith, now over twenty years ago, made a famous discovery. He found a fragment of a tablet, bearing words, which he deciphered as follows: "On the Mount Nizir the ship stood still. Then I took a dove, and let her fly. The dove flew hither and thither, but finding no resting place, returned to the ship." Every Englishman who knows his Bible would have guessed, as George Smith immediately did, that he had before him a piece of a Chaldean account of the deluge. He searched for more fragments, and found them. He went out to Assyria, visited the king's palace, and found still more tablets and pieces of tablets, some of them just those he required to fill up missing gaps in the story. Since its first translation by its discoverer it has been again translated and retranslated by some of the acutest scholars in Europe, so that we now possess a fairly complete knowledge of it; a few missing words or even lines, and occasional obscurities occur, but these are of no great importance. In a town which has the privilege to number the distinguished Assyriologist, Prof. Sayce, among its residents, there will be no necessity to present the story more than briefly. It runs as follows: Sitnapistim, the Chaldean Noah, is warned by Ea, the god of wisdom and the sea, that the gods of Surippak, a city on the Euphrates, even then extremely old, had decided in council to destroy mankind by a flood. Sitnapistim is told to build a ship in which to save himself, his family, household, and belongings. Anticipating the curiosity of his neighbors, since he had never before built a boat, he asks what answer he is to make when questioned as to his unusual proceedings. Ea, who as the god of wisdom is naturally a master of evasion, provides him with a subterfuge, and Sitnapistim sets about building his boat. He forms it of timber and reeds, and makes it watertight by filling up the crevices with pitch, which he poured over it both within and without. It is of great interest, as showing the local coloring of the legend and the survival of an ancient custom, to observe that this practice of paying the native boats of the Euphrates with pitch has persisted in Mesopotamia down to the present day, natural pitch being used, which occurs at various localities in the valley, but particularly near the town of Hit. Sitnapistim's method of procedure, both in building and paying his boat, may still be witnessed at Hit as a matter of almost every-day occurrence.

Sitnapistim having provisioned the vessel, and brought into it all his goods and chattels, received an intimation of the immediate approach of the catastrophe; he went on board with his family and friends, closed the roof, and prudently intrusted the helm to the sailor—Buzar-sadi-rabi. Heavy rain fell during an anxious night, and as soon as daybreak appeared—

"There arose from the foundation of heaven, a dark cloud,
The storm-god Ramân thundered in its midst and
Nebo and Merodach went in front.
As leaders they passed over mountain and plain.
Ninîb went therein, and the storm behind him followed.
The Anunnaki raised high their torches,
With their radiant brightness the land glittered,
The turmoil of Ramân reached to heaven,
All that was light was turned to darkness.
. . . .
In the earth men perished. . . .
Brother beheld not his brother, men knew not one another. In the heaven
The gods were terrified by the deluge, and
Hastened to ascend to the heaven of Anu.
The gods were like a dog—sat down cowering on the ring wall of heaven.
Ishtar cried like one filled with anger.
Cried the mistress of the gods—the sweet-voiced—
'The former generation is turned to clay. . . .
What I have borne, where is it?
Like fish spawn it fills the sea.'"

For six days the flood lasted and ceased on the seventh, and then Sitnapistim is made to say:

"I looked on the sea and called aloud,
But the whole of mankind was turned to clay.
I opened the air-hole, and the light fell on my face:
I bowed low, sat down, and wept,
Over my face flowed my tears."

Sitnapistim then beheld the land, Mount Nizir, on which the ship grounded. It remained swinging there for seven days; on the seventh day Sitnapistim sent out a dove, which returned, then a swallow, which flew to and fro, but also returned, and finally a raven: "The raven went, saw the going down of the waters, came croaking nearer, but did not come back." Sitnapistim then left the ship with his people, built an altar on the summit of the mountain, and offered sacrifice. The poem then runs:

> "The gods smelt the savor, the gods smelt the sweet savor,
> The gods gathered like flies over the sacrificer.
> The mistress of the gods, Ishtar, lifted up the (bow?) which Anu had made according to her wish."

A discussion then takes place among the gods, who all through are very human, and in its course Ea suggests to Bel, who seems to have been the prime mover in all the mischief, that he should for the future destroy mankind in a less undiscriminating manner—by wild beasts, pestilence, and famine. The scene ends happily with the apotheosis of Sitnapistim and his wife.

The surprising resemblance of the story to the biblical narrative, extending into identity of words, as in the case of the "gods smelt the sweet savor," points to direct derivation or borrowing, and there can be very little doubt in deciding on which side the borrowing lay. The biblical narrative is indeed a Jahvistic or monotheistic edition of the Chaldean. To this conclusion the most distinguished Assyrian scholars have been led. I need only mention here Prof. Sayce, whose opinion is expressed on page 119 of his work on The Higher Criticism and the Monuments, published by the Society for Promoting Christian Knowledge, during the current year.

The Chaldean story certainly reduces the flood to much smaller dimensions, and so far brings it nearer the range of probability; the rain lasted only seven days, and the waters have subsided sufficiently at the end of a fortnight for Sitnapistim to land. They do not cover all the high mountains, and the stranding of the ship on Mount Nizir when the flood was at its climax gives us a maximum height, which it can not have exceeded; for if this mountain had been deeply submerged, it could not have arrested the passage of the ship. The height of the Nizir mountains is about one thousand feet above the sea level, which still leaves room for a very respectable flood.

The skepticism which prevailed in the middle of this century with regard to legends seems to have given place to an almost equally great credulity. The older argument seemed to be that the presence of some obviously unveracious statements in a legend condemned the rest, want of faith in some was want of faith in all; while the more modern view would appear to be that since so many discredited legends have been found to enshrine some important truth, all are to be assumed trustworthy till they are proved otherwise.

It may be in this spirit that Suess has elaborately discussed the Chaldean legend as though it presented us with a trustworthy account of the Mesopotamian deluge.

Reasoning from the facts as it records them, Suess lays great stress on the course taken by the ship from Surippak, supposed to have been situated near the mouth of the Euphrates, to the land of Nizir, a distance of about two hundred and forty miles up stream. Had the flood been produced solely by heavy rainfall and a consequent overflowing of the swollen rivers, the ship instead of being carried inland would have been drifted out to sea—i. e., southward into the Persian Gulf. Suess therefore suggests that a great wave was produced in the Persian Gulf, partly by a cyclone and partly by an earthquake. This wave of twofold origin then rolled in upon the low-lying land of Mesopotamia, and drove its floods of water up the valley till they washed the foot of the Nizir hills.

Of all catastrophes none are more terrible, none more disastrous than those thus produced. When the shock of an earthquake occurs beneath the sea, and affects the adjacent land, a trembling of the ground is first felt, then the sea retires and leaves the beach bare, only to return in a long, mighty wave which breaks with violence on the shore. Thus on October 28, 1746, Callao in Peru, after being shaken by an earthquake, was overwhelmed by a sea wave and utterly destroyed; of its five thousand inhabitants only two hundred survived the flood. Still more destructive was the famous earthquake of Lisbon, November 1, 1755, when the inhabitants, without a warning, were destroyed in the falling city, and in six minutes sixty thousand persons perished. The sea in this case, as in others, retired first, and then rose fifty feet or more above its usual level, swamping the boats in the harbor; at Cadiz the wave is said to have reached a height of sixty feet, and it was felt over the greater part of the North Atlantic Ocean, arriving even on our own shores, as at Kinsale in Ireland, where it rushed into the harbor and poured into the market place.

That a great sea wave so produced might have thus arisen in the Persian Gulf is quite within the bounds of possibility, particularly as a zone of the earth's crust, very liable to earthquakes, stretches across the mouth of the gulf near the Ormus Mountains.

But if we are to follow the legend, we must follow it faithfully, and as a result of the most recent investigations it turns out that all the passages which were supposed to refer to an earthquake have been mistranslated. The earthquake is thus put out of court, and we are left with what help we can get from the hurricane, a kind of disturbance which often vies with the earthquake in the destructive nature of the sea waves to which it gives rise.

The Andaman Islands of the East Indies are a center which give birth to some of the most terrific hurricanes in the world. Traveling more or less westward and northward, these whirlwinds sweep over the waters of the Bay of Bengal and raise the sea into waves mountains high, which every now and again rush over the low-lying lands of the Ganges delta, overwhelming the unfortunate inhabitants by myriads. Thus on the night of October 14, 1737, one of these waves, estimated at forty feet in height, suddenly overtook the dwellers by the Ganges and destroyed them to the number of one hundred thousand, or, as some say, three hundred thousand souls. These storms do not, as a rule, travel toward the Persian Gulf, and the North Arabian Sea is singularly free from them; but Suess, tracing the course of the storm of October 24, 1842, suggests that for once, in the case of the deluge, an East Indian storm may have lost its way and blundered, as it were, into the Persian Gulf. The track of this storm of 1842 was as follows: At five o'clock on October 24th it reached Pondicherry; it then slightly altered its direction and veered more to the southwest, and on the 25th at midday it crossed the western Ghats, and then divided into two parts; the south center need not concern us. The northern center traveled northeastward toward the Persian Gulf, and was felt from the Gulf of Aden to Cape Guardafui, wrecking in this tract a number of vessels.

The greatest estimated height of storm waves is from forty to forty-five feet, and, as Suess points out, it must have needed a much greater wave than this to drown out all Mesopotamia up to the Nizir hills. How much greater, is a question we are fortunately able to answer positively, thanks to the accurate measurements made by the engineer Czernik during a survey for a projected railway. The Tigris rises very slowly from its mouth inland, but at Bagdad it is already one hundred and fifty-four feet above the sea level, and at Mansurijah, the lowest point where its tributary Diala Tschai emerges from the Hamrin Mountains, the height is given as two hundred and eighty-five feet; but the land of Nizir lies even still more to the north than this, and the Lower Zab, which cuts through it, can not have a less elevation than six hundred or seven hundred feet. No storm wave of which we have any record, no recorded earthquake wave, nor any combination of the two, approaches even remotely the height that would be required to carry the sea even to Bagdad; while as for the Nizir Mountains, the Valiant Pherson, who "nearly spoilt the flood," might have drank up all the sea water which came there without any assistance from Glenlivat. If we admit that the Tigris valley was ever submerged up to this point and restored to its original condition in the course of fourteen days, we are confronted with a catastrophe not only stupendous in degree, but of a nature beyond our present powers of explanation.

But are we compelled to admit anything of the sort, and would it not be well before doing so to inquire a little more closely into the credentials and character of the Chaldean story? We have seen that the tablets on which it occurs were found in King Assurbanipal's library, and it is fairly certain that they were copied from others much older preserved in the ancient city of Erech, the city of books. It is indeed probable that the tablets in Erech may date from the time of King Khammarubi, or from about 2350 B. C. The tablets present themselves therefore with good recommendations, and we proceed to the character of the story itself. It does not occur alone, but as one chapter out of twelve in a long poem of about three thousand lines, concerning the adventures of a mythical hero named Izdubar or Gizdubar, perhaps the same as Nimrod, that "mighty hunter before the Lord" of biblical story, and plainly the prototype of the Greek Hercules.

The first tablet, containing the first chapter, is incomplete. So far as can be made out, it sets forth the misfortunes of the city of Erech, probably under the oppression of its Elamite enemies, who were so terrible in battle that poor Ishtar, its protecting goddess, "could not lift up her head against the foe."

The second and third introduce Gizdubar, already famous as a hunter, as the hero, who was looked for to deliver the city. His rivals induce Ururu, the mother of the gods, to fashion a strange being, Eabani, half man and half bull, to fight with Gizdubar. This monster comes to Erech, bringing with him a powerful lion, desert-bred, to fight Gizdubar; but the hero succeeds in slaying the lion, and so wins the friendship and esteem of Eabani. In the fourth and fifth tablets the friends encounter and overcome the terrible tyrant Humbaba, whose voice was as "the roaring of the storm, his mouth wickedness, and his breath poison." The sixth tablet, which is well preserved, tells how the hero was beloved of Ishtar. "Be my husband," she says, "and I will be thy wife. I will make thee to ride in a chariot of gold and precious stones, with golden wheels and diamond horns. When thou enterest our house under the pleasant fragrance of the cedar, men shall kiss thy feet. Kings, princes, and lords shall bow down before thee, and bring tribute." Gizdubar, however, is not to be seduced; he repels the advances of the goddess, who then presents herself as a naturally angry woman before her father Anu, and persuades him to frame a divine bull which is to destroy Gizdubar. He and Eabani together slay this bull, however, and the goddess, now terribly incensed, pronounces a terrible curse upon Gizdubar. The seventh tablet is unfortunately missing. The eighth, ninth, and tenth narrate how Gizdubar, suffering under the divine anger, loses his friend Eabani and is smitten with a grievous illness. He journeys to the river's mouth to consult his divine ancestor Sitnapistim. On his way he crosses a desert where "scorpion men" guard the dark path to the "waters of the dead," which separate him from his quest. On the shore of this sea he finds a park of the gods, with wonderful trees bearing precious stones for fruit. After waiting here a long time a ferryman takes him over to the fields of the blessed, where he meets Sitnapistim. He tells his sorrowful tale, and the heart of Sitnapistim is filled with pity; but, alas! neither gods nor men can give him help. In the eleventh tablet Gizdubar inquires of Sitnapistim how he became immortal, and receives in answer the story of the deluge. After its recital Sitnapistim heals Gizdubar of his disease, and gives him the plant of life, its name being "Altho'-a-graybeard-the-man-becomes-young-again." Unfortunately, an evil demon robs him of this on the way home. In the twelfth and last tablet Gizdubar returns to Erech and utters a lament over his lost friend Eabani, whose ghost subsequently appears and recounts the doings of the dead in Hades.

Thus the deluge story is a myth within a myth, containing statements plainly unveracious; and how we are to distinguish in this mass of fiction the true from the false passes the wit of man to conceive. If we say of the deluge part of it that it is a gross exaggeration, the judgment will sound mild, but this is all that is requisite to reduce the catastrophe to commonplace proportions.

Whether Gizdubar ever existed in the flesh or not has been doubted; it is certainly remarkable that each of the chapters of the poem corresponds to one of the signs of the zodiac, and they are arranged in the same order as the signs of the zodiac. A fanciful correspondence is thus drawn between the succession of events in the life of Gizdubar and the yearly course of the sun through the heavens, and it has consequently been maintained that Gizdubar is no other than the sun himself personified. The stages in the life of man find, however, so ready an analogy in the course of the sun, that this conclusion is by no means forced upon us, and we may turn to another identification of more significance in our inquiry. It is that of the Greek story of Heracles with the legend of Gizdubar. Heracles himself is no other than a Greek Gizdubar, the Chaldean Eabani corresponds to the centaur Cheiron, the tyrant Humbaba to the tyrant Geryon, the divine bull to the bull of Crete, the park of the gods to the garden of the Hesperides, the lion slain by Gizdubar to the lion of Nemea which Hercules slew, and finally, just as Gizdubar is ferried across the waters of the dead, so Hercules is taken by Helios in the golden boat of the sun across the ocean.

As the Greeks have borrowed so much of the legend it would be surprising if they had not taken the rest, including the story of the deluge, and accordingly we find the Greeks provided with a legend of the flood, or with more than one, as they appear to have had more than one Heracles; but that which most closely accords with the Chaldean is the flood of Deukalion.

On the other hand, the Egyptians, who had sun stories of their own, did not borrow the legend of Gizdubar, and are silent as to a deluge; a fact of extreme importance when we consider that the Egyptian civilization was contemporaneous with the Chaldean, if not indeed older. The Nile is gentler in its overflowing than the Tigris, so that Egypt did not suffer under the scourge of unexpected floods.

If, finally, we turn to China, also possessed of very ancient historic records, and liable to the destructive deluges of the Yellow River, which have earned for it the designation "The Curse of China," we discover a deluge story of great importance, to which Suess has already called attention. In the third Schû of the Canon of Yao, a monarch who reigned, it is supposed, somewhere about 2357 B. C., and therefore contemporaneous with Khammurabi, we read: The Tî said, "Prince of the Four Mountains, destructive in their overflowings are the waters of the flood. In their wide extension they inclose the mountains and cover the great heights, threatening the heaven with their floods, so that the lower people is unruly and murmur. Where is a capable man whom I can employ this evil to overcome?" Khwan was engaged, but for nine years he labored in vain; a fresh engineer, named Yû, was therefore called in; within eight years he completed great works: he thinned the woods, regulated the streams, dammed them, and opened their mouths, provided the people with food, and acted as a great benefactor to the state.

It is refreshing thus to pass from the ornate deceptions of legend to the sober truth of history; and if the facts on which the Gizdubar legend of the deluge is founded could be expressed in the same simple language, we should probably find it narrating similar events, or events as little calculated to surprise us as those of the straightforward Chinese Schû.

History then fails to furnish evidence of any phenomenon which can be called catastrophic in the geologic sense of the word, and geology has no need to return to the catastrophism of its youth; in becoming evolutional it does not cease to remain essentially uniformitarian.

And the careful foster-mother? She too, as it appears to me, has widened her studies, and must, I should think, recognize with pride the stalwart growth of her early friend. May they be drawn nearer together, and feel the warm glow which is produced by the sympathy of a common love for truth!

SKETCH OF ZADOC THOMPSON.

THE slopes and intervales of the Green Mountains have ever been a home of sterling worth. Much of it has lain modestly hidden unless some compelling occasion called it forth, as the Revolution brought out Ethan Allen and Stark of Bennington. This region has had its workers in science, who, with more generous facilities or a more assertive spirit, could have equaled in prominence many whom the world calls famous. The subject of the present sketch is an example, for he became known in his lifetime only so far as the patient performance of valuable labors of necessity brought him into notice.

Zadoc Thompson was born in Bridgewater, Windsor County, Vt., May 23, 1796. He was the second son of Barnabas Thompson, whose father was one of the early settlers in that part of the country.

His early life was a continual struggle with poverty. Having from childhood a passion for writing and publishing books, he earned part of the expenses of his education in this way. His first publications were almanacs, which he sold traveling about the State on foot. Thompson's Almanack became as famous in Vermont as Robert B. Thomas's in Massachusetts, and shared the honors with the latter publication in adjoining States. Its success was to a large extent due, it is said by those who should know, to a chance remark—it can hardly be called a prediction—which came one day when a clerk, who was at work upon the almanac, found that no weather forecast had been given for July. Prof. Thompson was at the time much absorbed in some investigations, and, when interrupted by the printer's inquiry as to the July weather, hastily replied, "Say, Snow about this time." The printer took him at his word and printed snow as a part of the probable weather for July. Contrary to all expectations or precedent, in July of that year there was in Vermont a fall of snow! This apparently remarkable knowledge of the probabilities of the weather made Prof. Thompson famous as a weather prophet, and greatly increased the sale of his almanacs. It should be added that Prof. Thompson made constant use of such meteorological instruments as he could obtain, and that he was one of the first in his State to study the weather in a careful and scientific manner.

Mr. Thompson was graduated from the University of Vermont in 1823, at the advanced age of twenty-seven years, and immediately turned his attention to making known the natural and civil features and history of his native State to its own inhabitants and to the world beyond its borders, which was the chief occupation of his life. Within a year his first publication in this field, a Gazetteer of Vermont, appeared at Montpelier. His first bound volume was an arithmetic, published in 1826, which had a general sale through the State. While serving as principal of an academy in Canada, he issued a geography and map of Canada for schools, which passed through several editions.

In 1832 Mr. Thompson edited and was the chief contributor to the Green Mountain Repository, a monthly magazine published for about a year at Burlington. In the following year appeared his History of Vermont from its earliest settlement to the close of the year 1832.

Taking up the study of theology and supporting himself in part by teaching in the Vermont Episcopal Institute and elsewhere, he was prepared for orders, and became a deacon in the Protestant Episcopal Church in 1836. He preached from time to time in various parishes of northern Vermont and New York, and usually supplied the pulpit of St. Paul's Church, Burlington, during the illness or absence of the rector. His health not being good enough to allow of his undertaking the labors of a parish, and being a man of "deep and unconquerable modesty of spirit," he never advanced to the priesthood.

His earlier works aroused in him a desire to issue something larger and fuller in the same line, and for many years he industriously collected from various "oldest inhabitants" and scattered records facts relating to the history, geography, and natural resources of Vermont. From 1838 to 1842 he devoted most of his time to putting together these materials and publishing the resulting Natural, Civil, and Statistical History of Vermont. His attainments in natural history were at that time limited, and he obtained considerable assistance in preparing the accounts of the plants and several classes of animals for this book from other New England naturalists. Having made the mammalia quite a specialty, he described these himself.

The undertaking was most thoroughly and conscientiously carried out, and by the time the book was ready for the press all his savings had been expended. At this juncture the Burlington publisher, Mr. Chauncey Goodrich, who was a neighbor and friend of Mr. Thompson, offered to get out the book for him at the usual prices for the labor and materials without any contingent share in the profits, and to wait for payment from the sales of the work. This generous offer was promptly accepted, and the volume, consisting of six hundred and fifty-six closely printed octavo pages, was duly issued. There were three parts to the work, each of which, if printed less compactly, would have made a fair-sized volume. The first was devoted to the natural features and productions of the State; the second was the civil history; and the third was Mr. Thompson's Gazetteer, revised and enlarged. When Mr. Goodrich several times urged him to issue it in three volumes at six dollars instead of one volume at two dollars and fifty cents, and thereby get twice as much profit from each copy, he steadily declined. Having felt the inconvenience of limited means himself, his sympathies were with those in the same position, and he did not deem it right that those who could not afford the higher price should be deprived of a benefit that their richer neighbors enjoyed, even though the lower price would give him but scant return for the labor, time, and money he had expended. On its appearance the General Assembly of Vermont, regarding the work as a benefit to the State, subscribed for a hundred copies and voted five hundred dollars to the author. By this means and the proceeds of other sales he was enabled to cancel his debt to his publisher in little more than a year.

At about this time Mr. Thompson issued a text-book on the Geology and Geography of Vermont, in which his power of clear and concise statement is well exemplified. He found time also to prepare annual astronomical calculations for the Messrs. Waltons, of Montpelier. In 1845 he issued a pamphlet Guide to Lake George and Lake Champlain, with a map and other illustrations.

A State Geological Survey having been authorized by the General Assembly, the Governor in 1845 appointed Prof. Charles B. Adams State Geologist. Prof. Adams chose Mr. Thompson and the Rev. S. R. Hall as his assistants. In one season these two men explored together one hundred and ten townships. The analyses required by the survey were made at New Haven by Denison Olmsted, Jr., until his death in 1846, afterward by Thomas Sterry Hunt. The survey came to an untimely end by the refusal of the General Assembly of 1847–'48 to make an appropriation for preparing its final report. The notes, specimens, and other materials gathered were allowed to lie in boxes at Burlington and Montpelier for about a year. Then, having had a partial sense of the value of these materials impressed upon it, the General Assembly authorized the Governor to appoint some suitable person to get them together and deposit them in the State House. Governor Coolidge appointed Prof. Thompson, and the latter reported the execution of his commission in October, 1849. Many of the field notes were in a peculiarly abbreviated shorthand used by Prof. Adams, and, on his death in 1853, became almost wholly useless.

In 1847 Governor Eaton had appointed Prof. Thompson to carry out a resolution of the General Assembly in regard to international literary and scientific exchanges. He wrote a report of proceedings and instructions, presenting the advantages of the exchange system so clearly as to reflect great credit upon himself and upon his State.

From an address which he delivered in Boston, in 1850, on the invitation of the Boston Society of Natural History, we learn something of the difficulties under which his knowledge of natural science was obtained. "What I have accomplished in the business of natural history," he said, "I have done without any associates engaged in like pursuits, without having any access to collections of specimens, and almost without books." In this address, while showing the difficulties, he at the same time insisted upon the importance of the cultivation of natural history in country places. A habit of observation and comparison of objects, he said, could be acquired quite as readily in the country as in the city. He urged that the study of natural history should be introduced more generally into our colleges and common schools, for the reason that such a study "would refine and improve the moral sensibilities of our people, and sharpen and invigorate their intellectual powers." Prof. Thompson's love for natural history was inborn, and throughout his life amounted to absolute devotion. It was the supreme force in his life. From early childhood until the end, his diligent study of Nature and zeal in collecting facts, and objects to illustrate them, never faltered. He was not only a student of Nature but her ardent and most constant lover. He also enjoyed mathematical studies and was fond of statistics, and these qualities rendered his work in all departments of science more accurate and orderly than it might otherwise have been.

Certain of his friends (his modest worth had made him many of these), knowing his great desire to see the Exhibition of 1851 at London, furnished him the means of making the trip. After an absence of three months, during which he had spent some time in Paris, he returned to his home in Burlington much benefited in spirit and in health. Yielding to repeated solicitation, he published soon after his Journal of a Trip to London, Paris, and the Great Exhibition in 1851, which gave a most realizing impression of what he had seen to those who had not made the trip.

In the ten years following the publication of his History of Vermont, railroads and telegraphs were introduced into the State, and various discoveries in its natural history were made, all of which furnished him material for a valuable supplement of sixty-four pages, issued early in 1853. The General Assembly of this year discovered what a blunder had been made in strangling the geological survey, and passed a bill appointing Prof. Thompson State Naturalist, "to enter upon a thorough prosecution and completion of the geological survey of the State, embracing therein a full and scientific examination and description of its rocks, soils, metals, and minerals; make careful and complete assays and analyses of the same, and prepare the results of his labors for publication under the three following titles, to wit: first, Physical Geography, Scientific Geology and Mineralogy; second, Economical Geology, embracing Botany and Agriculture; third, General Zoölogy of the State." At first he planned to do no more than collate and arrange such material as had been accumulated by his predecessors; but he soon found this very unsatisfactory, and, abandoning this plan, he undertook to go over the whole ground anew. He had for years been unknowingly preparing for just this task, and he threw himself into it with his accustomed energy and devotion, and suspended all other work; but ere long his overtaxed strength gave way, and his last illness was upon him. At first he could not be willing to lay aside a task so congenial, and which he so greatly desired to finish; but soon his naturally quiet and trustful disposition overcame all discontent, and in full acquiescence in the will of the God in whom he had always trusted and whom he had tried to serve, he came to the end in peace, on January 19, 1856. At this time he also held the professorship of Natural History in the University of Vermont, to which he had been appointed in 1852.

His friend for over a score of years, Dr. Thomas M. Brewer, editor of the Boston Atlas, and himself a naturalist of no small ability, thus referred to Prof. Thompson's death: "His loss, both as a citizen and a public man—he has not left his superior in science behind him in his own State—is one of no ordinary character. We have known him long and well; and in speaking of such a loss we know not which most to sympathize with, the family from whom has been taken the upright, devoted, and kind-hearted head, or that larger family of science who have lost an honored and most valuable member. Modest and unassuming, diligent and indefatigable in his scientific pursuits, attentive to all, whether about him or at a distance, and whether friends or strangers, no man will be more missed, not merely in his immediate circle of family and friends, but in that larger sphere of the lovers of natural science, than Zadoc Thompson."

When his death was announced to the Boston Society of Natural History, of which he was a member, Prof. William B. Rogers took occasion to express the high respect in which he had held him as a thorough and persevering worker in geology, saying that he possessed a larger amount of accurate practical knowledge than would have been supposed from his modest and retiring manners, and exhibited a great natural sagacity in those departments of science which he loved.

No account of the life and labors of Prof. Thompson is at all complete without some mention of his wife, for without her aid and sympathy he never could have accomplished what he did. In childhood they roamed the fields together in search of interesting objects, and later, as husband and wife, they pursued with increased enthusiasm the same study of Nature; and long after Mr. Thompson's death his wife continued her observations of animals and plants. Moreover, being a very shrewd and efficient manager in all household matters, she was able to carry the family through financial difficulties which otherwise would have frustrated many of her husband's scientific undertakings. Their home was not only a home, but it was also a museum and a laboratory. It was a very modest little white cottage, surrounded by a profusion of flowers when the season permitted, and inside, every available shelf or stand was crowded with specimens which either had been or were to be carefully studied, while not seldom there were in or about the house pens, cages, or tubs in which were kept many living animals, whose daily life was under closest scrutiny. Mrs. Thompson not only tolerated these inroads upon her housekeeping, but delighted to assist her husband in his work, and really deserves to be considered a colleague in many of his labors.

Personally, Prof. Thompson was tall, angular, of a very quiet and sedate yet very pleasant manner, a man of most amiable and sweet temper, loved by all who knew him, and respected for his sound sense and accurate judgment. Though retiring by nature, he was fond of long chats around the winter hearth with such neighbors as were congenial. Prof. Joseph Torrey was his most intimate friend, being an excellent botanist, and with him Mr. Thompson's intercourse was most delightful. He was simple, almost childlike in his tastes. Naturally somewhat conservative, his training in science had given him an open mind to all new truth. It is not improbable that the sober manner which he usually maintained came from the shadow of death which had long rested upon him. He was affected by organic disease of the heart, which finally ended his life, and for many years, knowing the possibility of sudden death, he did not trust himself far from home alone. Most often his companion was a Mr. Hills, who was draughtsman and engraver of nearly if not quite all the cuts used in his publications.

The museum in the Vermont State House contains about three thousand specimens collected by Prof. Thompson. He was one of the most reliable correspondents of the Smithsonian Institution, and corresponded also with many of the leading naturalists both at home and abroad. His achievements won him a medal from the French Exposition of 1855.

EDITOR'S TABLE.

THE NATURE OF POLITICAL AUTHORITY.

PROF. R. T. ELY, in an article entitled Fundamental Beliefs in my Social Philosophy, contributed to the October Forum, raises the question, "What is the source and sanction of the authority of the state?" "Is the state," he goes on to ask, "a mere aggregate of individuals accomplishing their purpose simply by brute force? Does might make right? If it does, then is not the question between anarchy and its opponents simply a question of superior force? But if might does not make right, what does make right? Has the state an ethical nature? If the state is itself nonethical, can the power which it exercises have an ethical element? But if it is devoid of an ethical element, can it rest upon anything less than mere brute force?" This is rather a long string of questions, and the professor tells us that he will not attempt to answer them; but he observes that if the state is a divine institution and derives its authority from God, "then we have a ground of opposition to anarchy." Otherwise—he evidently means us to infer—our ground is very weak.

It seems to us that this is a good example of the confusing of a comparatively simple matter by the introduction of what Auguste Comte would have called "metaphysical" considerations. Let us take the several questions as they come. "Is the state a mere aggregate of individuals accomplishing their purpose simply by brute force?" Answer: No, the state is an aggregate of individuals whose views in regard to what is a desirable constitution of society are in the main harmonious, and who have no occasion to use brute force except upon a certain limited number of stupid offenders against laws which, in their general operation, make for the good of the community as a whole. "Does might make right?" Answer: No, might does not make right, but it is an excellent thing for giving effect to what the upholders of social order believe to be right. "If it does, then is not the question between anarchy and its opponents simply a question of superior force?" Answer: No, for if might *makes* right (which is the hypothesis), then right as well as might is on the side of the state. "But if might does not make right, what does make right?" Answer: The only way to "make right" is to do right actions. Right is something that can never be more than approximately attained; but we hold that social order is right because it secures, or at least makes possible, the happiness of the great majority of human beings, and deprives none of happiness save those whose happiness involves unhappiness to others. "Has the state an ethical nature?" We wonder whether Prof. Ely stopped to consider just what he meant by this question. "The state" has no character apart from the individuals who represent and carry on its action. If it be asked whether these persons, the legislature, the executive, the judiciary, have ethical aims in view, we may answer that in general they have—that is to say, they make, administer, and interpret laws with a general view to the good of the community and to principles of equity between the individual members thereof. So far as this underlying intention is present, the action of the state is ethical; so far as it is absent, is it nonethical. The obligation to be governed by such an intention is one that rests upon each person having public functions to perform *individually*. He either feels or does not feel individually a sense of duty in connection with his official acts: so far as he does, he helps to make the action of the state ethical; so far as he does not, he deprives it of an ethical character. To lay down the principle that "the state," abstractly considered, "has an ethical nature," is vain for any practical purpose, seeing that the question at once arises, How is that ethical nature to find expression except in the action of individuals, and if these do not carry a sense of duty, or their own "ethical nature," into their public acts, what are you going to do about it?

We suspect, however, that Prof. Ely, in asking this question, really means to ask whether the state has a warrant for undertaking various policies for the simple purpose of "doing good," as the phrase is. If we grant that the state has an ethical nature, he will doubtless infer and ask us to infer that the state should be a knight-errant for the correction of all evils and abuses. From that point of view our answer is: The state is no more and no less ethical than the persons who guide its action, and any ethical nature which it possesses simply represents on a very small scale the ethical nature of the community at large. All this talk about the state and what it could or should do diverts attention from the much more important question of calling into activity the ethical nature of individual citizens. If each citizen can only be persuaded to make himself an ethical element in the fullest sense, the task of government will become much lighter, and many of our social difficulties will completely disappear. On the other hand, if the Government is going to do the ethical business for the people, the outlook is not at all satisfactory: Government will be overburdened, and the ethical nature of the community will not be developed as it otherwise might be; in fact, it will run great risk of suffering partial atrophy.

Finally, we are told that if the state is a divine institution, and its authority comes from God, then we have a good answer to the anarchist; if not, not. The latter is not distinctly stated, but it is distinctly implied. Our answer to this is that "the state" is a divine institution, and derives its authority from God just as much as and no more than the New York Central Railway or any other corporation down to a village baseball club. It may be under righteous or unrighteous control, so may the railway, so may the baseball club. When it enacts dishonest and oppressive tariff laws, it is just as well not to lay too much stress on its divine mandate. On the other hand, when it enacts an honest law for the good of all; when it faithfully carries out its obligations, national or international; when it upholds justice between man and man, we set the seal of our moral approval on its action, but we do not ascribe any special authority to that action on the ground that "the state is a divine institution." We feel instinctively that nothing can be more divine than justice, and when the state succeeds in being just, we simply rejoice that it has been able to approximate to our conception of the divine. The state, in fact, does not, so far as this goes, differ in any respect from the humblest individual citizen who has it in his power to do right or wrong, to place himself in harmony with or in opposition to what he feels to be the will of God.

As to our answer to the anarchist, we need not be so particularly anxious about that. Unless we honestly believe we are in the right in wishing to preserve the existing frame of society, we had better give in to the anarchist and take counsel with him as to how we may remold things "nearer to the heart's desire." If we think we are in the right, we have simply to maintain our position and use what dissuasives we can on the anarchist fraternity. We should certainly be prepared to listen to any arguments they may bring forward that are not of the dynamite order.

Society, we may safely admit, is not perfect; and if the anarchist can point out possible improvements, then he is a helper from whom we should not turn away. But metaphysical views of the nature of state can give no help in any practical problem.

Being convinced by the course of recent events that the public needs professional guides in social affairs, the Society for Education Extension, of Hartford, Conn., has projected a School of Sociology, to be opened in the present autumn. Chester D. Hartranft, D. D., is to be its president, and among the lecturers already secured are Professors John Bascom, Austin Abbott, Otis T. Mason, William Libbey, Jr., William M. Sloane, and William O. Atwater. We have long maintained that definite laws underlie the phenomena of human society, or, in other words, that a science of sociology is possible. We should be glad to see a good institution for research and instruction in this field established, and hope that the undertaking of the Hartford society will meet with all deserved success.

LITERARY NOTICES.

Systematic Science Teaching. By Edward Gardnier Howe. International Education Series, No. 27. New York: D. Appleton & Co., 1894. Pp. 326. Price, $1.50.

This is a book the value of which to the educator, both parent and teacher, it would be difficult to overestimate. To the advanced instructors of to-day the value of science teaching is no longer in question. The book is full of suggestion, and shows the line of investigation adapted to each province of Nature.

Dr. Harris well says, in his preface, that the pupil must get not only the dead results but also the living method — the method of observation and discovery; that the powers of observation are strengthened chiefly by learning to think about what one sees; that seeing only fails to produce that cultivation of observation that the capacity for scientific observation produces—the act of recognizing, not the mere seeing, giving scientific knowledge. He goes on to say: "Science leads to invention, and invention leads to the demand for a scientifically educated class of laborers. Education emancipates the laborer from the deadening effects of repetition and habit, the monotony of mere mechanical toil, and opens to him a vista of new inventions and more useful combinations." The necessity is suggested for the introduction of the results and methods of science into the elementary schools as early as possible, in view of their influence upon civilization.

Mr. Howe's work is very carefully graded, and he insures the constant interest of the pupil by a happy selection of objects from Nature. The most valuable feature, however, of this work is the detailed hints and directions to the teacher and pupil, that will secure correct and accurate habits of scientific observation.

The results of this systematic teaching of science have been exceedingly satisfactory. Interest has rarely flagged, and the senses have been developed to a surprising degree; the hand has been trained in the art of experiment, and the mental powers have made a steady and healthy growth. An exactness and freedom of expression have been attained which is the truest index of a mind full of observed facts and trained to the thoughtful consideration of matters presented. The advanced pupil has gone to the study of books with ease and profit, but the work has reached deeper and further; the inborn love of childhood for birds, flowers, and pretty stones has quickly responded to wise encouragement and become the present source of much happiness, and this of the purest sort. Incidentally tending to keep out low pleasures, it has been in many cases the prelude to the recreations of mature life.

That with the pleasurable acquiring of much useful knowledge the sense can be quickened, the mental powers developed, and a loving interest in ever-present and pure things be fostered, which in mature life shall render us in a great degree independent of time, place, or man's device for needed recreation, is certainly all that need be said in its favor.

In encouraging the teacher to patience and advising the school board to generosity in regard to this work, Mr. Howe says, "If the children are learning 'to *think* to a conclusion,' if they are becoming *observant*, if they are *interested* in their school and go home full of the things they have seen and done, do not criticise because those 'things' are 'bugs and weeds,' nor complain because more words are not learned, or arithmetical problems solved. The 'words' may be meaningless and problems mechanical, but active, willing seeing and thinking is in the line of all that is desirable."

Tenth Annual Report of the Bureau of Ethnology. To the Secretary of the Smithsonian Institution, 1888-'89. Pp. 822. Eleventh Annual Report, 1889-'90. Pp. 553. By J. W. Powell, Director. Washington: Government Printing Office.

The work of this bureau is substantially continuous, so that these two noble reports may be treated as one. In this work the lines of investigation which have appeared from time to time the most useful or the most pressing have been confided to persons trained in or known to be specially adapted to their pursuit. During the period covered by these reports, the work of exploring the mounds of the eastern United States was carried on under the superintendence of Dr. Cyrus Thomas; during the latter part of the time Dr. Thomas was engaged in preparing a final report on his work. Colonel Garrick Mallery visited Maine, Nova Scotia, and New Brunswick in studying the pictographs of the Abnaki and Micmac Indians. W. J. Hoffman gave his attention to pictographs, petroglyphs, and birch-bark records in the Northwest, and to the records and ceremonies of the Midē'wiwin or Grand Medicine Society of the Ojibwas, an order of shamans professing the power to prophesy, to cure disease, and to confer success in the chase. H. W. Henshaw and Jeremiah Curtin collected vocabularies and myths on the Pacific coast, and did other linguistic work. James Mooney investigated the customs, languages, etc., of the Cherokees at their reservation in North Carolina, made a collection of the plants used by them in medicine, and studied their antiquities. Victor Mindeleff explored ruins and collected potteries in Arizona. The Rev. J. Owen Dorsey prepared many papers embodying the results of previous studies. A. S. Gatschett completed his Klamath Grammar, and embodied in literary form the fruits of his other investigations among the Klamath Indians. The illustrations for the publications of the bureau were edited by W. H. Holmes, who was also active in his studies of aboriginal archæology. The publications of the bureau for the two years include the Bibliographies of the Iroquoian and Muskhogean Languages, by J. C. Pilling; The Problem of the Ohio Mounds, by Cyrus Thomas; Textile Fabrics of Ancient Peru, Ancient Art of the Province of Chiriqui, Colombia, and A Study of the Textile Art and its Relation to the Development of Form and Ornament, by W. H. Holmes; Aids to the Study of the Maya Codices, and the Circular, Square, and Octagonal Earthworks of Ohio, by Cyrus Thomas; Osage Traditions, by the Rev. J. Owen Dorsey; and the Central Eskimo, by Dr. Franz Boas. The volume containing the tenth report is nearly all occupied with the elaborate work, richly illustrated, of Colonel Garrick Mallery, on the Picture Writing of the American Indians. The volume of the eleventh report contains papers on The Sia (Pueblo), by Matilda Coxe Stevenson; Ethnology of the Ungava District, by Lucien M. Turner; and A Study of Siouan Cults, by J. Owen Dorsey.

School Management. By Emerson E. White, A. M., LL. D. American Book Company. Pp. 320. Price, $1.

The subject emphasized in this volume is character training. The author considers that the proper end of school government is to prepare pupils for self-control and self-direction in life. Good order and application in study are essential conditions in attaining this result, but must not be substituted for the goal itself. From this it follows that the well-governed school depends more upon what the teacher is than what his method may be. If only one law were written above the door of every American schoolroom it ought to be, No man or woman shall enter here as teacher whose life is not a good model for the young to copy.

The elements of governing power are described as fresh knowledge, skill in instruction, heart-power, self-control, present-mindedness, wisdom in common things, and positive moral character. The best qualified teacher, however, may fail if his methods of instruction or discipline are brought into disrepute through official interference, or if his surroundings are cramped and unhealthful.

The mechanical means of government suggested are the proper seating of pupils, a good programme, a self-regulating system, and as few rules as possible. Under the head of moral training is embraced the education of the will, school incentives, punishment, and the principles of direct ethical instruction. Thirty-two topics in morals and manners are named and the material given for fifteen lessons in the primary grades and for sixteen in higher classes. A discussion of the function of religion in the school is given at the close. In this it is held that religious motives may be rightfully introduced in order to render moral teaching efficient.

Although the ethical value of several of the stories may be questioned, the fundamental lessons are such as are greatly needed in public schools, and in the hands of an earnest teacher the book can not fail to be a means of moral uplifting.

The Orthoëpist. By Alfred Ayres. New York: D. Appleton & Co. Pp. 292. Price, $1.

This is a revised edition of a little manual upon pronunciation that appeared fourteen years ago. A thousand words that are often mispronounced have been added, and among these are many foreign names which betray the unlettered. We are told to avoid saying *ŏl'wuz* for *al-wāys*, *sparrowgrass* for *as-par'a-gus*, and *be-cŏz* for *be-cause*. Educated people may pass by the ranks where these vulgarisms are enrolled and meet foreign recruits of doubtful address.

Although the author presents *chamois* as *shăm'wa* and *haricot* as *ă'rē'kō'*, he states, "It is well to make one's pronunciation when speaking English as English as permissible." From this we find that Mr. Ayres has his little linguistic leanings, since the word singled out for Anglicizing is *cicerone*, given as *sis-e-róne*, while *massage*, which in the International is English *mass'-age*, appears here only as *ma-sazh'*. Chemical terms are variously marked. The author favors *quī-nīne*, and says of *iodine*, "My impression is that long *i* will ultimately prevail." *Bromide* and *chloride* are marked both short and long, from which it may be judged that Mr. Ayres is unfamiliar with the late decree of chemists making the *i* short, and even dropping the final *e* in spelling. Among English words boatswain is given as *bosn*, a colloquialism according to the International, while *bellows* and *strew* are preferred as *bĕl-lus* and *strō*. In regard to his own profession, he tells us that any pronunciation but *or'thoëpy* and *or'thoëpist* sounds inelegant to him. Unhappily, we know the Greek progenitor of the word is ὀρθοέπεια, and that the French with loyal grace make this *orthoépie*. In English too we remember *or-thog'ra-phy* and *orthog'a-my* from the same root ὀρθός, and we can not understand why there should be a lack of elegance in accenting the word "correct" correctly according to its descent.

But probably the whole trouble is with us; we are asking that the orthoëpist should verify his decisions in a scientific manner by some rule of consistency or etymology, whereas his art is in an inchoate state, and this little book helps us to realize its struggle for development.

A System of Lucid Shorthand. Devised by William George Spencer. With a Prefatory Note by Herbert Spencer. New York: D. Appleton & Co. Pp. 30. Price, 50 cents.

Those who have examined his Inventional Geometry could not fail to be convinced that W. G. Spencer was a man of no small mental caliber. This conviction will be strengthened by a glance at the production before us. The system of shorthand which it embodies was devised by him in the course of a few years preceding 1833. The present exposition was drawn up by his son, Herbert Spencer, in 1843, and is now printed unchanged, except by the addition of four specimens. In his prefatory note Mr. Herbert Spencer states that he has been impelled to publish the system at this late day "from the conviction, long since formed and still unshaken, that the Lucid Shorthand ought to replace ordinary writing. Possessing, as it does, not equal legibility but greater legibility (the distinctions among the symbols being so much more marked), and having at the same time the brevity which shorthands in general possess, the use of it for all purposes would be immensely advantageous to mankind." A letter from Herbert Spencer to his father, and one from his father to him, both written early in 1843, are reproduced in photoprint, as specimens of continuous writing by this system.

Wealth against Commonwealth. By Henry Demarest Lloyd. New York: Harper & Brothers. Pp. 563. Price, $2.50.

The larger part of this book is taken up with the detailed history of the Standard Oil Trust, the facts being cited from records of courts and from the testimony presented to congressional and State legislative committees. While Mr. Lloyd has written an arraignment, and is at no pains to conceal his hatred of this trust, he offers a mass of evidence which in volume and significance is fairly startling. Abating all that in his book is due to the heat of a prosecuting attorney, enough remains to show that aggregated wealth in this country has been and is grossly abused to the public oppression. The vast power of the Standard Oil Trust began in the dishonesty of railroad managers, who, interested in the dividends of the trust, betrayed their own employers, the stockholders in the railroads, and not only carried oil for the trust at specially low rates, but at times paid to the trust the cash taken from its rivals in the shape of exorbitant rates. Advantaged by such plunder as this, the progress of the trust to colossal wealth was rapid; competition with it became impossible; and, passing from the carriage and refining of oil to production, it is now in possession of the principal oil fields of America. With the true genius of conquest it soon discarded the railroads for pipe lines, building these with the capital placed in its coffers by the railroads themselves; and if, as the more economical mode of transportation, the pipe lines were inevitable, it is still true that their introduction was hastened by the suicidal treachery of the railroad chieftains.

It is an everyday assumption that direct pecuniary interest is an efficient check upon the wastes and frauds of servants. This assumption is contradicted in every page of the history of the Standard Oil Trust. Through supineness or through the bribery of leading representatives the stockholders of the railroads concerned have been absolutely indifferent to the wholesale and repeatedly exposed theft of their property. In two notable instances—in Columbus, Miss., and in Toledo, Ohio—the communities withstood the trust manfully and succeeded. These two cases are the only ones of importance where, by trusting each other, the members of American communities have managed to preserve industrial freedom threatened by the trust.

Mr. Lloyd has no remedy to suggest for the abuses he describes with so much passionate force. He looks only to arousing public indignation by a simple recital of the facts.

A Journey in Other Worlds. By John Jacob Astor. New York: D. Appleton & Co. Pp. 476. Price, $1.50.

There are always some members of a community who, like Grant Allen, prefer their science dry; but there are also others, it is impossible to judge how large this class may be, that like scientific truths flavored and put up in palatable packages. To please the latter is manifestly the purpose of this book. The aim to arouse interest in the wonders of Nature is a worthy one, and, on Jesuitical principles, it may be allowable to give hypodermic injections of science, but the *sine qua non* of all this is that pure science only should be thus instilled, for if facts be diluted with flights of fancy the recipient may in the end fail to recognize what is truth and what is not.

In the romance before us we are introduced to the world in the year 2000, and to the office of a company whose business it is to straighten the axis of the earth. This it endeavors to do by shifting the superfluous weight of water from the pole nearest the sea to the one leaving it. The Arctic Ocean is alternately pumped out and replenished, the power being furnished by dynamos at Niagara and the Bay of Fundy. On the Antarctic continent the crust is thin, so energy is obtained from sunken boilers which supply superheated steam from the earth's interior.

Several friends "tired of being stuck to this cosmical speck with its monotonous ocean, leaden sky, and single moon," attempt a journey to Jupiter in the Callisto, a cylindrical car made with double sides of glucinum. It is protected against the intense cold of space by an interlining of mineral wool and charged with *apergy*, the opposite of gravitation. It is consequently repelled from the earth's surface until attracted by Mars and Jupiter, when the charge is tempered to prevent annihilation. The average speed of the ship is three hundred and eighty miles a second.

The celestial voyage is an interesting lesson in astronomy. The travelers enjoy a near view of our moon, go within ten miles of the satellites of Mars, pass through the nucleus of a comet, approach various asteroids, and finally, in a little short of twelve days, land upon Jupiter. The state of development there corresponds to the Carboniferous age upon earth. The explorers breakfast upon mammoth, while all about them are known and unknown monsters, turtles, tortoises, and jellyfish. The flowers through contraction of their fibers sing at sunset and attract the birds; but gigantic ants thirty feet long trouble the newcomers, and after a brief survey of Jupiter they depart for Saturn. There they meet spirits who materialize and tell them of many unknown laws of Nature, explaining the process of building a body from the elements. Through the services of one of these, Ayrault visits the earth in spirit form, and concludes that he would rather resume his terrestrial shape and return to our insignificant planet. Shortly after, the Callisto leaves Saturn and the adventurers are restored to earth.

The book is well illustrated, and perchance may prove to be a bypath to science.

Law and Theory in Chemistry. By Douglas Carnegie, M. A. London and New York: Longmans, Green & Co. Pp. 222. Price, $1.50.

This book contains the substance of a course of lectures delivered before an audience of teachers of elementary chemistry in a summer school at Colorado Springs. Seven subjects are treated, namely: The birth of scientific chemistry, the phlogistic period, chemical classification, the atomic theory, kinds of compounds, molecular architecture, and chemical equilibrium. Obviously the volume is not a complete treatise on chemical theory or any division of it, and the author offers it as a "companion book" for students who wish "to recapitulate and coordinate the more important principles of chemistry before proceeding to more detailed and advanced works." The author has selected for attention those essential topics which are treated inadequately or not at all in current text-books, or which present especial difficulties to the student. He has aimed to show these topics in their proper perspective, and to point out the trend of modern research with respect to them.

A Dictionary of Electrical Words, Terms, and Phrases. By Edwin J. Houston, A. M., Ph. D. Third edition. New York: The W. J. Johnston Company, Limited. Pp. 667. Price, $5.

If a special dictionary is needed for any branch of science it certainly is for electricity. Electrical matters have a side of interest for the scientist, the business man, the mechanic, and for numerous users of electrical appliances. Moreover, the phenomena of electricity are so manifold and so peculiar, and the apparatus for exhibiting or utilizing them exists in such great variety, that a large vocabulary of electrical terms has necessarily arisen. This vocabulary, furthermore, is rapidly growing with the growth of electrical science, so that it can not be mastered without competent assistance. Such assistance Prof. Houston undertook to supply in 1889, when the first edition of this dictionary was issued. He and his publishers have spared no pains to keep up with the growth of the electrical vocabulary since that time, by issuing a second and a third enlarged edition. The present edition, which follows the second after an interval of scarcely two years, has been increased by twenty per cent, the additions being inserted as an appendix. Prof. Houston's dictionary deserves the term cyclopedic, for not only are the words and phrases carefully defined, but the nature or construction of the thing defined and the electrical principles applying to it are set forth, while a great many pieces of apparatus are figured, and many processes are illustrated by diagrams. There are five hundred and eighty-two illustrations in the volume, and over six thousand words, terms, and phrases are defined. Where there are several possible catch-words in a phrase, cross-references from the others to the one under which the phrase is defined are liberally inserted. The mechanical execution of the book is of a high grade.

The Evolution of Woman. By Eliza Burt Gamble. New York: G. P. Putnam's Sons. Pp. 356. Price, $1.50.

This work shows considerable research and careful collating of testimony, but is much stronger historically than scientifically. The title is a misnomer. Not even an attempt is made to show the evolution of woman, or of the special aptitudes with which the author endows her. When once she appears upon the scene her development is dropped and only her relationship with man is discussed. The book might be more aptly called The Rise and Fall of Woman, with a Prophecy of her Renaissance. Beginning with an account of the earliest forms of life and proceeding to sex differentiation, the author attempts to prove that the female organization is generally superior to the male throughout the organic world. Among bees, aphides, and tadpoles it has been noted that abundant nutrition, light, and moisture result in females, while unfavorable conditions give rise to males. Among plants staminate flowers open first, and "the larch bears female blossoms in its luxurious stage; but as soon as its vigor is lost, male flowers appear." In the human race, more boys are born after epidemics, wars, and famine. The masculine element is, however, not only conditioned upon starvation, but cases of reversion and abnormities are much more numerous with men, while their liability to defective sight and color-blindness indicates that the male power of vision is deteriorating. The author denies that the earlier races of men lived in promiscuity and lawlessness, and deems it more probable that, as among birds and mammals, the females were courted and held in honor. Subsequently kinship was reckoned through the mother and a system of matriarchy established. The prevalence of the gens and early supremacy of woman is attested by the feminine names given to tribes and countries as well as by customs and allusions in historic periods. The author has bestowed great care upon this part of her argument, and it furnishes a plausible explanation of wife-capture and divers obscure wedding rites.

The origin of marriage is described in no gentle terms, the existence of love being ignored. The early Grecian state is well depicted, and an excellent picture is given of Spartan and Athenian women. The change in the position of woman from her status under early Roman law to that under the Antonines, when the influence of Stoic philosophy was felt, is also well brought out. With the conclusion as well as with various assertions scattered throughout the book it is impossible to agree. Some are contrary to observed and verified facts, and one premise has neither scientific authority to support it nor any evidence furnished in its favor—i. e., that the higher faculties are transmitted through the female. It may safely be said that there is no embryologist or biologist so rash as to claim that one parent transmits certain qualities exclusively. Neither would any student of human nature affirm that passion or affection was monopolized by either sex. As to maternal love, we do not know whether or not it is "divine, uncreated," but we do know that paternal love is also a primary instinct, not only strong in mankind, but found among birds and fishes. All parental love, however, is a consequent, and it may be noticed that hyperexaltation of it often follows thwarting or lack of sexual love which is its natural antecedent.

Twelfth Annual Report of the United States Geological Survey, 1890–'91. By J. W. Powell, Director. Part I, Geology, pp. 675, with Map; Part II, Irrigation, pp. 576. Washington: Government Printing Office.

During the year covered by the geological report topographical work was carried on by the survey in twenty-seven States and Territories, and an area of 44,100 square miles was surveyed and mapped. Geological work went on on the two lines of the areal distribution of formations and of the study in field and office of various problems in rock structure and history. New work was instituted upon the mineral phosphates of Florida, and in co-operation of the State and national surveys in New Jersey. Paleontological work was carried on on the two lines of the identification and correlation of geological formations by the organic remains contained in them, and of the study, from a biological point of view, of the faunas and floras contained in the rock for the purpose of obtaining a critical knowledge of the genera and species, and of the evolution of life and its relations to the environment during geological time. In the division of chemistry and physics a series of valuable measures of earth temperatures was obtained in a dry well four thousand five hundred feet deep at Wheeling, W. Va. Accompanying the report are papers on the Origin and Nature of Soils, by Prof. Shaler; the Lafayette Formation (or the Atlantic Coastal Plain), by W J McGee; the North American Continent during Cambrian Time, by C. D. Walcott; and the Eruptive Rocks of Electric Peak and Sepulchre Mountain, Yellowstone National Park, by J. P. Iddings.

The irrigation survey embraces two divisions of primary importance, and a third, of more immediate apparent utility, dependent upon them. First is the systematic mapping of the arid regions; the second division consists of measurements of the amount of water flowing in the most important streams and computations of the quantity available each day of the year, either for immediate irrigation or for storage purposes; and the third division consists of engineering examinations of such localities as the knowledge of the topography and of the water supply seemed to indicate as favorable for great irrigation developments. The results of the third year's work of the survey, except the topographical maps which are issued from time to time, are shown in this report, which gives a description of 147 reservoir sites surveyed and reported for segregation, with the hydrographical data, fully illustrated by diagrams. The report is accompanied by a description, by Mr. Herbert M. Wilson, of the irrigation works of India as a practical example of irrigation engineering. The total area of land segregated for the 147 reservoirs—33 in California, 46 in Colorado, 27 in Montana, 39 in New Mexico, and 2 in Nevada—is 165,932 acres, which will afford a water surface, should all the reservoirs be filled to the height designated in the segregations, of 108,350 acres, and would be capable of supplying about a million and a half acres of cultivated land. A caution is given to the effect that the oscillations of water supply from year to year are so great that measurements made in any one year must be looked upon with distrust if large interests are at stake.

Race and Language. By André Lefèvre, Professor in the Anthropological School, Paris. The International Scientific Series, Volume LXXII. New York: D. Appleton & Co. Pp. 424. Price, $1.50.

Wherever the several races of man have spread they have carried their respective languages, so that discoveries concerning the distribution of peoples throw light upon the history of language and *vice versa*. Hence there is much advantage in considering race and language together as is done in this book. The author finds in the history of language abundant traces of evolution, starting from inarticulate cries and passing through the syllabic, agglutinative, and inflected stages to the highest stage—the analytic. Certain languages have stopped on the lower planes of development and the people who speak them are, for the most part, those who have not gone forward in civilization nor spread out from their early homes over other lands. Thus, while inflected languages, and especially the Indo-European family, have been widely diffused, the agglutinative tongues have retreated to the borders of the civilized world. Taking up each class of languages in turn, the author passes in review the monosyllabic group of the extreme East, the agglutinative idioms of Central and Southern Asia, the Malayo-Polynesian and the African languages, telling something about the peoples by whom each is employed. The literature, rudimentary in several cases, of each group is also described. Thus we learn that the genius of the Malay is less suited to moral treatises than to tales and legendary histories. The most original contribution of the people of the Sunda Islands to literature is their popular poetry, and their kinsmen, the Polynesians, share their gift of poetical improvisation. After the African a class of agglutinative languages which the author calls polysynthetic is discussed. This class includes Basque and Eskimo, Algonkin and Iroquois, Nahuatl and Ketchua.

Passing to inflected and analytic tongues, the history of the Semites and the Indo-Europeans and their several languages is sketched. The rest of the volume—seven chapters—is devoted to a more detailed survey of the Indo-European family, its roots, parts of speech, compounds, and its phonetics being separately discussed. In the closing chapter the chief events in the history of the English and French languages are noted.

Practical Lessons in Physical Measurement. By Alfred Earl, M. A. London and New York: Macmillan & Co. Pp. 350. Price, $1.25 net.

Believing that a training in physical measurement is the most solid basis of scientific knowledge, the author has prepared this book as a laboratory manual for an introductory course of study in science. It is devoted to simple measurements of length, mass, and time, and care has been taken to make the course logically progressive. The author hopes also that the book may serve in some degree to bridge over the space between the laboratory and other class rooms by acting as a "practical arithmetic," and to some extent as a "practical grammar." A large number of exercises on each variety of measurement are given, and the general character of the course is promising for thorough results.

In *The Care and Feeding of Children* (Appleton & Co., 50 cents) *Dr. Emmett Holt* offers a guide to mothers and nurses in the form of a catechism. The questions and answers were first prepared for the instruction of nursery maids, and pertain to the proper oversight of babies from a few days old to as many years. The directions have the merit of precision and of brevity; and, while many of the precautions are needless for healthy children, no harm can come in any case from following the rules given for infants over a year old.

As usual with books of its kind, the importance of rearing babies naturally is not sufficiently emphasized, and several suggestions tend to defeat such nurture. Patented foods are, however, rigorously condemned with reason, and this is perhaps more than might be expected, even of a doctor, in an artificial age.

The American Historical Register is a new periodical, begun with the September number, 1894, as a monthly gazette of the patriotic societies of our country, with *Charles H. Browning* as editor in chief and a number of men and women representing the patriotic societies as associate editors. It is intended to be generally historical, biographical, and genealogical in its scope, and to be a literary exchange and repository for American historical students. The first number contains an account of the work of the Association for the Preservation of Virginia Antiquities, and articles on the Hillegas family, the Daughters of Liberty; Major William Dyce, of New York; Stories of Colonial Families; General James Taylor, of Kentucky; General William Henry Harrison, Major George Croghan, and the Medal of Honor Legion. (Published at Philadelphia.)

A Laboratory Manual of Physics and Applied Electricity has been arranged and edited by Prof. *Edward L. Nichols*, from his own work and that of his associates in the department of physics in Cornell University, to supply in some measure the needs of a modern laboratory, in which the existing manuals of physics have been found inadequate. The author has thought best in it to encourage continual reference by the student to other works and to original sources rather than to provide a complete and sufficient source of information. The first volume, now before us, embraces a junior course in general physics, and has been especially prepared by Ernest Merritt and Frederick J. Rogers. It is the outgrowth of a system of junior instruction that has been gradually developed during a quarter of a century, and affords explicit directions, together with demonstrations and occasional elementary statements of principles. (Published by Macmillan & Co. Price, $3.)

The fifth *Report of the Missouri Botanical Garden*, for 1893, represents the financial condition of the trust as sound and the garden as kept in good condition. The trustees are able to carry forward a surplus of $14,649. The additions to the herbarium during the year consisted mainly of current American collections. As now arranged, the herbarium contains the Engelmann collection of 98,000 specimens of all groups; the general herbarium of higher plants, 108,000 specimens;

and the collection of thallophytes, 16,420 specimens, making in all about 222,420 specimens. It also has received considerable collections of wood wedges, thin veneers of woods mounted as transparencies, and the set, so far as issued, of Prof. Nördlinger's sections. The scientific papers published in the report comprise a study of the Venation of Willows, by Dr. N. M. Glatfelter; Material for a Monograph on the Tan Woods, by J. Christian Bay; The Sugar Maples, with a winter synopsis of all North American Maples, by Dr. Trelease; Notes on a List of Plants collected in Southeastern Missouri, by B. F. Bush; and some papers of a more special and technical character by Dr. Trelease and J. C. Whitten.

A posthumous work by M. *A. de Quatrefages*, entitled *Les Émules de Darwin* (the Rivals of Darwin), is published by Félix Alcan, Paris, in two volumes. In it the learned author, after examining the work of Darwin and his French predecessors, passes in review the conceptions of those who were his rivals—or perhaps we might better say his co-workers—in bringing the new doctrines to the attention of naturalists, or in trying to perfect the doctrine of the master. These *émules* are Alfred Russel Wallace, M. Naudin, Mr. Romanes, Carl Vogt, Felippi, Haeckel, Huxley, Owen, Mivart, Gubler and Koelliker, D'Omalius d'Halloy, and Erasmus Darwin, of whose work full reviews and as "impartial as possible" are given. From this examination the author receives but one impression—that of our impotence to resolve the great problem which so many eminent men have attacked in vain. This review is preceded by a preface by M. Edmond Perrier, in which the work of Quatrefages is summarized at length, and by a eulogy or address on his life and labors, delivered by M. E. T. Hamy at the opening of the course in anthropology of the Museum of Natural History, Paris, in May, 1892. These biographical notices occupy about half of the first volume.

The *Annual Report of the Unit d States National Museum* for the year ending June 30, 1892, gives the number of specimens in the collections as at that time 3,223,941, showing that in ten years from what was practically the date of occupancy of the museum building the collections had increased sixteen fold. The institution is crowded for space, and will soon be compelled, unless it is relieved, to discourage rather than seek additions. It has already lost several large and important collections on this account. Besides the reports of the assistant secretary in charge, Dr. G. Brown Goode, and of the curators of the several departments, the volume contains papers on Japanese Woodcutting and Woodcut Printing, by T. Tokuno; the Relation of Biology to Geological Investigation, by Charles A. White; Scientific Taxidermy for Museums, by Dr. R. W. Shufeldt; The Shofar, by Cyrus Adler; The Crump Burial Cave, by Frank Burns; Minute Stone Implements from India, by Thomas Wilson; and Comparative Oölogy of North American Birds, by Dr. Shufeldt, with a bibliography and list of accessions.

In *A Study of Certain Figures in a Maya Codex*, Mr. *J. Walter Fewkes* takes up a peculiar figure in the Codex Cartesianus, which is known as that of the "long-nosed god," and inquires into its meaning. A relationship is traced with the rain god, and certain features in the arrangement of the figures are supposed to represent the four world-quarter symbols.

The students of Leland Stanford Junior University should have a thoroughly intelligent appreciation of the functions of law and development in Nature if they properly digest the course of lectures on *Factors in Organic Evolution* given by President *Jordan* with the assistance of some of the other professors. This we can infer from the syllabus, which comes to us as a volume of one hundred and forty-nine pages printed on one side of the paper, and gives the subheads treated in each of the fifty-eight lectures. The scope of the course may be gathered from the following subjects of some of the lectures: The Unrolling of the Universe; Heredity: the Great Conservative Force in Evolution; The Meaning of Sex; Ontogeny and Phylogeny; The Origin of the Eye; Law of Self-activity; Evolution of Plants; The Way out of Pessimism; The Fool-killer and his Mission; The Evolution of the Idea of God; and The Evolution of the Common Man. A list of books recommended for reading is added.

The eleventh volume of the *Bulletin of the United States Fish Commission* for 1891 contains papers on A Reconnaissance of the

Streams and Lakes of Western Montana and Northwestern Wyoming, by Barton W. Evermann; a report of Investigations made in Texas in 1891, by the same author; A Statistical Report on the Fisheries of the Gulf States, by J. W. Collins and Hugh M. Smith; Report on a Collection of Fishes from the Albemarle Region of North Carolina, by Hugh M. Smith; The Spawning Habits of the Shad, by S. G. Worth; A Preliminary Report on the Aquatic Invertebrate Fauna of the Yellowstone National Park, Wyoming, and the Flathead Region of Montana, by S. A. Forbes; Notes on a Collection of Fishes from the Southern Tributaries of the Cumberland River in Kentucky and Tennessee, by Philip H. Kirsch; Report on the Fisheries of the South Atlantic States, by Hugh M. Smith; Report on the European Methods of Oyster Culture, by Bashford Dean; and The Classification of the Myxosporidia, a group of protozoan parasites infesting fishes, by R. R. Gurley.

PUBLICATIONS RECEIVED.

Agricultural Experiment Stations. Bulletins Michigan: Cultivated Raspberries. Pp. 75.—Nortn Dakota Weather and Crop Service, August, 1894. Pp. 15.—Nebraska. Pp. 30.

American Historical Register No. 2. Monthly, Philadelphia. Pp. 88. 35 cents. $3 a year.

Ashley, John T., Brooklyn, N. Y. Hebrew Influence upon Civilization. Pp. 72.

Balfour, G. W. The Senile Heart; its Symptoms, Sequelæ, and Treatment. New York: Macmillan & Co. Pp. 100. $1.50.

Bass, Florence. Nature Stories for Young Readers. Animal Life. Boston: D. C. Heath & Co. Pp. 172. 35 cents.

Bradford, E. H., M. D., and Lovett, R. W., M. D. Distraction in Treatment of Hip Disease. Pp. 20. with Plate.

Bread from Stones. A New and Rational System of Land Fertilization and Physical Regeneration. Philadelphia: A. J. Tafel. Pp. 135. 25 cents.

Branner, J. C., State Geologist. Annual Report of the Geological Survey of Arkansas for 1891, Vol. I; do. for 1892, Vol. II. Pp. 349, with Map, and pp. 207.

Call, R. Ellsworth. On the Induration of Certain Tertiary Sandstones of Northeastern Arkansas. Pp. 6, with Plate.—A Contribution to a Knowledge of Indiana Mollusca. Pp. 20.

Chute, H. N. Physical Laboratory Manual. Boston: D. C. Heath & Co. Pp. 213. 80 cents

Committee on Finance, United States Senate. Replies to Tariff Inquiries. Fifty-two papers.

Conway, M. D., Editor. The Writings of Thomas Paine. Vol. II. New York: G. P. Putnam's Sons. Pp. 523. $2.50.

Cronise, Adelbert, Rochester, N. Y. The Pitch Lake of Trinidad. Pp. 6, with Plate.

Cuadrado, Gaston Alonso. La Ley de la Selectión natural en la Lucha por la Existencia (The Law of Natural Selection in the Struggle for Existence). Habana. Pp. 80.

Dean, Bashford. A New Cladodont (Fossil Shark) from the Ohio Waverley. Pp. 5, with Plate.

English, George L., & Co. Catalogue of Minerals. Sixteenth edition. New York. Pp. 124

Foster, Burnside, M. D. Rational Medicine and Pharmacy. Pp. 38.—The Bubo Plague in China. Pp. 7. St. Paul, Minn.

Foster, Horatio A. Central Station Bookkeeping. New York: W. J. Johntson Company, Limited. Pp. 159.

Franklin Institute, Philadelphia. Announcement and Programme of Lectures, 1894-'95. Pp. 22.

Freer, Paul C. Descriptive Inorganic Chemistry. Boston: Allyn & Bacon. Pp. 550.

Gannett, Henry. A Manual of Topographic Methods U. S. Geological Survey. Pp. 300, with Plates.

Goler, G. W., M. D. Diphtheria: How is it Propagated? Pp. 7.

Halsted, Byron G. Report of the Botanical Department of the New Jersey Agricultural College Experiment Station. Pp. 150.

Hinrichs, G. D. The True Atomic Weights of the Chemical Elements and the Unity of Matter. Prospectus.

Hollick, Arthur. Fossil Salvinia. Pp. 5, with Plate

Hopkins, W. J. Preparatory Physics. New York: Longmans, Green & Co. Pp. 147.

Howe, E. G. Systematic Science Teaching. New York: D. Appleton & Co. Pp. 326. $1.50.

Illinois Factory Inspector's Report. Smallpox in the Tenement-house Sweat-shops of Chicago. Pp. 57.

Irving, R. D., and Van Hise, C. R. The Penokee Iron-bearing Series of Michigan and Wisconsin. U. S. Geological Survey. Pp. 534, with Plates.

Jenkins, B. G. Tellustria. A Method for Determining Astronomically the Variations in the Temperature and Pressure of the Atmosphere. London: R. Morgan. Pp. 22, with Plate. 2 shillings.

Lee, Fitzhugh. General Lee. (Great Commanders' Series.) New York: D. Appleton & Co. Pp. 433. $1.50.

Linnæan Society of New York. Abstract of Proceedings for the Year ending March 27, 1894. With Two Papers. Pp. 104.

Locy, Prof. W. A. Metameric Segmentation in the Medullary Folds and Embryonic Rim. Pp. 20.—The Mid-brain and the Accessory Optic Vesicles. Pp. 3. Lake Forest, Ill.

Mas n, Otis T. Woman's Share in Primitive Culture. New York: D. Appleton & Co. Pp. 295.

Matthew, W. D. The Intrusive Rocks near St. John, N. B. Pp. 20.

Nansen, Fridtjof. Eskimo Life. Translated by William Archer. New York: Longmans, Green & Co. Pp. 350, with Illustrations. $4.

New York Academy of Sciences. Transactions. Vol. XIII. 1893-'94. Pp. 280.

Osborn, Henry F. From the Greeks to Darwin. An Outline of the Development of the Evolution Idea. New York: Macmillan & Co. Pp. 289. $2.

Packard, Alpheus S On the Systematic Position of the Siphonoptera. Pp. 56.—On the Inheritance of Acquired Characters in Animals with a Complete Metamorphosis. Pp. 40.

Plotten, J. Victor. Conversational Method in French. Halifax, N. S. Pp. 224.

Psychical Research, Proceedings of the Society for. Part XXVI. Vol. X. London: Kegan Paul, Trench, Trübner & Co. Pp. 466.

Prinz, W., Brussels, Belgium. Agrandissements de Photographies Lunaires (Enlargements of Lunar Photographs). 3 Sheets.

Queensland (Australia). Report of the Proceedings of the Rust in Wheat Conference. March, 1894. Brisbane. Pp. 77.

Radcliffe, A. G. Schools and Masters of Sculpture. New York: D. Appleton & Co. Pp. 593.

Recreation' Vol. I. No. 1. Monthly. G. O. Shields, Editor, New York. Pp. 40. 10 cents. $1 a year.

Ries, Heinrich. Microscopic Organisms in the Clays of New York State. Pp. 5, with Plates.

Salt, Henry S. Animals' Rights considered in Relation to Social Progress. New York: Macmillan & Co. 75 cents.

Shufeldt, R. W. Lectures on Biology. Pp. 102.

Scudder, S. H. Tertiary Rhyncophorous Coleoptera. U. S. Geological Survey. Pp. 206, with Plates.

Torrey, Bradford. A Florida Sketch Book. Boston: Houghton, Mifflin & Co. Pp. 242. $1.25.

United States Department of Agriculture. Report on the Agriculture of South America. By Almont Barnes. Washington: Government Printing Office. Pp. 189.

United St tes Fish Commission. Bulletin, Vol. XII. For 1892. Marshall McDonald, Commissioner. Washington: Government Printing Office. Pp. 489.

United St tes Geological Survey. Bulletins 97 to 117.

United States Geological Survey. J. W. Powell, Director. Thirteenth Annual Report. Part I, Report of the Director. Pp. 240. Part II, Geology. Pp. 372, with Plates. Part III, Irrigation. Pp. 486, with Plates. Washington: Government Printing Office.

University of Arizona. Third Annual Register. 1893-'94. Tucson. Pp. 92.

Wall Street Man, A. The Man from the West; or, from the Chaparral to Wall Street. New York: J. S. Ogilvie Publishing Company. Pp. 246. 50 cents.

Willey, Arthur. Amphioxus and the Ancestry of the Vertebrates. New York: Macmillan & Co. Pp. 316. $2.50.

Williams, F. H. Walt Whitman as Deliverer. Pp. 20.

Woollcombe, W. G. Practical Work in General Physics. New York: Macmillan & Co. Pp. 83. 75 cents.

POPULAR MISCELLANY.

Unexplored Geographical Fields.—As among the more important fields where special geographical research may still be profitably carried on, Mr. Clements R. Markham mentions the north polar area, a vast extent of which is unknown; the south polar area, of which this is still more the case; and plenty of interesting work still in our own quarters of the globe. Even in the British islands some of the lakes were unsurveyed, and were not systematically sounded until the work was begun in Cumberland in 1893. The topography of the Alps might be considered fairly complete, but there are still physical inquiries of great interest that commend themselves to scientific Alpine travelers; such as the extent and action of ice, the oscillations of glaciers, the origin of the Föhn wind, and the effects of the destruction of forests. The historical geography of the Alps is also in process of elucidation. At present there are only three regions—in Africa—of considerable area, which offer opportunities for discovery on a large scale; namely, the Sahara, the region adjoining it to the south and extending across Wadai to the watersheds of the Congo and Nile, and the region to the east of the upper Nile, stretching south of Abyssinia, through the lands of the Gallas and Somalis, to the eastern seaboard of the continent. Outside the regions referred to we might be said to have obtained a fair knowledge of the general geographical features of the African continent. Much detail remains to be filled in, and much of the work executed in a hasty and superficial manner requires to be done over again. There are also regions of great interest that have been visited, but which would well repay detailed examination. In the continent of Asia British geographers have been very active during the present century. Perhaps the most interesting and important unknown Asiatic region is the southern part of Arabia, from Yemen on the west to Oman on the east, and between the seacoast and the states of Nejd in the interior. Hadramaut, with its lofty mountains and cultivated ravines, its settled population and historic past, is almost a sealed book to us. The exploration of this district is about to be undertaken. Much work is yet to be done in Asia Minor. The most important unexplored field includes the upper valley of the Euphrates and eastern Cappadocia.

Selection in Seed-growing.—To the seedsman, says Mr. C. L. Allen, in an address before the Horticultural Congress, published by W. Atlee Burpee & Co., Philadelphia, selection is not a cause but an effect. In the development of a type, selection is the principal agent employed, but doubly important is its office in preserving a type after it is secured. There are two separate and distinct principles in selection, and the two are antagonistic; they are both methodical, but for entirely different purposes. In the one instance we select with a view to the greatest possible increase in seed production, and in the other for just the opposite purpose. In our cereals selections are made to produce the greatest amount of seed with the least possible amount of straw. To that end, in the best wheat-growing sections, the longest and best-filled heads are selected, and those, too, in which the grains are the heaviest, for seed purposes. The seed thus saved is given the greatest possible aid to reproduction by growing it on soil best adapted to its development; by giving each plant sufficient room to grow strong, rather than tall; and by furnishing plant food proportionate to its necessities. At the proper time, if the same careful selection is again made and the same care in cultivation given, there will result another marked improvement, both in size and productiveness of the grain. The operation, oft repeated, will establish a type superior to that from which the first selection was made. To preserve that type, the same care must be given that was necessary to produce it. In selection for vegetables, where seeds are only used to reproduce the plant, the opposite course must be pursued, and forms must be chosen that produce as little seed as possible. It has often been demonstrated that when any given type has been developed by selection, either rapidly or slowly, under favorable conditions of soil and climate, it will as rapidly revert when grown under reverse conditions. It is also true that any form that will materially revert when grown under changed conditions for a few years will proportionately change in one year. This will, in a measure, account for the deterioration of varieties where the stock seed has been grown under different conditions from those under which the type originated. In most instances one year's growth will not materially change a type, but in all cases where a type is to be preserved it requires the same care in selection and cultivation and other conditions as those under which it originated.

University Extension.—The American Society for the Extension of University Teaching looks upon the creation of a literature embodying the experience of the movement as a prime condition of its ultimate success. Such literature has been materially enriched during the last twelve months. The number of lecture courses given during 1893 was larger, and the number of people attending the courses was, in the aggregate, greater than in any previous year. An appreciable advance has been made toward bringing home the benefits of university extension to some classes of society who have for the most part thus far stood aloof from it. The society's net receipts for the year were $8,119. The programme for the last year included lecture courses on a variety of subjects in history and literature, and "class courses" on subjects in which civics and physiology and hygiene played a conspicuous part. "It is in these days of newspapers, cheap story papers, labor unions, and similar agencies," says the report, "not a question of culture or no culture; it is a question of culture of the right sort, obtained under the guidance of properly qualified teachers, or culture of the wrong sort, under the guidance of uneducated and interested parties. Which shall it be? The socialist, the anarchist, the fanatic is to-day supplying systematic culture to a large and increasing number of our population. Shall some counteracting agency be kept at work or not? No one can study the extension movement carefully, investigate what it accomplishes for individuals and communities, without becoming convinced that even if it were to go no further than providing isolated courses of lectures upon the various branches of human culture, which should be given now in one place and now in another, occurring one winter and dropping out the next, it would still be eminently worth support and maintenance."

Palæography.—Palæography—the art of identifying, comparing, and deciphering ancient manuscripts—is founded on our knowledge and experience of the development of modern forms of writing. Children at school learning to write from the same copy form hands much alike, which become differentiated according to the individual characters of the several pupils, while they still bear the marks of a common style. "Any one," says Mr. E. M. Thompson, in his Greek and Latin Palæography (published in the International Scientific Series), "will readily distinguish the handwritings of individuals of his own time, and will recognize his friend's writing at a glance, as he recognizes his face; he has more difficulty in discriminating between the individual handwritings of a foreign country. Set before him specimens of the writing of the last century, and he will confuse the hands of different persons. Take him still further, and he will pronounce the writing of a whole school to be the writing of one man; and he will see no difference between the hands, for instance, of an Englishman, a Frenchman, and a Fleming. Still further back the writing of one century is to him the same as the writing of another, and he may fail to name the locality where a manuscript was written by the breadth of a whole continent." In the ancient Greek texts, with which palæography has largely to do, however remote the date of the documents which we are studying, Mr. Thompson observes, the impression is produced that all sorts of men wrote as fluently then as they do now. If, then, we find such evenly distributed facility in writing so far back, we must infer that the art was developed among the Greeks, or picked up by them from some other people very far back. In the earliest Greek inscriptions the writing was in the Semitic style, from right to left. This was superseded by the *boustrophedon* style, which read from right to left and left to right, in alternate lines; and that gave way to the present style. Many valuable Greek codices have recently been found. The pasteboards of the coffins discovered by Mr. Petrie at Gurob, in the Fayoum, Egypt, have furnished many. They are composed of papyri pasted together, which, being carefully separated, have been found to contain manuscripts of the third century B. C., the oldest specimens of Greek writing we have. Thus have been recovered fragments of Plato's Phædo, the lost play Antiope of Euripides, and Aristotle's Constitution of Athens, which was written on the back of an account roll of a farm bailiff in Hermopolis, A. D. 78–79. These finds are encouraging to a more systematic search of the Egyptian depositories. Of mediæval styles, no school developed the purely ornamental side of calligraphy so thoroughly and rapidly as the Irish. The finest manuscript of the style is the Book of Kells, now at Trinity College, Dublin. England is chiefly indebted to Ireland for its style, while the styles of the Roman school of missionaries were "foreign," and never became fully naturalized. The round hand was chiefly used for books and charters, while the pointed hand, though also employed for books, was most frequent in documents. These hands gradually suffered changes and degeneration, were affected and partly displaced by the French minuscule, and hence gradually became differentiated into the multitude of nondescripts that now pass for English handwriting.

The Grand Falls of Labrador.—An account of his visit to the Grand Falls of Labrador has been given by Henry G. Bryant, of Philadelphia, in the Century Magazine and in a Bulletin of the Geographical Club of Philadelphia. They are situated on the Grand or Hamilton River, which rises in the lakes of the upland region of the peninsula and flows in a general southeasterly direction into Hamilton Inlet—the great arm of the sea which, under various names, penetrates into the interior a distance of one hundred and fifty miles. No scientific explorer has advanced far into the country, and all that is known of it is derived from vague information furnished by Indians, a few missionaries, and the Hudson Bay Company's men. The first white man to visit and describe the falls was John McLean, of the Hudson Bay Company, in 1839. They were visited twenty years afterward by Joseph McPherson. These are the only white men who are known to have seen the Grand Falls till the summer of 1891, when Mr. Bryant and an expedition from Bowdoin College reached them independently of one another. Mr. Bryant, accompanied by Prof. C. A. Kenaston, of Washington, and a Scotch and an Indian assistant, left Northwest River Post, at the head of Hamilton Bay, on August 3d, to proceed up the stream by canoe. On the 27th they reached the point where the further navigation of the stream is obstructed by rapids, whence they proceeded overland and reached the falls September 2d. "A single glance showed that we had before us one of the greatest waterfalls in the world. . . . A mile above the main leap the river is a noble stream four hundred yards wide, already flowing at an accelerated speed. Four rapids, marking successive depressions in the river bed, intervene between this point and the falls. At the first rapid the width of the stream is not more than one hundred and seventy-five yards, and from thence rapidly contracts until reaching a point above the escarpment proper, where the entire column of fleecy water is compressed within rocky banks not more than fifty yards apart. Here the effect of resistless power is extremely fine. . . . An immense volume of water precipitates itself over the rocky ledge, and under favorable conditions the roar of the cataract can be heard for twenty miles. Below the falls, the river, turning to the southeast, pursues its maddened career for twenty-five miles shut in by vertical cliffs of gneissic rock which rises in places to a height of four hundred feet. The rocky banks above and below the falls are thickly wooded with firs and spruces, among which the graceful form of the white birch appears in places." The height of the falls was found, by as accurate a measurement as could be made with cord, to be three hundred and sixteen feet. The highest elevation reached by the expedition was in the vicinity of the falls, and appeared by aneroid measurement to be somewhat in excess of fifteen hundred feet. From the point where the river leaves the plateau and plunges into the deep pool below the falls, its course for twenty-five miles is through one of the most remarkable cañons in the world. Besides the topographical and meteorological data, valuable botanical collections and ethnological collections illustrating the life and customs of mountaineer (Montagnais) Indians and Eskimos were obtained.

Hair Stimulants.—The best promotive of hair growth is general vigor, which, prevailing where hair should be as well as in the rest of the body, stimulates its development along with that of other functions. For baldness, hair lotions containing cantharides, attracting an increased blood supply to the part, may be useful when the affection is caused by mere sluggishness of the cutaneous circulation; but it fails to reach the cause of disease where the hair is lost through seborrhœa. Such cases are benefited by remedies which kill microbes, such as sulphur, mercurial applications, and antiseptic drugs. The effect of the microbe on the greasy and dry scales in seborrhœa which causes proliferation of the epithelium is such as to lead to atrophy of the hair, and if the disease is not arrested, atrophy of the whole follicle, and consequent permanent alopecia. Where the damage to nutrition is not so great, the hair is without luster and turns more or less gray, and then the hair restorers which color the hair from without and not from within are resorted to. Sulphur and acetate of lead are often ingredients of these applications, and perchloride of mercury is too frequently the leading constituent of many vaunted remedies. It is doubtless of much value as a destroyer of microbes when used in suitable cases, but when applied indiscriminately for long periods is in danger of producing injurious effects. Pilocarpine hypodermically injected, or given internally as tincture of jaborandi, is of value as a promoter of growth of hair, but is too powerful a remedy for indiscriminate use, besides inducing copious perspirations and depression of the heart. Less direct means may be found in tonics of iron, strychnine, quinine, etc.; but more powerful are cod-liver oil and change of air, generally to a bracing climate. Baldness is, however, a symptom of such diverse conditions that there is no routine treatment for it, but the cause should be carefully sought out and intelligently dealt with.

Hygiene of the Teeth.—Writing of the hygiene of the teeth, the Lancet observes that all caries of the teeth begins from without, no such thing as internal caries having ever been demonstrated; hence, if the surfaces could be kept absolutely clean there would be no decay. To the question, "When ought the cleansing of the teeth to begin?" the certain answer is, "As soon as there are teeth." "A small toothbrush, charged with some precipitated chalk flavored with an aromatic drug to make it pleasant, is perhaps the best means—not a towel, which only removes the secretion from the labial and lingual surfaces and not from between the teeth, where decay is most rife." If this habit is acquired early, the very desirable result is likely to follow of immunity, to a greater or less extent, from dental trouble. Later on something more can be done by passing a piece of waxed dental floss silk between the teeth every day. Toothpicks may do harm if abused, by causing irritation of the gum between the teeth, and its consequent absorption; and if the picks are made of wood, splinters are liable to be left behind, which have in many cases caused even the loss of a tooth; but used judiciously they are of great value in routing the attacking forces in caries—namely, accumulations of food and mucous secretions. It has been urged against them that they might dislodge a filling; but if a filling is so insecure it must be faulty, and the sooner it is replaced the better, for decay, due to the impossibility of keeping the surface clean, must be going on underneath it.

A Foot, Stilt, and Horse Race.—A race between three pedestrians, three stilt walkers, and three horses took place from Bordeaux, France, early in May, over a course, returning to Bordeaux, of four hundred and twenty kilometres. At ninety-one kilometres the horses were ahead, one an hour and a half in advance of the third; the stiltmen were behind them, and the pedestrians were far in the rear, with one of them dropped from the course. At one hundred and fifty kilometres a stiltman had got ahead of one of the horses. At one hundred and sixty-six kilometres one of the horses was taken out ill, and the horse which had been passed by a stilt walker had caught up with him. At two hundred and thirty-five kilometres the pedestrians had given up the struggle. At three hundred and five kilometres the rivals were the leading stilt walker and the horse which he had once passed, the other horse beginning to fail. The rivalry between the stilt walker and horse was kept up till the end of the race, when the horse came into Bordeaux twenty-eight minutes ahead. The time was sixty-two hours and twenty-seven minutes.

Marine Silk.—To the various kinds of silks known in trade must now be added, according to the French journal L'Industrie textile, a marine silk, derived from shells, or from the filaments, technically known as the *byssus*, which are secreted by some mollusks, including the mussels, which fasten themselves to the rocks. These filaments are very strong, as one may easily find out by trying to pull apart a cluster of mussels attached by them to one another. Though very fine, the filaments of the mussel shells are generally too short to be of much use; but they are long enough in some kinds, among which is a *pinna* very common in the Mediterranean and known to French fishermen as the *jambonneau*, or little ham, from its peculiar shape and color. These shells are raked up from a depth of between six and nine metres near the coast of Sicily. The threads are slender but extremely tough, and a considerable effort is required to detach them from the rock. The tuft, having been detached from the shell, is washed in soapsuds and dried in the shade. The useless parts are cut away, and the available threads are rubbed in the hands to give them suppleness, and then sorted and separated by combing—an operation in which a waste of about two thirds of the raw material is incurred. Two or three of the threads are spun with a thread of silk, whereby a very strong cord is obtained. The cord is washed in water acidulated with lime juice, rubbed again with the hand, and smoothed with a hot iron, by which it is finally given a beautiful brownish gilt color.

John Wesley an Evolutionist.—It will probably be a novel idea to our Methodist friends to find in John Wesley a precursor of Spencer and Darwin in outlining the doctrine of evolution. This has, nevertheless, been done by William H. Mills, in a paper read before the Chit Chat Club of San Francisco, entitled "John Wesley an Evolutionist." Mr. Mills exhibits as his authority a work entitled Wesley's Philosophy, in two volumes, which was published by the Methodist Book Concern in New York in 1823. In this work, in which Mr. Wesley expressed himself as believing that he was presenting only such matters as had been established by investigation and research, he says: "The same general design comprises all parts of terrestrial creation. A globule of light, a molecule of earth, a grain of salt, a particle of moldiness, a polypus, a shell-fish, a bird, a quadruped, and man, are only different strokes of this design, and represent all possible modifications of the matter of our globe. My expression falls greatly beneath reality; these various productions are not different strokes of the same design; they are only so many points of a single stroke, that by its infinitely varied circumvolutions traces out to the astonished eyes of the cherubim the forms, proportions, and concatenations of all earthly beings. This single stroke delineates all worlds." Mr. Wesley says again: "All is metamorphosis in the physical world. Forms are continually changing. The quantity of matter alone is unvariable. The same substance passes successively into the three kingdoms. The same composition becomes by turns a mineral, plant, insect, reptile, fish, bird, quadruped, man." Further, Mr. Wesley spoke of the bat and flying squirrel as animals "proper for establishing the gradation that subsists between all the productions of Nature"; of the ostrich as seeming to be "another link which unites birds to quadrupeds"; and of the ape as a rough draught of man. He also considered the most primitive form of organic life as the connecting link between the animal and the vegetable to be the polypus. It did not occur to Mr. Wesley that man as the result of evolution had a debased origin, but he went on to say: "Has God created as many species of souls as of animals? Or is there only one species of soul in animals, differently modified according to the diversity of organization? This question is absolutely impenetrable by us. All we can say concerning it is this: If God, who has always acted by the most simple means, has thought proper to vary the spiritual perfection of animals merely by organization, his wisdom has so ordained it. At the summit of the scale of our globe is placed man, the masterpiece of earthly creation." Further: "Mankind have their gradations as well as the other productions of our globe. There is a prodigious number of continued links between the most perfect man and the ape."

Tropical Animals in Frost.—The animals in the London Zoölogical Gardens were surprised by a hard frost (16°) in the last days of November, 1893, but, according to an observer who was there to see, the animals from warm and tropical regions seemed no more inconvenienced by the cold than were their fellow-residents from far northern regions. With every pond and pool sheeted with ice, and the gravel walks as hard as granite, birds and beasts from such regions as Burmah, Assam, Malacca, and Brazil "were abroad and enjoying the keen air; and others, which are usually invisible and curled up in their sleeping apartments until late in the day, were already abroad, sniffing at the frost and icicles, and as Mr. Sam Weller's polar bear 'ven he was a-practicing his skating.' A visit to the Gardens in such weather suggests a modification of too rigid ideas of the limitation of certain types of animals to warm or torrid climates, and illustrates the gradual and reluctant character of the retreat of species before the advance of the glacial cold in remote ages. No creatures are, as a rule, more sensitive to cold than the whole monkey tribe. Yet there is at least one species of monkey which habitually endures the rigors of a northern winter. One of the cleverest antique Chinese drawings at South Kensington represents a troop of monkeys caught in an avalanche of snow. The grotesque discomfiture of these pink-faced monkeys rolling down the hillside, helplessly clutching at each other's bodies and tails, grinning and grimacing as their heads emerge from the powdery snow, is something more than the fancy of a Chinese painter. The incident is probably drawn from an actual scene, and one of the creatures, the Scheli monkey from the mountains of Pekin, was in an open cage in the Gardens, and in far better health and spirits than in the height of summer. Its fur had grown thick and close, and the naked face had assumed the dark madder-pink with which it was adorned in the Chinese drawing. When presented with sticks crusted with hard ice, it sucked the chilly dainty with great relish, and only showed signs of sensitiveness to cold by putting its fingers to its mouth, then sitting on its hands to warm them. The behavior of this northern monkey is only strange by contrast with the general habits of its kind. But the indifference to cold of the capybara, a gigantic water guinea pig from the warm rivers of Brazil, is not easy to explain. Two of these quaint creatures had left their snug sleeping apartments, and were stepping gayly among pools of half-frozen water and broken ice. One had gained an extra coat by burrowing in its straw and then emerging with a pile upon its back; and when this fell off, retired and shuffled on another pile; but the other seemed quite contented to sit without protection in the sunniest corner of the inclosure. The whole colony of porcupines (six in number) . . . were abroad and in the highest spirits, erecting and rattling their quills, and sitting up to inspect their visitors like gigantic rabbits." The demeanor of the semitropical birds was even more interesting than the power of adaptation to climate shown by quadrupeds. The Argus cock-pheasant from Sumatra or Borneo "was displaying its beauties in the open air, among leaves and grass tipped with icicles, and showed plumage so close and perfect that it was impossible to doubt that the colder climate had, if anything, added a luster to its unrivaled wealth of ornament."

Mental Growth through Physical Education.—In a paper on Mental Growth through Physical Education Jakob Bolin begins his argument by showing how muscular work, or physical exercise, serves to keep the metabolism of the body at a proper level. Then it operates on the mind thus: "When you are sitting at your desk for any appreciable length of time, sunk in profound thoughts, these thoughts, however pure and lofty, are actually slowly poisoning your brain, decreasing its aptitude to the work at hand, and you will find, as time passes, that you are not able to keep your attention fixed, your will power has lost its grip, your memory is deteriorated, you can not grasp an idea as before, and there creeps over you a certain feeling of lassitude and dullness; your temples throb, your face is flushed, there is a sensation of fullness, your head aches. And all this because your thoughts—your mental work—have pumped up into your head a quantity of blood giving the necessary fuel for these thoughts, but there has been no agent at work strong enough to remove the ashes and refuse. But rise from your table, take a few deep inhalations, move your arms in rhythm with the respiration, walk for a quarter of an hour, and you will probably find the unpleasant symptoms gone and yourself ready to begin anew; your attention, which was wandering, has become fixed, your will power is stronger, your memory its own self, your ideas from vague have become more clear and your conclusions more logical. And the temporary beneficial effects of occasional muscular work are easily made permanent by applying the remedy steadily and systematically." Another purpose than this is also served in systematic gymnastics, in which a uniformity of movement and a definite rhythm are cultivated. By these "we endeavor to teach our pupils to have, by means of their muscular sense, a due appreciation of the proper order of things and also to do things exactly each at its proper time, to let things follow each other in a previously arranged order, to complete one thing before they undertake a new enterprise; we teach them also by the same means not to feel as if each were a completeness by himself, but try to let them acquire the habit of considering themselves as units of a greater whole, which suffers if not each unit works with the aim in view of gaining the greatest perfection for the whole. In the gymnasium each one must subordinate himself to the welfare of his class; in the baseball field that sensation of identification with the team is created; in the rowboat each works in harmony with everybody else; and thus, through evolving this feeling of belonging together, we hope to react favorably upon the doings of these same individuals as units of a greater whole, the community, the nation, humanity, so as to direct their mental as well as physical capacities toward the common welfare, toward the progress of the race, to make not a better man but better men."

Domestic Birds of the Chinese.—Fowls form a considerable part of the food of the better classes in China, and the breeding and rearing of them constitute an important industry. Four varieties of fowls are described in the report of the United States consul at Ching Kiang, each of which has its peculiar characteristics and qualities. Of the smallest of the breeds, the *chow*, a white cock, is carried on the coffin at funerals and is sacrificed at the grave; and it is customary on the native boats to kill one on New Year's day and sprinkle the blood on the bow for the propitiation of evil spirits and to insure good luck during the year. Ducks are reared in great numbers, and are largely used as food, both fresh and salted. They are all artificially hatched. After fledging, the birds are driven about in flocks through canals and from pond to pond, where they find their food. They are brought under strict discipline, and obey their keeper's call with extraordinary intelligence. The mandarin duck, a smaller variety, is reared for its beauty, and is prized as an embellishment to the artificial lakes with which the grounds of the wealthy are adorned. By virtue of their repute for conjugal fidelity a pair of them are introduced into wedding processions. The eggs, preserved by a peculiar process, after which they will keep for several years, form an important part of mandarin dinners. Geese, pure white, and of great size and majestic carriage like that of the swan, are bred; turkeys for foreigners and gold and silver pheasants are raised, and the cormorant is domesticated and trained to a wonderful degree of intelligence for fishing. The birds are taken out on the lakes and rivers in a small boat, one man to every ten or twelve cormorants. They stand perched on the sides of the boat, and at a word from the man they scatter on the water and begin to look for their game. They dive for the fish, and then rise to the surface with the catch in their bills, when they are called back to the boat by the fisherman. As docile as dogs, they swim to their master and are taken into the boat, when they lay down their prey and again resume their labor. The use of incubators in hatching eggs has been known and practiced in China for several hundred years, as it was also in ancient Egypt. The apparatus is described as very primitive; but the men engaged in the business know exactly the day when the young ducks or chickens will come forth, and are prepared to receive them.

NOTES.

It is the habit of centipeds to carry their young, clasped by means of their legs, to all parts of the under side of the body, though generally the young are clustered in dense masses. When the young are thus bunched together the body is coiled upon itself at that part; and the contrast between a centiped in this position, says Mr. J. J. Quelch, who describes the centiped's method in Nature, and a scorpion carrying her young upon her back, just as a small opossum does, is a very marked one.

The *sumpitans* or blowpipes of the Jakuns living on the Serting River in the sultanate of Johore are manufactured from a very long-jointed, straight variety of bamboo, which is generally carved and traced with many rude devices. The darts consist of thin splinters of wood about a foot long, having a plug of pith at the blunt end. The point is as sharp as a needle, and is covered with a black, resinous substance, which is in many cases extremely poisonous. Monkeys and other small animals die from its effects almost immediately; on man and the larger animals its action is less rapid, but quite as deadly. The poison is known to the Malays as *ipoh*.

An active discussion was had in the British Association on the question of the criterion by which a flint should be regarded as the work of man or of Nature. With regard to the ruder forms of what some extreme anthropologists include among palæolithic implements opinion was much divided; as it was also on the point as to how far the position in which such implements, even when recognized as artificial, are found can be accepted as an indication of their age. The moral suggested by the discussion is that many flints have been accepted as the handiwork of man on the most inadequate evidence, and that there is still much doubt as to whether man existed in the British islands in preglacial times.

Photographic records taken with the aid of the capillary electrometer of electric currents produced by speaking into the telephone were exhibited by Mr. Burch in the British Association. The letter *z* produced a complicated curve in which oscillations of current lasting only one three-thousandth of a second were visible with a lens. The speaker said that the electromotive force produced in using the ordinary telephone amounts to about one tenth of a volt; but with emphatic syllables it may rise high enough to produce electrolysis.

The question whether the intensity of the radiation of heat by the sun is affected by its condition as to spots has been studied by M. R. Savelief, of Kiev, in the light of observations made in the spring and the fall of the years 1890, 1891, and 1892. The results point to an affirmative answer, the radiation being greater as the sun-spot activity augments. A variation in one series of the experiments is interpreted as indicating that the increase is dependent, not so much on the absolute number of the spots as upon the intensity of their evolution; or it may mean that it is immediately consecutive on their diminution.

The meeting of the British Association at Oxford was attended by 2,311 persons, several hundred more than attended last year's meeting; and the receipts were £2,175. Appropriations of £1,100, or about £100 more than usual, were made for grants for research. The committee of recommendations proposed that Section D be called zoölogy instead of biology; that a separate section be constituted for botany; and that Section I consist of physiology with experimental pathology and experimental psychology.

The results of certain experiments concerning the effect of various forms of distraction upon memory, reported by W. G. Smith to the British Association, show that the memory is most efficient when the subject is allowed to learn various combinations of the alphabet without distraction of any kind. But the power of recollection is lessened to some extent by regular movements of the forefinger made by the subject while he is learning; still more by the simultaneous articulation of an unintelligible syllable; and most of all by the performance of simple addition during the experiments.

The committee of the British Association on an International Standard for the Analysis of Iron and Steel has reported, through Prof. W. C. Roberts Austin, that the composition of the remaining, before undetermined standard, No. 5, has now been determined by four different analysts, and is accurately ascertained. The standards will shortly be deposited with the Board of Trade, when the work of the committee will have been completed.

A museum of journals at Aix-la-Chapelle, Germany, founded in 1886 by M. Oscar Forkenbeck, is said to contain already five hundred thousand journals in all languages. The founder devoted his whole fortune for forty years to the acquisition of rare and curious specimens, and to subscriptions to journals in all parts of the globe. He received and read every day a considerable number of papers in thirty different languages. Having started the museum with ten thousand full collections, he addressed a circular letter to the press of the globe asking co-operation in his enterprise, and a large number of journals responded favorably.

In certain experiments made by him, Mr. L. Cobbett found that tissues which had once been the seat of erysipelas retained the power of reacting more energetically than normal tissues when inoculated with the sterilized products of cultures of the erysipelas organism. He suggested that immunity might be explained as being due to an ability on the part of the tissues to react to chemical substances produced by bacteria.

Sir John Murray reports that the study of the weather at Ben Nevis and Trieste has led to the isolation of two types of weather—namely, perfectly clear days and those on which some fog exists. The two types correspond to quite different characters in the hourly variation of temperature and pressure.

An extraordinary migration of "Croton bugs" was described by L. O. Howard in the American Association as witnessed by him in Washington one very dark day last summer. The migrating army, composed of many thousands of individuals, consisted almost entirely of female roaches carrying egg-sacks. An investigation of the circumstances led him to the conclusion that the observation indicated a development of the true migratory instinct, and that while the old residence of the insects might have supported its then occupants, provision for the sustenance of the young, as yet unborn, necessitated a journey in search of new quarters. The migration of this army upon a dark day suggested that it is by similar expeditions after nightfall that new houses become infested with roaches.

Aluminum has the property, when used as a pencil, of leaving an indelible mark on glass or any other substance having a siliceous base. A deposition of the metal takes place, and, while this may be removed by a suitable acid wash, the mark itself can not be removed by rubbing or washing. Magnesium, zinc, and cadmium have a similar property, but the mark of magnesium is easily removed, the application of zinc requires a wheel, and zinc and cadmium tarnish; while aluminum is permanent and remains bright. This property is susceptible of a variety of practical applications in decorating glass.

In his address before the Section of Geology of the British Association Mr. L. Fletcher suggested the importance to a highly civilized country of having within its own borders men who would make themselves familiar with all that was being done and had been done in the subject, would do what was possible to fill up the gaps in the science, and would make the results available for those who had not the opportunity to make so complete and original a survey for themselves. He recommended that by some means each university should be enabled to endow a professorship of mineralogy in such a way as to attract the most capable men to the study of the subject; and he pointed to the example lately set by Cambridge, which encouraged the students of physics, chemistry, and geology to acquire a knowledge of mineralogy and crystallography, and gave them credit for that knowledge in the examination for a degree.

As a result of elaborate investigations, Dr. J. S. Haldane has come to the conclusion that in colliery explosions the deaths from suffocation are due, not, as is generally supposed, to carbonic-acid gas, but to the preponderance of nitrogen and the deficiency of oxygen. Life could be saved if the colliers could be supplied with oxygen for an hour or so; and the author has devised an apparatus for enabling a man to breathe oxygen, of which sixty litres are compressed into a half-litre bottle, with tube and regulating taps, supplemented by a wire compress for the nose to prevent breathing through that organ.

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JANUARY, 1895.

PLEASURES OF THE TELESCOPE.

By GARRETT P. SERVISS.

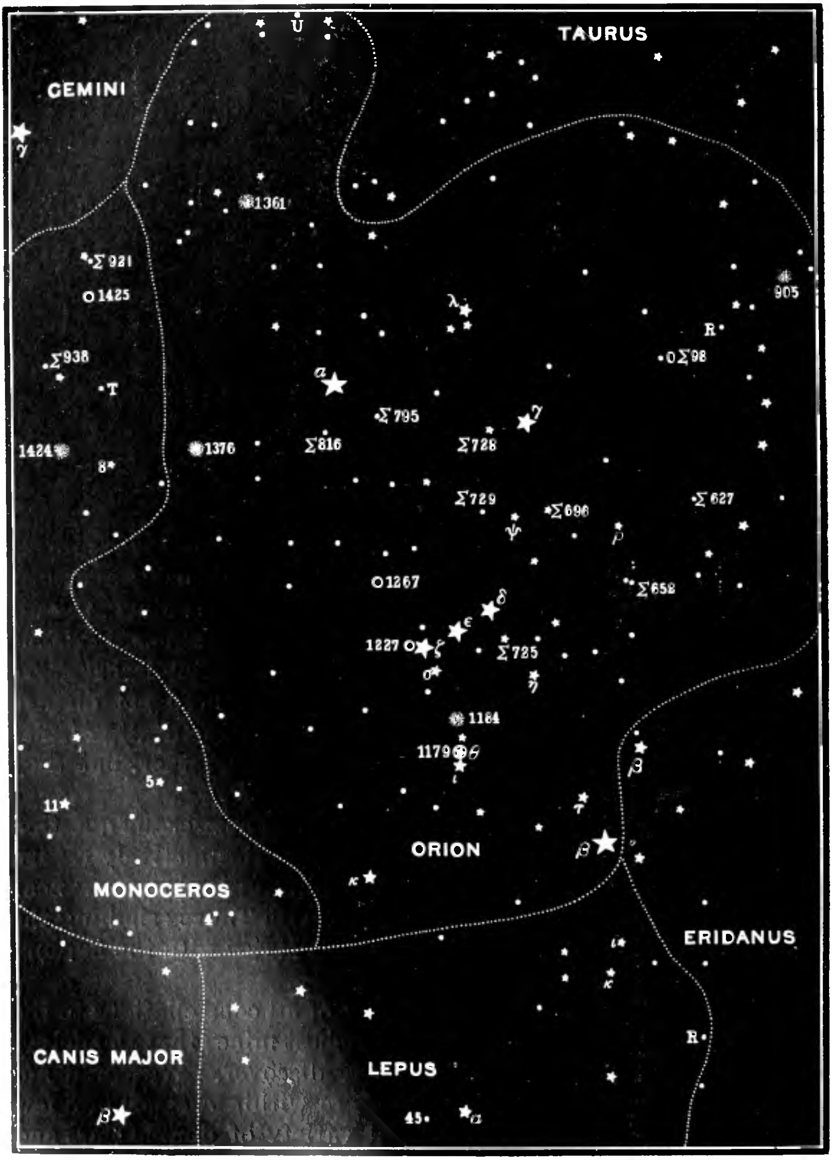
II.—IN THE STARRY HEAVENS.

LET us imagine ourselves the happy possessors of three properly mounted telescopes of five, four, and three inches aperture, respectively. A fine midwinter evening has come along, the air is clear, cool, and steady, and the heavens, of that almost invisible violet which is reserved for the lovers of celestial scenery, are spangled with stars that hardly twinkle. We need not disturb our minds about a few thin clouds here and there floating lazily in the high air; they announce a change of weather, but they will not trouble us to-night.

Which way shall we turn? Our eyes will answer the question for us. However we may direct them, they instinctively return to the south, and are lifted to behold Orion in his glory, now near the meridian and midway to the zenith, with Taurus shaking the glittering Pleiades before him, and Canis Major with the flaming Dog Star following at his heels.

Not only is Orion the most brilliant of all constellations to the casual star-gazer, but it contains the richest mines that the delver for telescopic treasures can anywhere discover. We could not have made a better beginning, for here within a space of a few square degrees we have a wonderful variety of double stars and multiple stars, so close and delicate as to test the powers of the best telescopes, besides a profusion of star-clusters and nebulæ, including one of the supreme marvels of space, the Great Nebula in the Sword.

Our star map No. 1 will serve as a guide to the objects which we are about to inspect. Let us begin operations with our smallest telescope, the three-inch. I may remark here that, just as the lowest magnifying power that will clearly reveal the object looked



Map No. 1.

for gives ordinarily better results than a higher power, so the smallest telescope that is competent to show what one wishes to see is likely to yield more satisfaction, as far as that particular object is concerned, than a larger glass. The larger the object glass and the higher the power, the greater are the atmospheric difficulties. A small telescope will perform very well on a night when a large one is helpless.

Turn the glass upon β (Rigel), the white first-magnitude star in Orion's left foot. Observe whether the image with a high power is clear, sharp, and free from irregular wisps of stray light. Look at the rings in and out of focus, and if you are satisfied with the performance, try for the companion. A good three-inch is certain to show it, except in a bad state of the atmosphere, and even then an expert can see it, at least by glimpses. The companion is of the ninth magnitude, some say the eighth, and the distance is about 9·5″, angle of position (hereafter designated by p.) 199°.* Its color is blue, in decided contrast with the white light of its great primary. Sir John Herschel, however, saw the companion red, as others have done. These differences are doubtless due to imperfections of the eye or the telescope. In 1871 Burnham believed he had discovered that the companion was an exceedingly close double star. No one except Burnham himself ever succeeded in dividing it, and he could only do so at times. Afterward, when he was at Mount Hamilton, he tried in vain to split it with the great thirty-six-inch telescope, in 1889, 1890, and 1891. His want of success induced him to suggest that the component stars were in rapid motion, and so, although he admitted that it might not be double after all, he advised that it should be watched for a few years longer.

Rigel has been suspected of a slight degree of variability. It is evidently a star of enormous actual magnitude, for its parallax escapes trustworthy measurement. It can only be ranked among the very first of the light-givers of the visible universe. Spectroscopically it belongs to a peculiar type which has very few representatives among the bright stars, and which has been thus described: "Spectra in which the hydrogen lines and the few metallic lines all appear to be of equal breadth and sharp definition." Rigel shows a line believed to represent magnesium; but while it has iron lines in its spectrum, it exhibits no evidence of the exist-

* The angle of position measures the inclination to the meridian of a line drawn between the principal star and its companion; in other words, it shows in what direction from the primary we must look for the companion. It is reckoned from 0° up to 360°, beginning at the north point and passing around by east through south and west to north again. Thus, if the angle of position is 0° or 360°, the companion is on the north side of the primary; if the angle is 90°, the companion is to the east; if 180°, to the south; if 270°, to the west, and so for intermediate angles. It must be remembered, however, that in the field of the telescope the top is south and the bottom north, unless a prism is used, when directions become complicated. East and west can be readily identified by noticing the motion of a star through the field; it moves toward the west and from the east.

ence of any such cloud of volatilized iron as that which helps to envelop the sun.

For another test of what the three-inch will do turn to ζ, the lower, or left-hand, star in the Belt. This is a triple, the magnitudes being second, sixth, and tenth. The sixth-magnitude star is about 2·5″ from the primary, p. 149°, and has a very peculiar color, hard to describe. It requires careful focusing to get a satisfactory view of this star with a three-inch telescope. Use magnifying powers up to two hundred and fifty diameters. With our four-inch the star is much easier, and the five-inch shows it readily with a power of one hundred. The tenth-magnitude companion is distant 56″, p. 8°, and may be glimpsed with the three-inch. Upon the whole, we shall find that we get more pleasing views of ζ Orionis with the four-inch glass.

Just to the left of ζ, and in the same field of view with a very low power, is a remarkable nebula bearing the catalogue number 1227. We must use our five-inch on this with a low power, but with ζ out of the field in order to avoid its glare. The nebula is exceedingly faint, and we can be satisfied if we see it simply as a hazy spot, although with much larger telescopes it has appeared at least half a degree broad. Tempel saw several centers of condensation in it, and traced three or four broad nebulous streams, one of which decidedly suggested spiral motion.

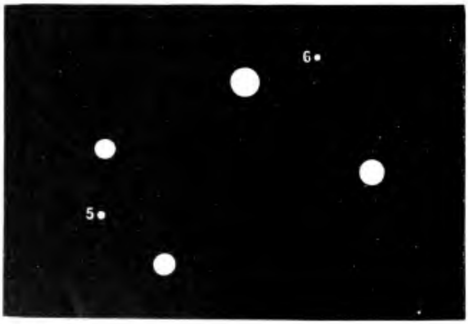
The upper star in the Belt, δ, is double: distance, 53″, p. 360°; magnitudes, second and seventh very nearly; colors, white and green or blue. This, of course, is an easy object for the three-inch with a low magnifying power. It would be useless to look for the two fainter companions of δ, discovered by Burnham, even with our five-inch glass. But we shall probably need the five-inch for our next attempt, and it will be well to put on a high power, say three hundred diameters. The star to be examined is the little brilliant dangling below the right-hand end of the Belt, toward Rigel. It appears on the map as η. Spare no pains in getting an accurate focus, for here is something worth looking at, and unless you have a trained eye you will not easily see it. The star is double, magnitudes third and sixth, and the distance from center to center barely exceeds 1″, p. 87°. A little tremulousness of the atmosphere for a moment conceals the smaller star, although its presence is manifest from the peculiar jutting of light on one side of the image of the primary. But in an instant the disturbing undulations pass, the air steadies, the image shrinks and sharpens, and two points of piercing brightness, almost touching one another, dart into sight, the more brilliant one being surrounded by an evanescent circle, a tiny ripple of light, which, as it runs round the star and then recedes, alternately embraces and releases the smaller companion. The wash of the light-waves in the atmosphere provokes many expressions of impatience from the astronomer, but it is often a beautiful phenomenon nevertheless.

Between η and δ is a fifth-magnitude double star, Σ 725, which is worth a moment's attention. The primary, of a reddish color, has a very faint star, eleventh magnitude, at a distance of 12·7″, p. 88°.

Still retaining the five-inch in use, we may next turn to the other end of the Belt, where, just under ζ, we perceive the fourth-magnitude star σ. He must be a person of indifferent mind who, after looking with unassisted eyes at the modest glimmering of this little star, can see it as the telescope reveals it without a thrill of wonder and a cry of pleasure. The glass, as by a touch of magic, changes it from one into eight or ten stars. There are two quadruple sets three and a half minutes of arc apart. The first set exhibits a variety of beautiful colors. The largest star, of fourth magnitude, is pale gray; the second in rank, seventh magnitude, distance 42″, p. 61°, presents a singular red, "grape-red" Webb calls it; the third, eighth magnitude, distance 12″, p. 84°, is blue; and the fourth, eleventh magnitude, distance 12″, p. 236°, is apparently white. Burnham has doubled the fourth-magnitude star, distance 0·23″. The second group of four stars consists of three of the eighth to ninth magnitude, arranged in a minute triangle with a much fainter star near them. Between the two quadruple sets careful gazing reveals two other very faint stars. While the five-inch gives a more satisfactory view of this wonderful multiple star than any smaller telescope can do, the four-inch and even the three-inch would have shown it to us as a very beautiful object. However we look at them, there is an appearance of association among these stars, shining with their contrasted colors and their various degrees of brilliance, which is significant of the diversity of conditions and circumstances under which the suns and worlds beyond the solar system exist.

From σ let us drop down to see the wonders of Orion's Sword displayed just beneath. We can use with advantage any one of our three telescopes; but since we are going to look at a nebula, it is fortunate that we have a glass so large as five inches aperture. It will reveal interesting things that escape the smaller instruments, because it grasps more than one and a half times as much light as the four-inch, and nearly three times as much as the three-inch; and in dealing with nebulæ a plenty of light is the chief thing to be desired. The middle star in the Sword is θ, and it is surrounded by the celebrated Nebula of Orion. The telescope shows θ separated into four stars arranged at the corners of an irregular square, and shining in a black gap in the nebula. These four stars are collectively named the Trapezium. The brightest is of the sixth magnitude, the others are of the seventh, seven and a half, and eighth magnitudes respectively. The radiant mist about them has a faint greenish tinge, while the four stars, together with three others at no great distance, which follow a fold of the nebula like a row of buttons on a coat, always appear to me to show an extraordinary liveliness of radiance, as if the strange haze served to set them off.

Our three-inch would have shown the four stars of the Trapezium perfectly well, and the four-inch would have revealed a fifth star, very faint, outside a line joining the smallest of the four and its nearest neighbor. But the five-inch goes a step farther and enables us, with steady gazing, to see even a sixth star, of only the twelfth magnitude, just outside the Trapezium, near the brightest member of the quartet. The Lick telescope has disclosed one or two other minute points of light associated with the Trapezium. But more interesting than the Trapezium is the vast cloud, full of strange shapes, surrounding it. Nowhere else in the heavens is the architecture of a nebula so clearly displayed. It is an unfinished temple whose gigantic dimensions, while exalting the imagination, proclaim the omnipotence of its builder. But though unfinished it is not abandoned. The work of creation is proceeding within its precincts. There are stars apparently completed, shining like gems just dropped from the hand of the polisher, and around them are masses, eddies, currents, and swirls of nebulous matter yet to be condensed, compacted, and constructed into suns. It is an education in the nebular theory of the universe merely to look at this spot with a good telescope. If we do not gaze at it long and wistfully, and return to it many times with unflagging interest, we may be certain that there is not the making of an astronomer in us.



THE TRAPEZIUM WITH THE FIFTH AND SIXTH STARS.

Before quitting the Orion nebula do not fail to notice an eighth-magnitude star, a short distance northeast of the Great Nebula, and nearly opposite the broad opening in the latter that leads in toward the gap occupied by the Trapezium. This star is plainly enveloped in nebulosity, that is unquestionably connected with the larger mass of which it appears to form a satellite.

At the lower end of the Sword is the star ι, somewhat under the third magnitude. Our three-inch will show that it has a bluish companion of seventh or eighth magnitude, at a little more than 11″ distance, p. 142°, and the larger apertures will reveal a third star, of tenth magnitude, and reddish in color, distant 49″, p. 103°. Close by ι we find the little double star Σ 747, whose components are of five and a half and six and a half magnitudes respectively, and separated 36″, p. 223°. Above the uppermost star in the Sword is a small star cluster, No. 1184, which derives a special interest from the fact that it incloses a delicate double star, Σ 750, whose larger component is of the sixth magnitude, while the smaller is of the ninth, and the distance is only 4·3″, p. 59°. We may try the four-inch on this object.

Having looked at α (Betelgeuse), the great topaz star on Orion's right shoulder, and admired the splendor of its color, we may turn the four-inch upon the star Σ 795, frequently referred to by its number as "52 Orionis." It consists of one star of the sixth and another of sixth and a half magnitude, only 1·5″ apart, p. 200°. Having separated them with a power of two hundred and fifty diameters on the four-inch, we may try them with a high power on the three-inch. We shall only succeed this time if our glass is of first-rate quality and the air is perfectly steady.

The star λ in Orion's head presents an easy conquest for the three-inch, as it consists of a light-yellow star of magnitude three and a half and a reddish companion of the sixth magnitude; distance 4″, p. 43°. There is also a twelfth-magnitude star at 27″, p. 183°, and a tenth or eleventh magnitude one at 149″, p. 278°. These are tests for the five-inch, and we must not be disappointed if we do not succeed in seeing the smaller one even with that aperture.

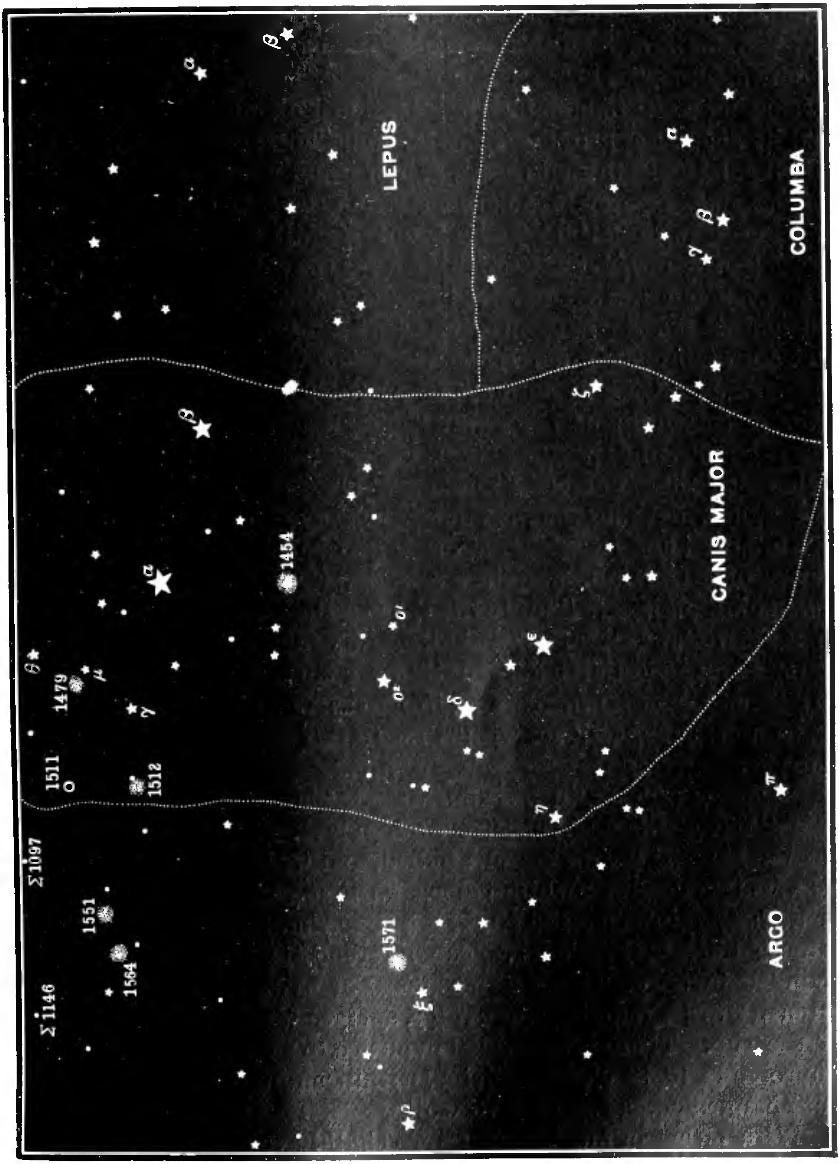
Other objects in Orion, to be found with the aid of our map, are: Σ 627, a double star, magnitude six and a half and seven, distance 21″, p. 260°. O Σ 98, otherwise named *i* Orionis, double, magnitude six and seven, distance 1″, p. 218°, requires five-inch glass; Σ 652, double magnitudes six and a half and eight, distance 1·7″, p. 184°; ρ, double, magnitudes five and eight and a half, the latter blue, distance 7″, p. 62°, may be tried with a three-inch; τ, triple star, magnitudes four, ten and a half, and eleven, distances 36″, p. 249°, and 36″, p. 60°. Burnham discovered that the ten-and-a-half magnitude star is again double, distance 4″, p. 50°. There is not much satisfaction in attempting τ Orionis with telescopes of ordinary apertures; Σ 629, otherwise *m* Orionis, double, magnitudes five and a half (greenish) and seven, distance 31·7″, p. 28°, a pretty object; Σ 728, otherwise A 32, double, magnitudes five and seven, distance 0·5″ or less, p. 206°, a rapid binary, which is at present too close for ordinary telescopes, although it was once within their reach; Σ 729, double, magnitudes six and eight, distance 2″, p. 26°, the smaller star pale blue. Try it with a four-inch, but five-inch is better; Σ 816, double, magnitudes six and half and eight and a half, distance 4″, p. 289°; ψ 2, double, magnitudes five and a half and eleven, distance 3″, or a little less, p. 322°; 905, star cluster, contains about twenty stars from eighth to eleventh magnitude; 1267, nebula, faint, containing a triple star of eighth magnitude, two of whose components are 51″ apart, while the third is only 1·7″ from its companion, p. 85°; 1376, star cluster, small and crowded; 1361, star cluster, triangular shape, containing thirty stars, seventh to tenth magnitudes, one of which is a double, distance 2·4″.

Let us now leave the inviting star-fields of Orion and take a glance at the little constellation of Lepus, crouching at the feet of the mythical giant. We may begin with a new kind of object, the celebrated red variable R Leporis (map No. 1). This star varies from the sixth or seventh magnitude to magnitude eight and a half in a period of four hundred and twenty-four days. Hind's picturesque description of its color has frequently been quoted. He said it is "of the most intense crimson, resembling a blood-drop on the black ground of the sky." It is important to remember that this star is reddest when faintest, so that if we chance to see it near its maximum of brightness it will not impress us as being crimson at all, but rather a dull, coppery red. Its spectrum indicates that it is smothered with absorbing vapors, a sun near extinction which, at intervals, experiences an accession of energy and bursts through its stifling envelope with explosive radiance, only to faint and sink once more. It is well to use our largest aperture in examining this star.

We may also employ the five-inch for an inspection of the double star ι, whose chief component of the fifth magnitude is beautifully tinged with green. The smaller companion is very faint, eleventh magnitude, and the distance is about 13″, p. 337°.

Another fine double in Lepus is κ, to be found just below ι; the components are of fifth and eighth magnitudes, pale yellow and blue respectively, distance 2·5″, p. 360°; the third-magnitude star α has a tenth-magnitude companion at a distance of 35″, p. 156°, and its neighbor β (map No. 2), according to Burnham, is attended by three eleventh-magnitude stars, two of which are at distances of 206″, p. 75°, and 240″, p. 58°, respectively, while the third is less than 3″ from β, p. 288°; the star γ (map No. 2) is a wide double, the distance being 94″, and the magnitudes fourth and eighth. The star numbered 45 is a remarkable multiple, but the components are too faint to possess much interest for those who are not armed with very powerful telescopes.

From Lepus we pass to Canis Major (map No. 2). There is no hope of our being able to see the companion of α (Sirius), at present (1894), even with our five-inch. Discovered by Alvan Clark with

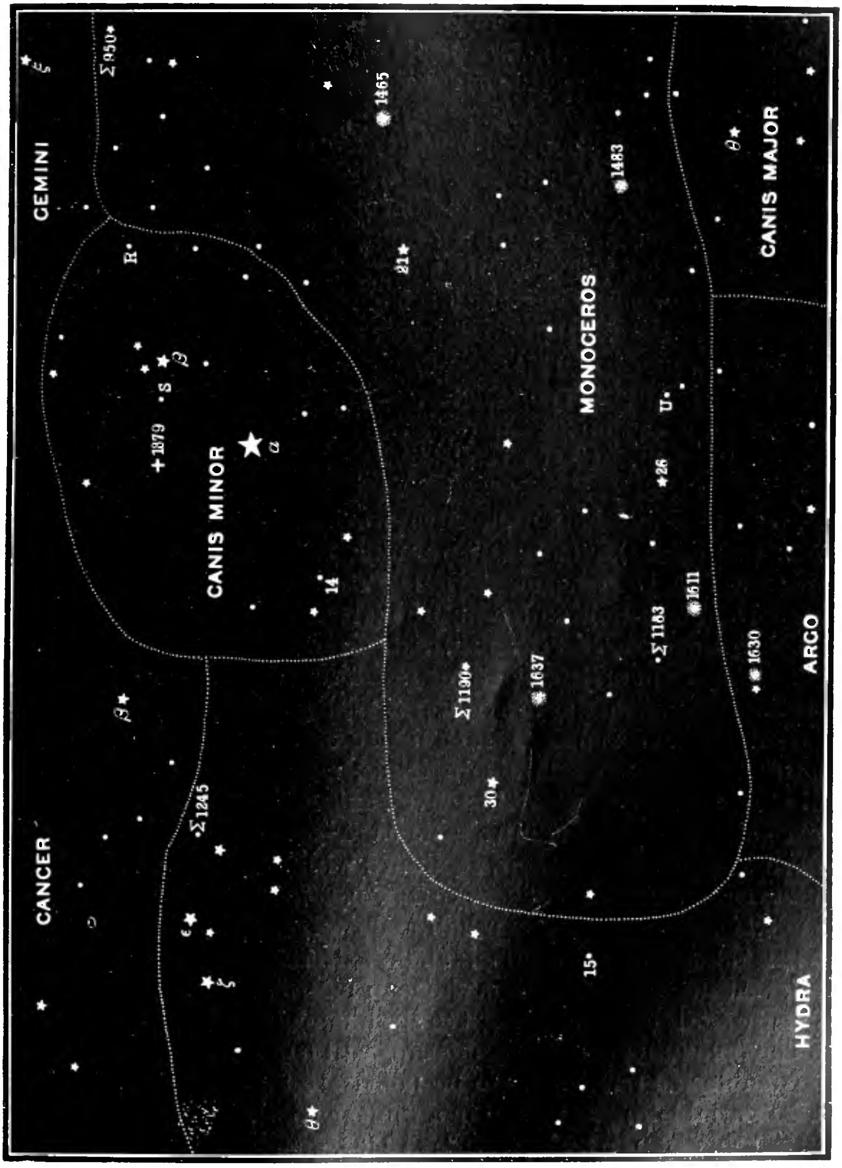


Map No. 2.

an eighteen-inch telescope in 1862, when its distance was 10″ from the center of Sirius, this ninth-magnitude star has since been swallowed up in the blaze of its great primary. It at first slightly increased its distance, and from 1868 until 1879 most of the measures made by different observers considerably exceeded 11″. Then it began to close in, and in 1890 the distance scarcely exceeded 4″. Burnham was the last to catch sight of it with the Lick telescope in that year. Since then no human eye has seen it. But during its visibility its motions were so carefully studied that we can have no doubt of its ultimate reappearance as it continues to pursue its orbit around the center of gravity between it and Sirius. According to Burnham, its periodic time is about fifty-three years, and its nearest approach to Sirius should have taken place in the middle of 1892. In that case it is now rapidly receding from periastron, and news of its emergence from the rays of Sirius should be expected at any time from Mount Hamilton, where a vigilant outlook is maintained. If we can not see the companion of the Dog Star with our instruments, we can at least, while admiring the splendor of that dazzling orb, reflect with profit upon the fact that although the companion is ten thousand times less bright than Sirius, it is fully half as massive as its brilliant neighbor. Imagine a subluminous body half as ponderous as the sun to be set revolving around it somewhere between Uranus and Neptune. Remember that that body would possess one hundred and sixty-five thousand times the gravitating energy of the earth, and that five hundred and twenty Jupiters would be required to equal its power of attraction, and then consider the consequences to our easy-going planets! Plainly the solar system is not cut according to the Sirian fashion. We shall hardly find a more remarkable coupling of celestial bodies until we come, on another evening, to a star that began, ages ago, to amaze the thoughtful and inspire the superstitious with dread—the wonderful Algol in Perseus.

We may remark in passing that Sirius is the brightest representative of the great spectroscopic type I, which includes more than half of all the stars yet studied, and which is characterized by a white or bluish-white color, and a spectrum possessing few or at best faint metallic lines, but remarkably broad, black, and intense lines of hydrogen. The inference is that Sirius is surrounded by an enormous atmosphere of hydrogen, and that the intensity of its radiation is greater, surface for surface, than that of the sun. There is historical evidence to support the assertion, improbable in itself, that Sirius, within eighteen hundred years, has changed color from red to white.

With either of our telescopes we shall have a feast for the eye when we turn the glass upon the star cluster No. 1454, some four degrees south of Sirius. Look for a red star near the center. Observe the curving rows so suggestive of design, or rather of the process by which this cluster was evolved out of a pre-existing nebula. You will recall the winding streams in the Great Nebula of Orion. Another star cluster worth a moment's attention is No. 1479, above and to the left of Sirius. We had better use the five-inch for this, as many of the stars are very faint. Not far away



MAP No. 3.

we find the double star μ, whose components are of the fifth and eighth magnitude, distance 2·8″, p. 343°. The small star is pale blue. Cluster No. 1512 is a pleasing object with our largest aperture. In No. 1511 we have a faint nebula remarkable for the rows of minute stars in and near it. The star γ is an irregular variable. In 1670 it is said to have almost disappeared, while at the beginning of the eighteenth century it was more than twice as bright as it is to-day. The reddish star δ is also probably variable. In my Astronomy with an Opera Glass will be found a cut showing a singular array of small stars partly encircling δ. These will be widely scattered, even with the lowest power of a telescope.

Eastward from Canis Major we find some of the stars of Argo Navis. Σ 1097, of sixth magnitude, has two minute companions at 20″ distance, p. 311° and 312°. The large star is itself double, but the distance 0·8″, p. 166°, places it beyond our reach. According to Burnham, there is yet a fourth faint star at 31″, p. 40°. Some three degrees and a half below and to the left of the star just examined is a beautiful star cluster, No. 1551. Nos. 1564, 1571, and 1630 are other star clusters well worth examination. A planetary nebula is included in 1564. With very powerful telescopes this nebula has been seen ring-shaped. Σ 1146, otherwise known as 5 Navis, is a pretty double, colors pale yellow and blue, magnitudes fifth and seventh, distance 3·25″, p. 19°. Our three-inch will suffice for this.

North of Canis Major and Argo we find Monoceros and Canis Minor (map No. 3). The stars forming the western end of Monoceros are depicted on map No. 1. We shall begin with these. The most interesting and beautiful is 11, a fine triple star, magnitudes fifth, sixth, and seventh, distances 7·4″, p. 131°, and 2·7″, p. 103°. Sir William Herschel regarded this as one of the most beautiful sights in the heavens. It is a good object to try our three-inch on, although it should not be difficult for such an aperture. The star 4 is also a triple, magnitudes sixth, tenth, and eleventh, distances 3·4″, p. 178°, and 10″, p. 244. We should glance at the star 5 to admire its fine orange color. In 8 we find a golden fifth-magnitude star, combined with a blue or lilac star of the seventh magnitude, distance 13″, p. 24°. Σ 938 is a difficult double, magnitudes six and a half and twelve, distance 10″, p. 210°. Σ 921 is double, magnitudes six and a half and eight, distance 16″, p. 4°. At the spot marked on the map 1424 we find an interesting cluster containing one star of the sixth magnitude.

The remaining stars of Monoceros will be found on map No. 3. The double and triple stars to be noted are S, or Σ 950 (which is also a variable and involved in a faint nebula), magnitudes sixth and ninth, distance 2·5″, p. 206°; Σ 1183, double, magnitudes five and a half and eight, distance 31″, p. 326°; Σ 1190, triple, magnitudes five and a half, tenth, and ninth, distances 31″, p. 105, and 67″, p. 244. The clusters are 1465, which has a minute triple star near the center; 1483, one member of whose swarm is red; 1611, very small but rich; and 1637, interesting for the great number of ninth-magnitude stars that it contains. We should use the five-inch for all of these.

Canis Minor and the Head of Hydra are also contained on map No. 3. Procyon, α of Canis Minor, has several minute stars in the same field of view. There is, besides, an invisible companion which no telescope has yet revealed, but which must be of immense mass, since its attraction causes perceptible perturbations in the motion of Procyon. One of the small stars just referred to, the second one east of Procyon, distant one third of the moon's diameter, is an interesting double. Our four-inch may separate it, and the five-inch is certain to do so. The magnitudes are seventh and seven and a half or eighth, distance 1·2″, p. 133°. This star is variously named Σ 1126 and 31 Can. Min. Bode. Star No. 14 is a wide triple, magnitudes sixth, seventh, and eighth, distances 75″, p. 65°, and 115″, p. 154°.

PROCYON AND ITS NEIGHBORS.

In the Head of Hydra we find Σ 1245, a double of sixth and seventh magnitudes, distance 10·5″, p. 25. The larger star shows a fine yellow. In ε we have a beautiful combination of a yellow with a blue star, magnitudes fourth and eighth, distance 3·4″, p. 198°. Finally, let us look at θ for a light test with the five-inch. The two stars composing it are of the fourth and twelfth magnitudes, distance 50″, p. 170°.

The brilliant constellations of Gemini and Taurus tempt us next, but warning clouds are gathering, and we shall do well to house our telescopes and warm our fingers by the winter fire. There will be other bright nights, and the stars are lasting.

BUCKLAND, when traveling, could never pass a quarry without stopping and examining it. On one journey the mare he rode "soon learned her duty, and seemed to take an interest in her master's pursuits; for she would remain quiet, without any one to hold her, while he was examining sections and strata, and then patiently submit to be loaded with the specimens collected. Ultimately she became so accustomed to the work that she invariably came to a full stop at a stone quarry, and nothing would persuade her to proceed until the rider had got off and examined, or, if a stranger to her, pretended to examine, the quarry."

TWENTY-FIVE YEARS OF PREVENTIVE MEDICINE.

By Mrs. H. M. PLUNKETT.

"Who would not give a trifle to *prevent*
What he would give a thousand worlds to cure?"

IN 1849 the Legislature of Massachusetts appropriated five hundred dollars to be expended in a preliminary investigation of the question whether any attempt at sanitation was worth while; and in the year 1893 she expended $62,876.82, under the supervision of her State Board of Health, much of which went to accomplished biological and chemical experts, to learn exactly on what a pure water supply depends. The previous work of the board in this field had been so well done that Prof. Henry Robinson, of England, in a paper read before the Congress of Hygiene and Demography, in London, in 1891, said: "The action that has been taken by the State Board of Health of Massachusetts, to protect the purity of inland waters, deserves to be specially commended as an example of broad and wise policy, in instituting the systematic investigation by engineers, chemists, and biologists of all that bears upon the purification of sewage and on the filtration of water. . . . The exhaustive reports under these different heads may be stated to be far in advance of anything that has been fairly attempted in this country." No better picture of the difference in public opinion at the two dates could be found than those two contrasting amounts of money. At the first, the apathy and indifference born of ignorance reigned; at the second, we behold the immense amount of intelligent effort constantly being put forth in this country as the fruit of a quarter of a century of sanitary education.

If a man is going to give a true history of an apple tree, it will not do to begin when the tiny shoot pushes itself up through the mold; he needs to give an account of the seed itself, how produced, when planted, and of the influences that produced its germination. The seed from which the vast mass of public-health legislation and action among English-speaking peoples has sprung, was planted in England by Edwin Chadwick, between the years 1830 and 1844, when his epoch-making Report on the Health of Towns was made to Parliament. Various commissions, with him at their head, had investigated the great mortality among the troops; had looked into the condition of the children employed in factories, mines, and collieries; had studied the terrible, always-prevailing typhus; but this tremendous array of facts, culminating in the statement that the average length of human life in agricultural Wiltshire was thirty-five years, and in Liverpool only fifteen years, roused the whole nation to ask, "Why?" and "Can nothing be done to remedy it?" Chadwick was a barrister of the Inner Temple when, in 1828, a trifling incident turned his attention from the law to the subject of vital statistics, of which few worthy of the name were in existence. An able article from his pen, on What might be done to Improve the Taking of Vital Statistics, at once drew the attention of the country to him, and pointed him out as a man of unique sagacity in "extracting from masses of details the master facts, and bringing these to bear for the elucidation of a master thought." Parliament at once made use of his remarkable abilities, and, beginning with finding out the worst that could be known, inaugurated measures, largely under his guidance, for the amelioration of evils, till to-day, they and we, live in a different world. Most worthily was he knighted by the Queen, and when he died was universally recognized as the father of sanitation. One of his earliest measures was the framing of an act to procure an accurate registration of births, marriages, and deaths; and Sir John Simon says: "Before that time a perfect chaos respecting the population and mortality reigned. Since that time a mass of statistics relative to life, health, and disease has been accumulating which will exert, and is exerting, an immensely beneficial influence upon the physical and moral welfare of these realms (England and Wales), and indeed, ultimately, on every people on the face of the globe. The discoveries in astronomy have not a more palpable application to navigation and commerce, or the investigations of chemistry to manufactures, than have the statistics of health and disease to moral regeneration." But it was Chadwick's report of 1844 that waked up a slumbering nation. Fifty years after, the death rate in the whole country had been cut down from thirty-two to eighteen in the thousand. The work going on there did not escape the eyes of progressive men here. Another layman, Lemuel Shattuck, of Boston, watched the matter in its every step of development, and being touched with the same fine "enthusiasm for humanity" as Chadwick, by voice and pen strove to kindle an answering flame at home. Largely through his influence, the Legislature of Massachusetts passed an act in 1849 by which the Governor was to appoint three commissioners who were to report and prepare a plan for a sanitary survey of the State, etc. They were to be paid, for the time actually spent in the discharge of their duty, the same compensation as members of the General Court, and for travel, and could spend fifty dollars for books, which were to belong to the State Library when they were done with them, but on no account were the expenses of the commission to exceed five hundred dollars!

The Governor appointed Lemuel Shattuck, N. P. Banks, and

Jehiel Abbott as commissioners, and Mr. Shattuck formulated their conclusions in a report that to-day is one of the most interesting and instructive of sanitary documents. Sanitary science, as we now know it, had not come into being then, so that to write about it as an existent fact was considerably like "coining a vacuum"; but Mr. Shattuck condensed into it all that history can teach on hygiene from Moses down, and, as he was keenly alive to all that was going on in England, he did not fail to call attention to the great awakening on the subject there, where already two sanitary journals were established, and public meetings were being held in all parts of the country, where it was declared that "sanitation is the great idea of the age." Every consideration which it was thought could influence the legislative mind was brought to bear. The commission called attention to the fact that there had already been costly and valuable reports made on insects; the invertebrates; on fishes, reptiles, and birds; and one on trees and shrubs; and they say it would be reasonable to suppose that *man* was entitled to a consideration equal to either of these subjects. They cite the fact that two costly expeditions had been fitted out to search for Sir John Franklin, and ask if the preservation of the lives of many possible Franklins is not as worthy an object. They maintain that the average of human life may be much extended, its physical power augmented, . . . untimely deaths prevented, and that measures for *prevention* will effect infinitely more than remedies for the cure of disease. They compute the needless loss of life and the cost of avoidable sickness. They appeal to intelligent men of all classes, medical and non-medical, and quote from Simon's Report on the Condition of London: "Ignorant men may sneer at the pretensions of sanitary science. Weak and timorous men may hesitate to commit themselves to its principles, so large is their application. Selfish men may shrink from the labor of change, wicked men may turn indifferently from considering that which concerns the health and happiness of millions of their fellow-creatures, but in the great objects which it proposes to itself it transcends in importance all other sciences, and in its beneficent operation it seems to embody the spirit and to fulfill the intentions of practical Christianity." They brought the argument home, by demonstrating that at least $7,500,000 were lost annually to Massachusetts through untimely deaths and needless sickness.

The Board of Health they recommended was to consist of two doctors, one lawyer, one chemist or naturalist, and two of other occupations; and an elaborate plan of action was drawn up, covering nearly every possible combination of circumstances that such a board would be likely to encounter. Dr. Bowditch said, twenty-seven years after, "This magnificent report fell flat from the printer's hands, but when in 1869 the State Board was established it was on the lines Mr. Shattuck had drawn." He did not live to see it carried into effect, but while he lived he never ceased to strive to bring the people of his State to correct views; and now that a great majority of the States have modeled their boards on that of Massachusetts, we can see that he did not labor in vain.

Meantime not all the rest of the country was asleep, for very earnest efforts were making in New York city looking toward the establishment of a central health authority. There was need enough of it, as these facts show: twenty thousand people were living in cellars; there were spots from which typhus was never absent; there were no less than three hundred and seventeen slaughterhouses with their inevitable fat-rendering and bone-boiling concomitants below Eightieth Street; and there is a credible witness now living who saw a small child killed in Madison Street, by one of the hogs which formerly ran loose in the city. It took fifteen years of effort, on the part of a set of men whose disinterested devotion to the best interests of humanity is beyond praise, before, in 1866, they secured a Board of Health for the city. Repeated decimating invasions of yellow fever had visited New Orleans, and in 1855 the Legislature of Louisiana passed a law for the establishment of quarantine, that involved the spending of much money; its authority was vested in a State Board of Health, and its powers were much enlarged in 1867. It was, no doubt, a valuable instrument with which to repel the invasion of exotic epidemics, but bore little resemblance to the thirty-seven State Boards of Health that have since come into being. The one was a frantic effort to repel an external enemy; the others direct their main efforts to the correction of internal sanitary sins of omission and commission. These, with their vigilant watchers in every hamlet, and their multipled publications of reports, pamphlets, directions, and leaflets—the true leaves that are for the healing of the nations—constitute a bureau of information that has saved thousands and thousands of lives. While Lemuel Shattuck's splendid programme of action was calmly slumbering in the State Library the war came, and all minor issues were swallowed up in the one "Shall we have a country left?" But even this had its compensations. Dr. H. I. Bowditch truly says, "Both North and South discovered the all-important advantages of cleanliness, sobriety, and strict methods of action, as opposed to the distress consequent on filth, intemperance, and chaotic rule." Dr. Bowditch himself, by the most persistent efforts, induced our military authorities to provide comfortable ambulances for the wounded, and from them has come the present ambulance system of the world—for Europe copied us in this matter.

The putting to sleep of Lemuel Shattuck's noble report by apathetic legislators did not prevent progressive minds from pursuing the subject, and there was a knot of men in Boston who kept up interest in the work by stated meetings among themselves, and occasional public meetings, at one of which Edward Everett delivered one of his most brilliant addresses; but when they ascended Beacon Hill and took the practical steps of asking for the organization of a State Board of Health, it was sure to be defeated by the rural legislator from "way back," typified by the one who said, "Them boards don't do no good, and they cost a sight o' money." Just before the war the prospect became hopeful, and then came the imperative "Halt!" to all the lines of forward-marching progress. During the four long, bitter years of contest the whole land had taken a lesson in the value of organized action, and as soon as we had caught our breath the march was resumed with a quickened step. Meantime England had made great strides in practical sanitation, and it had begun to be stoutly held that some of the most destructive diseases are not the visitations of an angry God for the moral derelictions of people, but are the direct and palpable outcome of the neglect of sanitary laws. Especially was it believed in England that typhoid fever, the decimating scourge of young manhood and young womanhood, can be averted; and on this side the water Dr. Bowditch had instituted an inquiry looking to discovering the preventable causes of consumption. The results, printed only for private circulation, made a great impression in medical circles—for bacteriology with its tubercle bacillus had not been even heard of. The phrases Preventive or State medicine had begun to be used, when, in 1869, a remarkable concatenation of circumstances, consisting of two distinct lines of action, resulted in the establishment of the Massachusetts Board of Health. Repeated repulses at the State House had completely disheartened the advocates of State medicine in Boston, but unexpected help was coming to their aid from the extreme western part of the State. Those familiar with the annals of sanitation will recall a fearful visitation known as the *Maplewood Fever*, which occurred in the year 1864 in Pittsfield, at the Young Ladies' Institute, in which out of seventy-seven pupils fifty-one had typhoid fever of a virulent type, and thirteen died—as the result of purely local causes, the direct result of ignorant sanitary neglect. The outbreak occurred in August, and in September, at the instance of Thomas F. Plunkett (husband of the writer), three of the professors, who had come to give their annual courses of lectures in the Berkshire Medical College, undertook a searching investigation. They were A. B. Palmer and C. L. Ford, of the University of Michigan, and Pliny Earle, Superintendent of the Northampton Insane Asylum, and after several months their fearless and exhaustive report was published in the Boston Medical and Surgical Journal and in pamphlet form. It created a profound sensation; but lest the proprietor of that school should be thought a "sinner above all others," it should be recalled that these were days prehistoric to sanitation, and that a bulky volume might be made up of the stories of epidemics caused by unsanitary conditions connected with schools and colleges. The man who had instigated the investigation was no enemy, but had been friend, trustee, and patron of the school from its foundation, but he was of the *fiat-justitia-ruat-cœlum* type, and the findings of the report, which proved that on those beautiful grounds, and only there, save in the case of day pupils who had been subjected to the same poison, was there any typhoid fever, sank deep into his heart. We quote one of the closing sentences: "To whatever extent the ignorance of sanitary laws may shield the violator from moral responsibility, it will not abate the physical penalty of such violation. This will fall with the same force upon the unconscious, the ignorant, the helpless, and morally innocent, as upon the intelligent, the powerful, and the wicked. . . . To prevent the poison of typhoid fever, when taken into the system, from producing its legitimate effects, except by natural agencies, would require as positive a miracle as to restore a severed head, or arrest the course of the heavenly bodies. Instead of closing our eyes and soothing our minds by casting the responsibility of a great calamity upon Providence, we should look to the physical conditions producing it, and see if these conditions are remediable." Some people thought these declarations of the preventability of disease by human agency bordered on the blasphemous, but the thought was "in the air." Dr. Budd, of Bristol, in England, had traced epidemics of typhoid directly to infected drinking water; and Dr. Austin Flint's classical study of the outbreak near Buffalo, N. Y., convinced medical men of its preventability, as well as here and there a progressive layman, but they all saw that only organized, concerted effort, fortified by law, could effect this exemption. Mr. Plunkett was chosen to the Legislature in 1868, and made some tentative efforts looking to a State Board, but the time was not auspicious. He was again a member in 1869, and in a faction fight in the dominant party had been able to render the candidate who was finally seated as Speaker an important service, and naturally the gentleman so seated was "willing to oblige," etc. Among the members were three physicians, and some other broad-minded progressive men; and rather late in the session, the motion was made to appoint a committee to inquire into the expediency of establishing a Board of Health. The man who made the motion was placed at its head, and the kindly disposed Speaker desired him to name his associates; he designated those to whom the cause would appeal. Word was sent to Dr. Bowditch and his fellow-sanitarians to come and present their reasons. A bill was drawn, but its champion did not care to have it discussed till late in the session, when many of the timid obstructionists would have hied themselves to their rural farms; and when speaking in its advocacy, he ignored the wails of the bereaved fathers and mothers of the Maplewood pupils, and based his plea entirely on economic grounds, saying that by the aid of law preventable diseases might be checked; that it had been shown that typhoid fever was a preventable disease. He called attention to the fact that it generally attacked persons in the productive age, and that scarcely one of the three hundred and thirty-five towns in the State but had at least one annual victim. He said a man of twenty-one represented an investment of ten thousand dollars; that it had cost at least five hundred dollars each year of somebody's money—public or private—to feed, clothe, shelter, and educate him; and thus the State sustained an annual loss of five million three hundred and fifty thousand dollars.

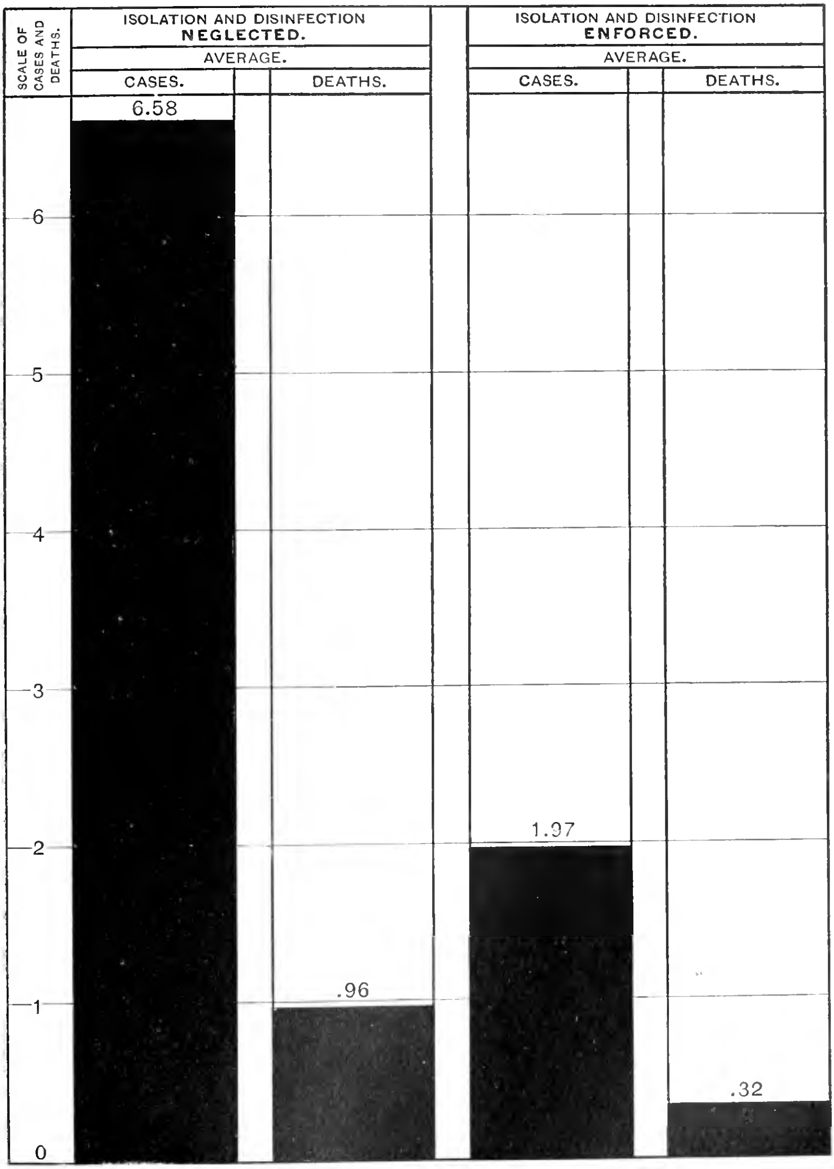
It seems humiliating that the issues of life and death should be made to hinge on a pocket argument, but it was effective, and the law establishing a State Board of Health was enacted June 21, 1869. The members were to be appointed by the Governor and Council. The act was not twenty-four hours old before an application from an unprogressive doctor-constituent came to its champion for a position. The Governor said, "I suppose you have some friends you would like to see on the board?" "No," was the answer, "only I think it goes without saying who should be at its head—Dr. H. I. Bowditch, who has worked disinterestedly for so many years toward this consummation; for the rest, all I ask is that you will not make it worthless by appointing a set of nobodies, on account of their political opinions." The Governor rose to the occasion; the pace he set has never been lost, and in the twenty-five years of its existence many of the ablest men in the Commonwealth have lent their powers to make it a success. The action of the member from the "western county" may be compared to that of the man who turns the jet and applies the match, thus setting the already waiting illuminant alight—a small but very indispensable operation. There are now thirty-six State Boards patterned very closely after this, under whose guidance a whole army of sanitarians is at work.

"Its banner bears the single line,
'Our duty is to save.'"

The board had to blaze out a new path into regions hitherto unoccupied. At its first meeting Dr. Bowditch said: "I know of no higher office in the State than that which we now hold, viz., that of inaugurating the idea of State medicine in Massachusetts. Upon our high or low appreciation of the position, and of the duties resulting from that position, and upon our wise or foolish performance of these duties, depends the success of the object aimed at. Our work is for the far future as well as for the present. . . . I wish to impress upon you the essential dignity of the offices we now hold, and that we should assume them with minds loyal to the truth. . . . State medicine ranks among the most important matters now discussed by the highest intellects and the humanest hearts in Great Britain. . . . The chief object of the physician is *to cure;* the far higher aim of State medicine is, by its thorough and scientific investigation of the hidden causes of diseases that are constantly at work in an ignorant and debased community, to *prevent* the very origination of such diseases." He quoted Simon's "platform," that the sole object of State medicine is "the improvement in human health, and the lengthening out of human life of each individual man and woman." He also cited Dr. Farr's: "The primary object of public medicine is to prevent disease, but it also surrounds the sick with conditions most favorable to recovery, and diminishes the death-roll of the people. But supposing every condition most favorable for the operation of State medicine, we should still see grave defects in many persons; shortcomings in others; in many, organic degeneracies; in many, criminal depravities. How, out of the existing seed, to raise races of men to divine perfection is the final problem of public medicine. Public hygiene is a want, as much as air and public roads and waters are public necessities, and as such, must be cared for and paid for by the community."

The high ideal was nobly lived up to, and in a sort of manifesto addressed to the Municipal Boards of Health, nominally existing in all the towns of the State, they say: "We believe that all citizens have an inherent right to the enjoyment of pure and uncontaminated air and water and soil; that this right should be regarded as belonging to the whole community; and that no one should be allowed to trespass upon it by his carelessness or his avarice, or even by his ignorance. . . . These propositions are recognized in existing statutes, but they are not enforced, and the reason of that is, that the public mind is not sufficiently aware of the dangerous elements around us, does not understand the connection between filth and disease, and is not convinced that undrained land is not wholesome to live upon." The board at once set about collecting the mortality statistics in the principal cities and towns of the State, and addressed themselves to investigating the corruption of springs, wells, reservoirs, and aqueducts, the sale of dangerous drugs, the sale of "swill milk" and watered milk, the sale of unwholesome meat, the condition of tenement and lodging houses, but say that "local and private interests have, it is thought, often been strong enough to paralyze the action of local health authorities"—an opinion that was violently confirmed a few years after, when they found themselves involved in a lawsuit with a powerful firm who were corrupting the water supply of a town with offal. It rendered a report to the Legislature of 1870, when it had been at work only six months, and had little of achievement to relate; but in the lofty ideals it holds up, and its catalogue of reasonable hopes for the future, though only a pamphlet of fifty-eight pages, it remains to this day a good sanitary bible for the earnest disciple. It would be amusing if it were not painful to see how gingerly it walked, claiming only "advisory" powers, it was by no means firm in the saddle and dreaded lest some "watchdog of the treasury" should land it on the ground. In the second year, an investigation was begun of the possibilities of improvement in tenement houses, which it is not too much to say has led up to the immense improvement in that class of dwellings throughout the United States; and in the third year it was directed by an act of the Legislature on April 6, 1872, to "consider the general subject of the disposition of the sewage of towns and cities and to report to the next Legislature their views, with such information as they can obtain upon the subject, from our own or other lands." This was the beginning of the accurate study of a subject that has a personal interest for every man, woman, and child. It has been prosecuted uninterruptedly since, and at the end of nearly two decades, in 1890, it put forth its monumental and authoritative three-volume report, one of which relates to the general work of the board, one to Purification of Sewage and Water, and one to Examination of Water Supplies. Dr. Bowditch had said in 1869, "Public health has so wide a field that help is needed from all—from the chemist, the engineer, the naturalist, and from the humblest citizen as well as the highest statesman." He didn't mention the bacteriologist, because that interesting personage did not exist. He was beginning to be evolved in Pasteur, who was studying the "parasitic diseases of silkworms," and in Tyndall, who was earnestly probing the truth or falsity of the doctrine of "spontaneous generation," but, as we now know many of him, he was *non est*. No less than four chemists *par excellence*, one civil engineer, and one professed biologist, outside the regular corps of medical and other contributors, help to make this a work that puts this country in advance of all Europe, and which will find a place in all scientific libraries.

Typhoid Fever in Michigan in 1890. The figures represent the number of persons per 10,000 inhabitants. They were compiled from the State Board's "Vital Statistics," obtained from the reports of local Health Officers.



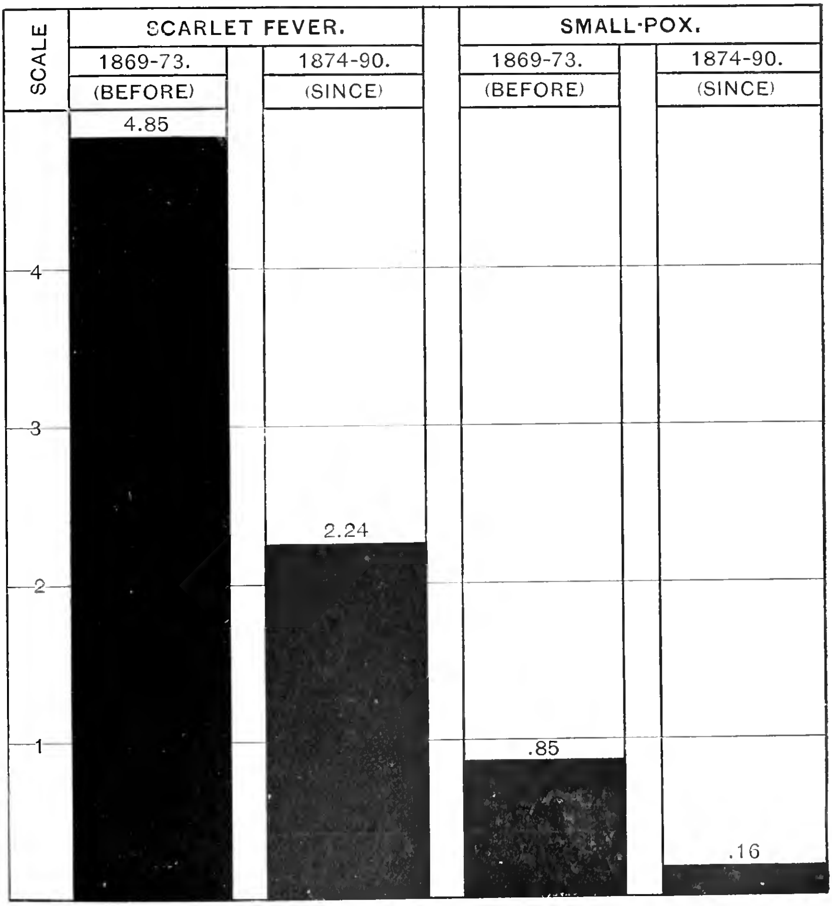
In 1876 Dr. Bowditch made an address at Philadelphia on the then status of preventive medicine, in which he prophesied a grand future for it, and said, "The touchstone which tests the earnestness of any individual or community in reference to any subject is a willingness to spend money in the furtherance of it," and the five hundred dollars that was to be spent in 1849, in finding out whether the State had best do anything toward public hygiene, and the $62,876.82 that was spent in 1893 for expert work by her trained corps of sanitarians, are capital indices of the contrasting condition of public opinion at the two periods.

Knowledge and light can not be fenced in or shut out, and the example set in the early home of the Puritans saw its first answering spark on the Pacific coast. It was only two decades since the irruption of the Forty-niners when California, in 1870, established her State Board, "in order to remain on the level of other intelligent people in other States." Her influential citizens had gone from the East as grown men, and some of them had been disciples of Lemuel Shattuck in Boston. Some of our young States have made astonishing advances, because not hampered with a set of conservative obstructionists, and when once started on the track of progress have shown a fruitful activity quite overshadowing the action of older communities. In the very next year Minnesota established a State Board, and thus a nucleus for the growing work of preventive medicine was planted on the four borders of the land, that at New Orleans being the most palpable and obvious, as the quarantining and disinfecting and fumigating of yellow fever, is a much more perceptible process than the noiseless but sure elimination of malarial fever from Maryland by extensive sanitary underdraining.

Two of the men who had investigated the Maplewood fever were professors in the medical college at Ann Arbor. They were indefatigable in efforts to influence the Legislature, and did not rest till Michigan had a State Board of Health, with Dr. Henry B. Baker as its secretary—an enthusiastic knight of sanitary science, possessed of a phenomenal ingenuity in popularizing its study among the million, and in making its work valuable. The work it has done in reducing the death-rate from scarlatina, diphtheria, and smallpox is a true nineteenth-century miracle.

Maryland and the District of Columbia followed in 1874, Mississippi in 1875, and Tennessee in 1877. It required eight years to get ten boards, and when we scan the legislation that gave them being, and see how little money was given them to work with—scarcely enough to pay necessary postage on the letters that must pass before any *rapport* could be established between the central authority and the separate municipalities—it is apparent that the public mind was far from convinced as to their utility, and the public heart was by no means "fired" with zeal to aid their work. A pathetic story attaches to the North Carolina Board. Dr. Thomas F. Wood—one of those patient, self-sacrificing men whose worth is never half known till they are dead—had labored unremittingly through the columns of a medical journal that he conducted for a State Board. At last the

Lives saved by Public Health work, by comparison of death-rate in Michigan before and after the establishment of the State Board of Health. Compiled from the Vital Statistics gathered by local Health Officers, and showing at a glance the value of enforced sanitation. Lives saved from scarlet fever in seventeen years—7,265.



Legislature yielded to his importunate zeal. He devoted the entire earnings of his journal to sustaining it for four years of "anxiety and hardship"; but the blood of the martyrs has been the most fertilizing material that has ever been expended on this crooked old earth, and before his lamented death in the prime of life in 1892, he saw his State with a thoroughly organized health service in every corner.

Lack of space forbids a detailed statement of the work which at the close of the first decade had gained such a momentum that thirty-seven boards in as many States have been formed, young Oklahoma—bent on having every improvement that can attract immigration—bringing up the rear. Most of them are composed entirely of physicians. No commendations are too strong for these true knights of science, who, in the spirit of "truth for truth's sake," have labored unceasingly and unselfishly to promote preventive medicine.

The modern State Health Board is a highly organized educational machine, in each State employing experts to investigate the mistakes and errors, the needs and advantages of the region. At the first menace of invasion by cholera, yellow fever, or smallpox the State is at once transformed into a camp of instruction, through the myriads of pamphlets and leaflets that fly on the wings of every outgoing train to the farthest hamlet or lumber camp or mine, in many tongues—a true pentecostal dispensation of saving light and knowledge. It is twenty-five years since the first one drew its first timid breath. State medicine is now rapidly growing and will be a giant. Its twenty-fifth birthday seemed a good milestone at which to pause and, in mercantile parlance, "take account of stock." A circular letter was sent out to all the secretaries as follows:

1. When was your State Board established?
2. To the reform of what sanitary errors or abuses did it address itself?
3. What obstacles did it encounter?
4. What positive results has it effected?
5. By what methods does it promote sanitary and hygienic reforms?

From all but three, careful, painstaking, and most courteous answers have been received, often accompanied by documents of inestimable value, both as presenting a graphic picture of sanitation to-day in the localities whence they come, and as a mine of sanitary information.*

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* The names of the gentlemen thus kindly favoring me, and of the States to which they belong, are as follow: Alabama, Jerome Cochrane, M. D.; Arkansas, D. W. Holman; California, J. R. Lane, M. D.; Connecticut, Prof. C. A. Lindsley, M. D.; Delaware, F. B. Frazer; District of Columbia, W. C. Woodward, M. D.; Florida, Joseph Y. Porter, M. D.; Illinois, J. W. Scott; Indiana, C. N. Metcalf, M. D.; Iowa, J. F. Kennedy, M. D.; Kansas, M. O'Brien, M. D.; Kentucky, J. N. McCormac, M. D.; Louisiana, W. R. Harman, M. D.; Maine, A. S. Young, M. D.; Maryland, James A. Stewart, M. D.; Massachusetts, G. W. Abbott, M. D.; Michigan, Henry B. Baker, M. D.; Minnesota, C. N. Hewitt, M. D.; Mississippi, Wirt Johnson, M. D.; Missouri, R. C. Atkinson, M. D.; New Hampshire, Irving A. Watson, M. D.; New Jersey, W. D. Mitchell, M. D.; New York, J. S. Barnes, M. D.; Rhode Island, Gardner T. Swarts; South Carolina, H. D. Frazer, M. D.; North Carolina, Richard

The most glaring of all sanitary errors a quarter of a century ago was ignorance of the danger that lurks in an impure water supply, and the early efforts of most of the boards was directed to the protection of inland waters from pollution, and to inducing people in the older sections of the country whose ancient wells proved incomparable disease-breeders, to provide themselves with "piped"—i. e., protected—water wherever obtainable from an uncontaminated source. The legislative appropriations of money made it possible for the frontier and coast States to put in force efficient quarantine against those incursions of infectious disease that every now and again will strive to enter, in the person of the irrepressible immigrant. The newer, far western States have been the stamping-ground of quacks of every type, and the place where men with credentials bought from some "diploma mill" have passed as physicians, and where others, honest enough, have established themselves as doctors after acquiring so little of medical knowledge that an eastern man would not trust them with the care of a favorite cat. All those States have made a uniform push for registration of physicians, and in those where there are medical colleges, for a longer and more thorough course of medical education. The early boards had to make headway against prejudice and vested abuses, but they labored to enlighten and educate the people, and they reached a turn of the tide at about the end of the first decade, so that those that have been formed since were able at once to set about positive measures for good, and did not have to waste strength on combating obstacles. The history of the health boards supplies a beautiful example of the evolution of a sustaining public opinion—certainly "at the top" among the educated.

To the query, "What obstacles did it encounter?" there comes up one uniform chorus of groans over the apathy, indifference, and ignorance of the populace, and in some cases hostility from the medical profession itself, of whom better things might have been expected. If they tremble lest the world shall educate and sanitate itself into such perfect health that there will be no demand for their services, they can dismiss their foolish fears, for the more intelligent a man becomes in the structure of this "harp of a thousand strings," and the delicate adjustments on which its harmony depends, the less willing will he be to trust to an ignoramus when it gets out of tune. A long history might be made up of actual instances where greed of money has attempted

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M. Lewis, M. D.; North Dakota, F. H. De Vaux, M. D.; Ohio, C. O. Probst, M. D.; Oklahoma, J. O. Overton, M. D.; Pennsylvania, Benjamin Lee, M. D.; Tennessee, J. Berrien Lindsley, M. D.; Washington, G. S. Armstrong, M. D.; West Virginia, N. D. Baker; Wisconsin, U. O. B. Wingate, M. D.

to block the onward progress of sanitation. In Pennsylvania, added to indifference and ignorance, "was the direct and persistent opposition of manufacturers of every kind, the prosecution of whose business led them to dispose of their waste, no matter of how offensive a character, in the least expensive way, that is, by dumping it into the public streams." In Rhode Island there was "the usual and expected objection to the prevention of the sale of glandered and other diseased animals." In Maryland the obstacles were "ignorance, selfishness, obstinacy, old habits and customs, and the difficulty of obtaining such legislation as was necessary to sustain the authority of the board in suppressing nuisances." In Missouri it was "the opposition of all the unclean and dishonest who are practicing or pretending to practice medicine, and of the ignorant people outside of the profession who seem to be anxious to be humbugged and defrauded." In Michigan it was "the inertia due to the general ignorance of the people on sanitary subjects, and the sentiment of economy prompting to opposition on account of the cost; in North Carolina, "apathy, indifference, in some cases positive hostility, when the demand was made for money or for work that was inconvenient"; in Iowa, "ignorance of the masses." "Ignorance," "lack of funds," runs with tiresome iteration through many, for, though there are ample legal powers, there must be money to aid in their enforcement. One writer puts the difficulty very delicately as "civilization imperfectly developed"; while the Connecticut secretary comes down to details thus: "The obstacles in the way have been the unsuitableness of the persons who, *ex officio*, constituted the local boards of health, the paralysis of these boards resulting from long years of inaction and torpidity, and the settled conviction on the part of the majority of the old communities, that the habits and customs of their ancestors were good enough." The Rhode Island man goes still deeper into the psychological mysteries of the matter thus: "From the early instructions and habits of our first settler, Roger Williams, we have all been led to believe that we severally and individually are a law unto ourselves, and as soon as any new law or change is ordered, even by the representatives of the individual, it becomes at once our duty to oppose it"; and the secretary of Tennessee says, "Those obstacles usually encountered by missionaries in any field, who come to teach the new gospel that 'thou art thy brother's keeper.'"

The third question was, "What positive results has your Board achieved?" Before going into details, we would say the first great collective beneficial result of sanitation is in the moral realm—the successful propagation of the idea that a man has no more right to poison the water which his neighbor must drink, or the air he must breathe, than he has to put strychnine in his food—

either is potential murder, and is coming to be so regarded; and the next touches the sphere of the affections, as it has saved thousands and thousands of lives, as a long catalogue of diminished death-rates testifies. At the World's Fair Dr. Abbott had prepared a series of sanitary maps of Massachusetts, exhibiting the comparative ravages of the communicable diseases. The towns most deeply stricken by them were colored a bright carmine, and, by different patterns of cross-hatchings, the greater or lesser prevalence was indicated by lighter and lighter shadings, till at last one or two happy localities were left a pure white. In the map of *Typhoid Fever* one was instantly struck with the deeper dye of the rural districts, while for a radius of a hundred miles around Boston hardly a town showed more than a mild pink, and the general effect changed the whole aspect of that half of the State. The reason is not far to seek. The perpetual exhortations to "get pure water" have so moved the people that perhaps there is more "piped" water in that section than in any other equal area in the United States, a fact that takes on fresh significance when we consider that there is a population of two hundred and seventy-five persons to the square mile, and that parts of it have been lived in more than two centuries and a half. Such conditions call for much more vigilant supervision than "out west," where one person to the square mile lives on fresh, uncontaminated soil. That lighter shading means that to-day thousands of young men and women are "breathing this sweet air of life" who, but for the action that led up to it, and all it means, would be filling untimely graves.

The whole subject of vaccination, revaccination, and the establishment of vaccine stations where pure, active, and fresh bovine lymph is produced, has been so frequently and thoroughly discussed and acted upon by the several boards, that it is strange that any intelligent person should allow himself or his family to remain for a day unvaccinated. Still, in Minnesota seventy per cent of the school children are not vaccinated, and the knowledge of this fact so moved the State Board, that they at once established a station for the production of a safe virus. In Massachusetts, in the epidemic of 1872, there were five thousand six hundred and six cases of it, and in one year since there were but two. Self-interest has protected the State from the evil result of the incursion of unvaccinated French Canadians, for they are not allowed to go to work in the factories till after they show the vaccination certificate. In Rhode Island general gratuitous vaccination and the compulsory vaccination of school children have reduced the mortality to one twentieth of what it was, though this is a manufacturing State, subject to the irruption of hordes of the unvaccinated.

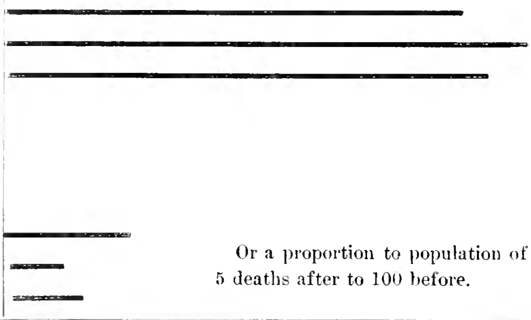
Mortality from Smallpox in Rhode Island before and after General Gratuitous Vaccination and Compulsory Vaccination of School Children.

BEFORE.

Five-year Periods.	Population.	Mortality from smallpox.
1863–'67...	184,965	44
1868–'72...	217,353	48
1873–'77...	258,239	46

AFTER.

Five-year Periods.	Population.	Mortality from smallpox.
1878–'82...	276,531	7
1883–'87...	304,284	3
1888–'92...	345,506	4



Or a proportion to population of 5 deaths after to 100 before.

Deaths from Smallpox in Massachusetts, by Decades.

Ten-year Periods.	Deaths.
1863–'72...	2,375
1873–'82...	922
1883–'92...	51

Previously to 1872 there had been an almost universal neglect of vaccination, and the idea of compulsory vaccination had not come into people's minds. The great epidemic of 1872, which swept around the world and destroyed thousands of lives, had the effect of rousing people to the value and practice of vaccination. Still, the factory towns, which were ever receiving fresh relays of the unvaccinated from Canada—especially the paper-mill towns, with rags from all over the world—would every now and again have an outbreak. At last stringent laws were passed at the instigation of the Board of Health for the vaccination of school children, and self interest accomplished the work in factories with such obvious good results that now a stringent State law aids in producing the result shown in the smallest of the three lines.

There is no need to recite how the States whose situation exposes them to cholera and yellow fever have, through their boards, provided themselves with all the means of enforcing necessary quarantine, and with the best disinfecting apparatus known to science, the mere possession of which has put old-fashioned panics to flight. Alas for Georgia! She stands forth a dismal foil to the above, and a dark object lesson. When yellow fever smote her second commercial town in 1893, her former State Board had been abolished and there was no organized *authority*. The Brunswick epidemic ought to silence the rivalries among doctors that led to the abolition of the board. Nashville, Tenn., in 1878, made enlightened preparations under the leadership of Dr. J. D. Plunket,* and, though there were twenty-four cases, either coming from other places or originating there, they were restricted, cared for in a hospital made ready, and the business of the city went on with no interruption; but there was concentrated authority at the center of things.

The large southern and western States—each of which is a sort of empire—have organized their work largely by counties, each of which has a board that reports to the central State Board, and they are doing a valuable work in the collection and collation of vital statistics—a work in which our country lags far behind European lands. Should our Congress see fit to create the Bureau of Public Health within the Department of the Interior, now asked for by the New York Academy of Medicine, and all sensible sanitary bodies everywhere, it would be bringing our country into step with other progressive peoples. Dr. Abbott, of Massachusetts, made a plea before the Sanitary Congress at Chicago for a national registration. Is not a numbering of the people, and an account of their sicknesses and deaths, of as much importance as the acreage of wheat or corn, and the number of acres that have been destroyed by weevils or fungi? It would seem that a central authority can better fence out those contagious diseases that pay no attention to State lines, than one diffused among a number of organizations, even though each one has its inalienable State rights.

The scientific and safe sanitation of the Columbian Fair grounds in Chicago, and the direct reduction of the typhoid-fever rate there from the hour when water from the contaminated intakes was shut off, and the new four-mile tunnel began to be used, is a distinct triumph of the science of sanitation.

The thirty-seven boards have very different phases of sanitary and hygienic errors brought to their attention, and naturally each attacks the evil that is most importunate in his section, and the result is that there is no detail of the house—its site, its material, construction, plumbing, heating, lighting, or ventilation—that is not exhaustively discussed by some competent mind; nothing pertaining to the hygiene of the individual escapes them, from protecting the newly born from blindness, up through all the perils of youth, middle life, and age, till at last he finds sanitary sepulture at the hands of a funeral director who has been carefully taught by his State board how to conduct the entombment of those who have died of the most virulent infections with perfect safety to the living. The frauds and adulterations in foods

* No connection of the writer, and spells his name differently.

and drugs are exposed, health resorts, prisons, hospitals, and public buildings are inspected, the poor are provided with sanitary homes—in short, the people are watched over and defended from the cradle to the grave. The steady lengthening of human life shows that their intelligent efforts are not wasted. The annual reports are an incomparable means of mutual education, for no new method of investigation or illustration appears in one that is not availed of by the others. The mere titles of the different topics to which study has been directed would fill several pages of this magazine.

The last query was, "By what methods does it promote sanitary and hygienic reforms?" The comprehensive reply deduced from the thirty-seven letters is "the education of the people" through reports, circulars, pamphlets, and leaflets, accompanied by most ingenious and instructive maps, charts, and graphic diagrams. While one of the most potent means of convincing and moving men is the human voice, with a clear brain, an enthusiastic soul, and a worthy cause behind it, the most lasting and universal is a judicious diffusion of printer's ink. Most of the boards keep on hand, circulars, giving plain directions how to care for and limit the spread of contagious diseases—a work made easier since bacteriology became the definite science that it now is. In one sanitary convention complaint was made that these tracts in large numbers remained piled up in the offices of the board. But there comes a moment when they achieve their destiny. Let a case of scarlatina break out, as soon as the telegraph can order, and the mail bring these documents, people are conning them for a way of escape, and that locality will never again be as densely ignorant as it was. The State of Pennsylvania sends out twenty-three different ones, and some of them printed in many tongues, for the benefit of her polyglot people; and there are few of the States that have not established similar fountains to send forth a fertilizing irrigation of knowledge. In the States of Michigan and Pennsylvania conventions held in localities that need them have been found of the greatest value. The first holds four a year, and already forty-eight separate localities have experienced this quickening visitation. In Ohio the State Board holds joint conventions now with the school teachers, and again with the "funeral directors." The Maine Board prints a monthly journal, and sends it to school teachers, clergymen, and heads of local boards. Maryland tries to send tracts to every family. In the larger and more sparsely settled western States the central board gets into very close and vital relations with local boards, and as a consequence two States, Tennessee and Indiana, report, "We no longer have epidemics of diphtheria, since we have learned to limit and counteract it." In Minnesota sixteen hundred and thirty local boards reported to the central authority in 1892, which proves that at least sixteen hundred and thirty persons are not asleep. The secretary wrote three thousand one hundred and fifty-three letters on subjects ranging from glanders and leprosy to vital statistics.

Says the secretary of Kentucky, "The growth of sanitary work in public confidence has been very marked, especially in the last three or four years."

The capital of our country presents a very perfect object lesson of what thorough sanitation is; it formerly was bad, as bad could be.

Progressive physicians early perceived the trend of preventive medicine, and also the advantage of a free interchange of ideas, and have now been formed into the American Public Health Association twenty-one years, through which Mexico, Canada, and the United States form a sanitary solidarity.

In 1879 the Sanitary Council of the Mississippi Valley was formed, and the struggle that the Nestor of sanitarians, Dr. J. H. Rauch, and Dr. Holt, had with the authorities of Louisiana to prevent concealment and dissimulation makes a lively and interesting story; but for twelve years there has been practically no yellow fever in New Orleans (since 1880), and the commercial value of the services of that council are immense, while there is no measuring the confidence inspired in millions of minds, that they will surely keep the fever or the cholera out.

Incidentally the new profession of sanitary engineer has come into being, and an immense amount of sanitary literature has accumulated. What of the future? The best sign of the times we have kept for the last: women are actually becoming interested in practical sanitation, and large classes of them have *paid money* to be instructed in it in Boston lately. The movement of these public bodies is important but extraneous; this feminine interest is vital and interstitial, and under woman's influence we look to see the physical life made doubly worth the living.

A hundred years ago to-day Jenner alone knew the secret of the means by which smallpox was to be virtually banished. Now hundreds of people know the precise conditions under which a successful crusade of extermination against consumption can be conducted. Is it too much to hope that fifty years will see it driven out from among civilized peoples?

Prof. Cyrus Thomas, who has made special studies of the subject for several years, has reached the conclusion that ancient Mexican civilization originated with the Malays of the South Pacific islands, and believes that he has established a connection between the languages of those tribes and that of the Mayas, showing it to be a direct offshoot from them.

ETHICS IN NATURAL LAW.*

By Dr. LEWIS G. JANES.

RESTING recently for a brief while, apart from the stress and turmoil of metropolitan life, close to the heart of Nature, in a tree-embowered home in a quiet New Jersey hamlet, whence the eye wandered across green fields to a distant wooded crest, inviting conquest by its promise of entrancing views—the sun flickering here and there through the overhanging boughs of the clustering maples which furnished grateful protection from its intenser heats—the earth-goddess wooed me irresistibly to optimistic contemplation of her supreme beneficence. But anon, in cyclonic rage, she hid the mountain crest in blinding mists, tossed the overhanging branches until they swayed like ocean waves before the blast, hurled limbs and fruit to earth, and through the long vigil of the night aroused the most lively feelings of apprehension for the safety of life and property. Again, treading the wooded crest in thoughtful contemplation, beneath its peaceful summer dress I found evidences of the Titanic struggles of former ages—huge columns of basaltic rock upheaved by Plutonic forces, and here, where the stream runs so gently and falls so musically to the lower level of the plain, was once the crater of a now long-extinct volcano.

From ages dim and remote, when the earth was a molten ball, the theater of fierce Plutonic activities, to the present time, when it woos and buffets man by turns as he applies his energies to its conquest, the "struggle for existence" has gone forward, determining in partnership with Nature's other evolutionary conditions the form and structure of continents and seas, the birth and growth of animal and vegetable life upon the planet, the origin of the human race out of brute ancestral conditions, and its progress toward a higher civilization.

Taking man as he is at his best, with a high sense of ethical obligation dominant in his consciousness, and aspirations for a nobler personality and better social conditions guiding his actions, what shall we say of the rational attitude of his mind toward the cosmic process which has given him birth, and upon which he is still dependent for the physical conditions of life? What of his moral nature as related to this process? What of the ethical attitude of the universe to man?

Upon this problem Prof. Huxley, one of the most versatile and virile writers among the modern apostles of the doctrine of evolution, has recently exercised his trenchant pen; and the outcome

* Read before the Congress of Evolutionists, Chicago, September 30, 1893.

of his Romanes address at Oxford has been hailed by skeptics as to the theory of evolution as a complete surrender of its claims in the higher fields of ethics and sociology. Using the nursery tale of Jack and the Beanstalk as illustration, Prof. Huxley assumes with the Hindu and Buddhist sages that the cosmic process is one of recurring cyclical changes—of alternating development and disintegration—in which no real and definite progress is discernible. And what is true in the field of physics, he says, "is true of living things in general. . . . The process of life presents the same appearance of cyclical evolution." Moreover, "where the cosmopoietic energy works through sentient beings, there arises, among its other manifestations, that which we call pain and suffering. This baleful product of evolution increases in quantity and intensity, with advancing grades of animal organization, until it attains its highest level in man. Further, the consummation is not reached in man, the mere animal; nor in man the wholly or half savage, but only in man the member of an organized polity; and it is a necessary consequence of his attempt to live in this way—that is, under those conditions which are essential to the full development of his noblest powers." Ergo, he tacitly and avowedly assumes, no moral tendency or purpose or effect are predicable of the cosmic energy; on the contrary, "the ethical progress of society depends, not on imitating the cosmic process, still less in running away from it, but in combating it." The relation of man to Nature is one of insoluble dualism and eternal antagonism. His only hope of individual salvation and social amelioration is to struggle continually against her cosmic tendencies, enduring an ever-increasing consciousness of the stress and pain involved of necessity in the age-long struggle. As a teacher in the field of ethics, she can only show him "how not to do it."

Without attempting an elaborate argument in reply to Prof. Huxley's positions, which have already run the gantlet of much favorable and adverse criticism, I may perhaps be permitted to make them the text of a brief exposition of what I conceive to be the true and logical bearing of evolutionary thought upon the great problem of man's relation to the universe, and of his moral nature to those physical and biological conditions under which he has come into existence, and upon normal relations to which his well-being admittedly depends.

Let me ask, at the outset, by what authority as an evolutionist does Prof. Huxley revert to the old theological conception which places Nature and man in radical antithesis? Is not the human mind, including its loftiest ethical determinations, as much the product of evolution, a part of universal Nature, as the brute forces which control the struggle for existence in the lower planes of being? If that in us which is to oppose and correct the cosmic process is not itself a product of the cosmic process, whence does it come? To the consistent evolutionist there could seem to be but one answer to this question. As such, Prof. Huxley would hardly fall back upon the discredited dogma of special creation, and no other refuge is left him from the logic of that conclusion which he has so persistently ignored.

Leaving out the Oriental imaginings and metaphysical speculations which so largely tinge and illustrate the thought of Prof. Huxley, and confining ourselves to what science definitely assures us regarding the cosmic process as illustrated in our own little earth, we are surely justified in viewing it as the exponent of something more and different from a merely cyclical alternation of evolution and degeneration. Whether viewed in its purely physical or in its biological aspects, the process of evolution on this planet has been one of progressive refinement, development, and progress—from a molten ball to a solid globe; from the theater of terrific Plutonic activities to a condition where such activities are rare and exceptional; from the coarse and rank vegetation of the Carboniferous era to the more delicate and beautiful growths of our own time; from lower to higher forms of life, from moneron to ape and from ape to man; from savagery to barbarism and from barbarism to civilization: such is the story of evolution as written in rock and soil, the rude inscriptions of the earlier races, and the nature of man himself, so plainly that he who runs may read. Occasional lapse and degeneration have indeed been incidental to this progress, rendering it rhythmical rather than serial in its method; but this does not detract from the impressive reality of evolution's majestic march through the centuries.

Not only has Prof. Huxley erred, as it appears to me, in giving a partial interpretation of the trend and meaning of the cosmic process in inanimate Nature, he seems to be still more grievously at fault in interpreting its significance when it mounts to sentiency in animal and human organisms. One is forced to wonder by what curious mental bias he was led to debit Nature with all the pain, misery, and suffering that sentiency implies, without crediting it with the conscious satisfactions, pleasure, and happiness which are equally the product of the evolutionary process. Mr. Spencer has shown by arguments which I believe to be unanswerable, and to which Mr. Huxley does not even allude in this address, that that "fullness of life," which is the final evolutionary test of genuine advancement in mental capacity; individual character, and progressive social amelioration, is directly proportionate to the relative amount of subjective satisfactions in sentient organisms, and that all progress is conditioned upon the excess of these satisfactions over the concomitant pain and suffering. The contrary assumption, he has shown, would result in a *reductio ad absurdum* so complete as to be logically unthinkable. The "pains innumerable and immeasurably great," which Prof. Huxley finds to be the accompaniment of the highest functional development of the sentient organism, are, on the whole, counterbalanced by pleasures still more immeasurable and complete.

Indeed, the "ape and tiger" surviving in human dispositions, the pains and griefs, the miseries and crimes, which are a part of the experience of civilized man, constituting his inheritance from a myriad generations of brute ancestors, are the *sine qua non* of all morality and all ethical progress. They furnish the *pou sto* of ethics, the underlying conditions without which there could be no such thing as a moral being. There can be no light without a concomitant shadow; all we can rationally ask is that the light shall furnish the medium for seeing the picture of life as it is. Without the shadows, no beauty of landscape or human countenance; without the darker shadows of suffering and sin, no moral beauty—no ethical advancement.

Prof. Huxley well says that "ape and tiger methods are not reconcilable with the ethical principle." This is certainly true of beings possessing a developed moral consciousness; but nothing is surer, from the evolutionist's standpoint, than that the sense of moral obligation was sired by these very "ape and tiger methods" as they have prevailed among the lower orders of sentient beings. The sense of obligation is primarily purely egoistic. The "ought" of primitive man was not a moral obligation; it was a recognition of something *owed* to himself. That impulse to self-preservation which is proverbially the first law of Nature, out of consciousness of obligation to self, developed, through experience, the application of this sense of obligation to that larger self, the family; through gregarious association to the still growing self, the herd or tribe; and again on to the state, the nation, and in the consciousness of a few—the perfect flower and fruitage of cosmic evolution—to man as man, to all forms of sentient life, to the earth itself as the teeming mother of the human race.

The sense of duty, as we now understand it, was not developed until the remote and indirect motive of race-maintenance and altruistic service was consciously and voluntarily substituted for the primary, egoistic motive of self-preservation. Yet, as I have elsewhere shown, "here has been no new creation, but merely a process of transformation, of evolution. The 'raw material' of morality is found in the simplest orderly manifestations of volitional activities in organic Nature; yes, back even in those steadfast laws and tendencies which are manifest in the action of the inorganic universe . . . In the last analysis, it is not *two* things that fill the mind with awe, as in the familiar phrase of Kant, but *one thing*, whether it be manifested in the order of the galaxies or in the orderly impulse to right action which we term conscience or duty." * That principle of gravitation which secures order among whirling atoms and orbs throughout the interstellar spaces finds its complete analogue in human societies in the sense of moral obligation. Here is no mere transcendental speculation, but a logical deduction from scientifically demonstrated facts. What is that very inviolability of law which is the stumbling-block of crude, sentimental thinkers on the problems of man's relation to the universe but an expression of steadfastness and honesty in Nature's dealings with us? How much better is it than the capricious Providence of the theologian!

Undoubtedly there was a distinct progress in morals, as Prof. Huxley declares, when action from right motive came to be regarded as the true moral test, in the place of acts conventionally estimated as right, when judged by their results, according to standards established by the dictum of political or ecclesiastical authority. But the reaction has been too great; ethical teachers have come to place the entire stress on the motive, ignoring the actual objective results of individual activities. The new science of ethics, which is dominated by the doctrine of evolution, finds an objective law of right, inherent in the nature of things, dominating all human associations, and makes conformity to this law, both in motive and in action, the highest moral ultimatum. The Quaker doctrine of the "inner light" and the transcendental theory of intuitional ethics need to be supplemented and corrected by the lessons of science and experience. Mr. Spencer has ably shown that individual intuition is born out of race experience, and that ethical theories hitherto regarded as irreconcilably antagonistic are harmonized by the solvent method of evolution. So, also, his much-misunderstood doctrine of the Unknowable supplements the Berkeleian idealism and Buddhistic nihilism which Prof. Huxley seems to regard as the highest logical resultants of human speculation; and by showing the absurdity and unthinkableness of the conception of a sequence of phenomena, either mental or material, without a nexus of reality, and scientifically demonstrating the symbolical character of our sense-perceptions, he has dealt a deathblow to the old-fashioned materialism and substituted for the metaphysical conception of a substance apart from phenomena — at best a fruitless abstraction — the strictly logical, affirmative, and scientific conception of a reality immanent in all phenomena, inconceivable, indeed, in its essential nature, because of the limitations of our knowing faculties,

* The Evolution of Morals.

but the existence and potency of which constitute the most certain of all our knowledge.

Not Nirvana, therefore, but effort; not death, but life, the development of moral power, and an ever-deepening moral consciousness through conflict with evil, is the lesson of evolutionary ethics. Nor are we left to despair at the duration and impotency of the struggle. Its final subjective outcome is foreseen to be—like that of all other conscious endeavor, become habitual—a natural spontaneity of right action wherein men shall serve the right neither for hope of reward nor fear of penalty, but from a divine inner necessity, which at once compels the volition and brings the unsought compensation of the highest intellectual satisfactions.

But, says Prof. Huxley, admitting that the moral consciousness is the result of evolution, "immoral as well as moral sentiments have been evolved by evolution. . . . There is, so far, as much natural sanction for one as for the other. . . . Cosmic evolution is incompetent to furnish any better reason why what we call good is preferable to what we call evil than we had before." Let it be granted that the facts of human experience are more powerful than any theories as guides to individual action. If it were not so, the progress of the race would indeed be slow. But what is this but a recognition of the fact that morality is the result of an actual process of evolution which is independent of all mere doctrinal speculation? No rational theory of ethics, however, can fail to recognize that a true philosophy of life, a correct understanding of its facts, must furnish a tremendous incentive to right action. Just here, indeed, has been one of the chief stumbling-blocks in the path of moral progress. The race has been weighed down with disheartening theories of total depravity, moral lapse, and the inefficacy of natural effort for the improvement of character, at variance with all the known facts of human history. But evolution demonstrates that immoral and even criminal actions as we now regard them are usually survivals of customs or habits at some past time justified by the conditions of the physical and social environment. This furnishes at once hope for further progress by demonstrating the progress which has actually taken place and evolved a sense of evil in the commission of unsocial acts, and a hint as to the right method of promoting advancement in morally defective individuals. The recognition of the defect as a survival of past customary conditions is itself conclusive testimony to moral progress. The ultimate objective test of the moral character of an action is its influence in promoting fullness of life in the individual and in the race. To say that there is as much natural sanction for an immoral as for a moral action because both exist in the present stage of social evolution, is equivalent to saying that there is an equal sanction for the violation of any other natural law with that for its obedience. The sanction of an action in either instance lies not in the mere fact of its performance, but in the improved conditions, material or social, which are its resultant effects. That which is upbuilding, which tends to fullness of life, is right; that which tends to deterioration and retrogression is wrong.

Mr. Huxley apparently gives away his entire case against evolutionary ethics by the assertion that the practice of goodness is directed "not so much to the survival of the fittest as to *fitting as many as possible to survive*." But surely it can not be doubted that those "fitted to survive" *will* survive; hence this confession constitutes a complete justification of evolutionary ethics. Viewed at short range by absolute standards, it may indeed be true that "survival of the fittest" is not always survival of the best. Relatively, however, it is the survival of the *best possible under existing conditions*; it points toward the morally perfect which can only be attained through repeated approximations of the relatively good.

It is true, indeed, that "the theory of evolution furnishes no millennial expectations" for the immediate future, and Prof. Huxley has not emphasized too strongly the importance of human intelligence and will in effecting moral regeneration. But these are powerful for good only as they are duly trained and cultivated; only as they rigidly note both cosmic and social conditions, and correctly estimate the trend and result of all the complex forces which center upon the life of the individual. It is the great virtue of the evolutionary ethic that it calls man back from the cloudland of metaphysical speculation, and seeks to enlighten his intellect and guide his steps by appeals to the scientifically ascertained facts of human experience and the laws by which they are governed. Back to Nature, not in her statical aspects, as dreamed by Rousseau and the eighteenth-century philosophers, but in her dynamical and evolutionary aspects, must we ever go for ethical guidance, encouragement, and inspiration.

To Herbert Spencer, more than any other among the apostles of evolutionary doctrines, we owe the logical demonstration of the unity of man and the universe which eternally forbids the separation of his moral nature from those conditions out of which his whole being had its birth, and to which it is at all times vitally related. No morality in the universe? None, then, is possible in man. Existing in man, it is predicable also of his great world-mother. This is the irresistible logic of evolutionary ethics. And of him, the ripest thinker on this problem now living, it may well be affirmed, in the language of a poet of the new dispensation:

"Man's thought is like Antæus, and must be
Touched to the ground of Nature to regain
Fresh force, new impulse, else it would remain
Dead, in the grip of strong Authority.
But, once thereon reset, 'tis like a tree,
Sap-swollen in springtime; bonds may not restrain,
Nor weight repress; its rootlets rend in twain
Dead stones, and walls, and rocks, resistlessly.

"Thine then it was to touch dead thoughts to earth
Till of old dreams sprang new philosophy,
From visions, systems, and beneath thy spell
Swift they uprose, like magic palaces,
Thyself half-conscious only of thy worth,
Calm priest of a tremendous oracle!"

ON THE ORIGIN OF WEEKS AND SABBATHS.

By the late Colonel A. B. ELLIS.

ALL over the world we find that peoples who are low in the scale of civilization reckon time by moons. In some cases a moon is the sole measure of time; in others a lunar year, composed of a certain number of moons, has been evolved; but the solar year only appears to come into use when some progress in civilization has been made. The most primitive method of measuring time, that which is found among all savages at the present day, is to count by moons, the recurrence of the moon at regular and short intervals of time affording a natural and easy mode of reckoning its lapse. A moon, or month, is reckoned from the first appearance of a new moon, and as the moon is chiefly visible by night, so it is by nights rather than by days that a moon is computed. In other words, time is measured by moons and nights.

The next step is to divide the moon into periods corresponding with its principal changes, which generally results in its being divided into halves and quarters, the fourteenth to the fifteenth night, which is the night of the full moon, dividing the twenty-nine and a half days which elapse between the advent of two new moons into two. In this connection it is curious to note that we still speak of the "quarters" of the moon. The month is thus divided into four equal periods; but as twenty-nine and a half days will not divide exactly by two or by four, each period consists of seven complete days and some nine hours extra. This is the plan which has been adopted by the Tshi tribes of the Gold Coast of West Africa. They have what may be called a seven-day week, but which is really a week of seven days and some nine hours, and in consequence each week commences at a different hour of the day. The first day of the first week commences when the new moon is first seen, usually about sunset, and each moon contains exactly four of these periods, or weeks. Say the new moon is visible at 5 P. M. on a Monday, then the first week will terminate about 2 A. M. on the next Tuesday but one, and will contain seven days and eight nights nearly. The second week, commencing at 2 A. M. on Tuesday, will terminate at 11 A. M. on the Tuesday following, and will contain seven and a half days and seven nights, approximately. The third week will terminate at 8 P. M. on the next Tuesday, and the fourth when the next new moon appears. Each of the seven days has a name: 1. Dyo-da, or Adjivo-da. 2. Bna-da. 3. Uku-da, or Wuku-da. 4. Yaw-da. 5. Fi-da. 6. Memin-da, or Memere-da. 7. Kwasi-da. It is sometimes said that these days correspond to ours, but that is not quite correct. The only correspondence is one of order—i. e., Dyo-da answers to Monday because it is the first of the series, and Fi-da to Friday because it is the fifth; but as the Tshi week is nine hours longer than ours, the days do not correspond in time.

The suffix *da*, which we see attached to these names, is derived from the verb *da*, "to sleep," and shows that, as we should expect, the period is a seven-night period rather than a seven-day period. From its connection with these words, *da*, or *eda*, has now acquired the meaning of "day." A week is *da-pen*, "a set of days," or *nuaotyo*, "eight days," because the week contains seven days and a part of an eighth. *Nua* is the plural of *da*. The word for "day," in contradistinction to "night," is *awia*, which properly means "sun." Month, or moon, is *sram*, a word which is derived from *sra*, "to watch for," and has reference to the custom of watching for the new moon. *Sram-fia*, "moon-appearing," is the beginning of the month, and *sram-wua*, "moon-dying," the end.

The Gã tribes of the Gold Coast likewise have a week of seven days and some nine hours, so that a lunar month consists of four of these periods. Their names for the days are: 1. Dsu. 2. Dsu-fo. 3. Fso. 4. So. 5. So-ha. 6. Ho. 7. Ho-gba. These seem to consist of three pairs and a single one, viz., the third day. Day and night, as contrasted one with the other, are *fane* and *nyon*, the former of which probably means "the redness," and no doubt refers to the sun, while the latter means "moon." *Nyon-dse*, "moon-appearing," means the beginning or early part of the month, and *nyon-gbo*, "moon-dying," the end. These two nations afford examples of a seven-day week being formed directly from the lunar month.

Now, as nations progress in knowledge and gain a more or less accurate notion of the solar year, they begin to compute time by years, rather than by moons. All uncivilized men being exceedingly averse to any change, they first endeavor to combine the old system with the new, and make the year contain twelve or thirteen moons; but experience soon shows them that a solar year does not contain an exact number of moons, and, in the end, they either abandon computation by moons altogether, or else arbitrarily fix the month as being of a certain duration, so as to make twelve or thirteen of them fit into the solar year. Of course, when this is done, the month is no longer coincident with a moon, but is simply what we may call a civil measure of time, quite independent of the moon and its phases. Thus we have made the solar year of three hundred and sixty-five days contain exactly twelve civil months, and to effect this we have distributed between the original twelve lunar months the number of days by which twelve lunar months fell short of a solar year—that is, eleven.*

Next, the same process is applied to the weeks, or subdivisions of a lunar month, and, just as the month is made a civil period having no relation to the moon, so is the week made a civil period having no relation to the lunar month. The month having severed all connection with the moon, the week ceases to mark the phases of the moon; the odd hours, which were required to make the week a true subdivision of a lunar month, are dropped, being no longer of use, and the week remains seven days exactly. The etymology of our own words shows that this was what we did ourselves. The word "month" is derived from "moon," and undoubtedly originally meant a lunar month, while the Anglo-Saxon *mona* (moon) means "measurer," of time understood. The word "fortnight" (fourteen nights), and the old name for week, "sen'night" (seven nights), show that these periods were reckoned by nights, and so had reference to the moon. They were, in fact, half moons and quarter moons, and the latter must have consisted of seven nights and nine hours. The word "week" itself is probably connected with the Anglo-Saxon *weaxan*, "to increase, wax," and had reference to the moon's phases. Sharon Turner says: "In their computation of time, our ancestors reckoned by nights instead of days, and by winters instead of years. Their months were governed by the revolution of the moon." †

The Aztecs afford another example of a people who, having

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* January, March, May, July, August, October, and December have each thirty-one days, or a day and a half more than a lunar month. Total, ten days and half. April, June, September, and November have each thirty days, or half a day more than a lunar month. Total, two days. February, on the other hand, has only twenty-eight days, or a day and a half less than a lunar month. $10\frac{1}{2}+2-1\frac{1}{2}=11$, the number of days required.

† Anglo-Saxons, vol. i, p. 201.

adopted the solar year as a measure of time, made the month a civil period, quite independent of the moon and its phases. Their solar year consisted of eighteen months of twenty days each, with five supplementary days; and they divided each month into four weeks of five days each, on the last of which was the public fair, or market day. This plan had the advantage of making both the month and the year contain an exact number of weeks. The lunar year, though discarded for ordinary computations, was retained for religious purposes, and was divided into periods of thirteen days, corresponding with the phases of the moon.*

Before the Aztecs adopted the civil month of twenty days, they had, if they had subdivided the lunar month at all, probably divided it into six periods, five of five days and one of the remainder of the month, or four days and a half approximately. We say, if they had subdivided the lunar month at all, because the difficulty of dividing twenty-nine days and a half appears to have been too great for many races. In the Society Islands time was reckoned by nights and moons, but any intermediate division was unknown. There were distinct names for each night of the moon. The fifteenth night was called "The moon with a round, full face," and the last night, "This is the night the moon dies." People always asked, "How many nights since?" instead of "How many days since?" These islanders had progressed sufficiently far to have some notion of the solar year. The Maoris of New Zealand reckoned by nights and moons, but had no weeks. Each night possessed a name, regulated by the moon's shape and age. They had a lunar year of thirteen moons.† The inhabitants of Madagascar had advanced beyond the stage of reckoning by moons, and had a solar year with civil months, but no weeks. Their months contained twenty-eight nights, and twelve months, with eighteen intercalary days, made a year. Their year was thus eleven days shorter than the true solar year, so that their New-Year's day fell eleven days earlier each year, till the cycle of thirty-three years was completed, when the festival was again held at the same season.‡

The Society Islanders and the Maoris had thus not subdivided the lunar month, and the Malagasy had not subdivided their civil month, but examples of nations who have done each are fairly numerous. In Ibo (lower Niger) a civil month of twenty-eight days has been adopted, and has been divided into seven weeks of four days each.# The Congoese also have a civil week of four

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* Nadaillac, Prehistoric America, p. 306.

† Thompson, The Story of New Zealand, vol. i, p. 198.

‡ Sibree, Madagascar and its People, p. 206.

\# Baikie, Narrative of an Exploring Voyage, p. 316.

days.* In Sofala (East Africa), according to De Faria, a civil month of thirty days was adopted, and divided into three weeks of ten days each. As, however, he says that the first day of the first week was the festival of the new moon, there must be some mistake. It looks more as if time were reckoned by lunar months, and consequently, while the first and second week might each be of ten days' duration, the third would be some hours short of that.† The ancient Greeks had a civil month of thirty days, divided into three weeks each of ten days. The Ahantas of the western districts of the Gold Coast divide the lunar month into three periods or weeks, the first and second of which are of ten days' duration, while the third consists of the remainder of the month. The first period, called *Adae*, is considered lucky; the second, called *Ajain-fo*, unlucky; and the third, called *Adim*, neither lucky nor unlucky. The Yorubas of the Slave Coast of West Africa reckon by nights and moons, and have subdivided the lunar month into six weeks of five days each, or rather, five of them actually contain five days, and the remaining one, which completes the month, about four days and a half. The Javanese week, before the week of seven days was adopted from the Mohammedans, consisted of five days.‡

The Siamese seem, like the Tshi and Gã tribes of West Africa, to have divided the lunar months into four periods of seven days and some odd hours, but, for convenience' sake, they have now made the odd months contain twenty-nine nights and the even months thirty. Their week is commonly said to consist of seven days, but as it is contrived that their sabbath, called *Vampra*, should always fall on the fourth day, and, in the first week of the month, should always be coincident with the fourth night of the moon, it is evident that each week must be of seven days and some hours' duration, or, if three of them are exactly seven days long, then the fourth must complete the lunar month and be eight days and a half long. In dates, the age of the moon, either waxing or waning, is reckoned by evenings, and hence the day of twenty-four hours is considered to begin at sunset.# This, of course, must be the case with all peoples who reckon by moons and nights; and so enduring is custom that the Italians and Bohemians still reckon the day of twenty-four hours from sunset to sunset.

When we tabulate our results, we get the following subdivisions of months, lunar or civil:

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* Johnston, The River Congo, p. 455.

† Astley's Collection, vol. iii, p. 397.

‡ Raffles, History of Java, vol. i, p. 475.

Bock, Temples and Elephants, appendix iii.

The Tshis, Gãs, and probably the Siamese, have four weeks of seven days and three eighths	$29\frac{1}{2}$ days.
The Ahantas, and probably the Sofalese, have two weeks of ten days, and one week of nine days and a half	$29\frac{1}{2}$ "
The modern European method is to count four weeks of seven days	28 "
The Ibos and Congoese have seven weeks of four days	28 "
The ancient Greeks had three weeks of ten days	30 "
The Yorubas have five weeks of five days, and one week of four days and a half	$29\frac{1}{2}$ "
The Javanese, and probably the Aztecs, had six weeks of five days	30 "

When we remember that the lunar month is of about twenty-nine days and a half duration, and that twenty-eight and thirty are the nearest numbers to twenty-nine and a half that will divide into an exact number of days, the conclusion is irresistibly forced upon us that with all the above peoples the week was designed to be a subdivision of the lunar month.

The subdivisions of the lunar month would appear generally to mark the phases of the moon. Naturally, the full moon would mark the termination of one subdivision and the commencement of another. Thus, with the Tshis and Gãs, the full moon marks the commencement of the third week of seven days and three eighths, and with the Yorubas the commencement of the fourth week of five days, in each case making the lapse of half a month. Where there is a ten-day week, the full moon is not coincident with the commencement of a week; but the week of ten days, and also that of five, is, like the practice of counting by scores, due to the fact that man has five fingers on each hand, all primitive peoples counting by fingers and toes, or hands and feet.

The Israelites had a week of seven days, and measured time by moons and nights: therefore, from the analogy of other peoples, we conclude that their week was originally a subdivision of a lunar month. When a new moon became visible a new month began, and like the rest of the world they reckoned their day of twenty-four hours from sunset to sunset. They had a lunar year of twelve months, and every two or three years an intercalary month was added to make it agree with solar time. The luni-solar year now used by the Jews was not introduced till 360 A. D.

It is commonly supposed that the week of seven days was invented by the Chaldean astronomers from the seven planets, but though it is beyond question that the days of the week derive their names from the planets, yet it by no means follows that the seven-day period owes its existence to the fact that the astronomers of Chaldea were acquainted with seven celestial bodies which moved. There is, indeed, no connection between alleged cause and effect—no reason why, simply because they knew of seven planets, they should invent a seven-day measurement of time. In the Chaldean astronomy the planets were arranged in order of magnitude of orbit—that is to say, as follows: Saturn, Jupiter, Mars, the Sun (i. e., the Earth), Venus, Mercury, and the Moon; and if the fact of the planets being seven in number led to the invention of a seven-day period, it is reasonable to suppose that each day would have been named in succession after a planet, and that the order of days would have been as above instead of what it is—viz., Saturn, Sun, Moon, Mars, Mercury, Jupiter, Venus. This order was altogether unintelligible until some clay tablets of the period of Sargon I, about 3800 B. C., which explained it, were exhumed in Chaldea. From these it was learned that each hour of the day of twenty-four hours was consecrated to a planet in the order of magnitude of orbit—viz., Saturn, Jupiter, Mars, etc.—and the day itself received the name of the planet to which the first hour was sacred. Thus, if the first hour of a day were dedicated to Saturn, the eighth, fifteenth, and twenty-second hours would also fall to that planet, the twenty-third to Jupiter, the twenty-fourth to Mars, and the twenty-fifth—that is, the first hour of the next day—to the Sun. In like manner the first hour of the third day would fall to the Moon, that of the fourth to Mars, that of the fifth to Mercury, that of the sixth to Jupiter, and that of the seventh to Venus. This is the explanation of the order of the days of the week, and it appears to be the result of a new idea being grafted on to an old institution—viz., the seven-day week. Before the Chaldeans could consecrate hours to planets, they must have divided their day into hours, and, if they could do this, why could not they perform the much simpler operation of subdividing the lunar month and inventing the week? *

The names, in the Chaldean order, appear to have been introduced into Egypt with the Ptolemaic hypothesis (A. D. 150), and the Romans borrowed them from the Egyptians. Before, however, the Chaldean order was introduced into Egypt, the Egyptians had a seven-day period, and the sixth-seventh day was then sacred to the moon, instead of the third, as under the Chaldean system. In a hymn to Amen-Ra, found in a hieratic papyrus of the fourteenth century B. C., and purporting to be a copy of an earlier document, occurs the following:

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* The Javanese system presents some curious points of resemblance to that of the Chaldeans. When they had a week of five days, each day of twenty-four hours was divided into five periods—viz., from sunset to 8 A. M.; from 8 A. M. to noon; from noon to 3 P. M.; from 3 P. M. to 4 P. M.; and from 4 P. M. to sunset. Each of these divisions was sacred to one of the five gods, Sri, Kala, Wisnu, Maheswara, and Brama, but the order of dedication changed every day. Thus, if the first period of one day were dedicated to Sri, that of the next day was dedicated to Kala, that of the third to Wisnu, and so on. (Raffles, *loc. cit.*)

"O Ra! adored in Aptu (Thebes):
High-crowned in the house of the obelisk (Heliopolis):
King (Ani), Lord of the New-Moon festival:
To whom the sixth and seventh days are sacred." *

Thus, in Egypt, in the fourteenth century B. C., the festival of the new moon was from sunset on the sixth to sunset on the seventh; and since the sixth-seventh of a month was always coincident with a new moon, the Egyptian months must have been lunar months, and their seven-day periods, if true quarters of a lunar month, must have been similar to those of the Tshi and Gã tribes. When, fifteen hundred and fifty years later, the planetary names arranged on the Chaldean system came into use for the days of the week, the Egyptians had adopted a civil month of thirty days, twelve of which, with five supplementary days, completed the solar year; and, as the month had become a civil period no longer connected with the moon, so the week became also a civil period, and was made seven days long exactly.

Among the Romans the first mention of a day named after a planet occurs in the third elegy of the first book of Tibullus, written about B. C. 24, where we find the words "Saturn's unlucky day"; and from Ovid, A. A. i, 415, it is clear that this notion was derived from Palestine. Every seventh day was considered unlucky, but whether the Romans had a civil week, and names for the other days, is uncertain, though the general belief is that they did not adopt the Chaldean seven-day period from Egypt till after the reign of Theodosius, A. D. 395. It is, however, fairly clear that in the early days of their history they reckoned time by half-moons and quarter-moons or lunar weeks. When they had invented civil months, the calends were invariably on the first day of the month, and were so named because the priests had been accustomed to call the people together on that day and announce what days were to be kept sacred during the month. The ides—so called, according to Macrobius (A. D. 400), from the Etruscan verb *iduare*, to divide—were at the middle of the month, either on the thirteenth or fifteenth, and the nones were at the ninth day before the ides, counting inclusively. If the ides fell on the fifteenth, the nones were on the seventh. The days between the calends and nones were called "the days before the nones"; those between the nones and ides, "the days before the ides"; and those from the ides till the end of the month, "the days before the calends." In March, May, July, and October the ides fell on the fifteenth and the nones on the seventh; in the remaining months the ides fell on the thirteenth and the nones on the fifth. Thus the only number that was constant was the number of days

* Records of the Past, vol. ii.

named from the ides, which were always eight—i. e., from the seventh to the fourteenth or from the fifth to the twelfth, while the number of days named from the calends and from the nones varied.

Now, this scheme as a mode of measuring time is so clumsy that we can not suppose it to have come into existence in this shape; it is more probable that it was an old plan which had been adapted to new conditions—viz., the invention of civil months. In 452 B. C. the year consisted of twelve civil months of twenty-nine and thirty days alternately, so as to correspond with the synodic revolution of the moon; and from this it is certain that at some earlier period time was reckoned by lunar months, and civil months had not been thought of. The Roman day, as with all other peoples who reckon by moons, commenced at sunset, for we find that religious festivals always commenced at that hour; the festival of Venus,* for instance, was celebrated on the first three days of April, and began at sunset on the last day of March. When the Romans reckoned by lunar months, the calends would be the day of the new moon, the ides would always correspond with the full moon, and the nones would mark the second quarter. This is simple and intelligible, and the ides would always "divide" the month, for from the day following the moon would begin to wane.† We think, then, that the system of calends, nones, and ides dated from a period when time was reckoned by lunar months, and was really a system of half-moons and quarter-moons, the nones falling on the night of the seventh-eighth, and the ides on that of the fourteenth-fifteenth, which brings us very near to the system of the Tshi and Gã tribes. The introduction of civil months destroyed the connection between the calends, nones, and ides and the phases of the moon; and the lunar week became a civil week of seven days, and finally the names for the days of the week were adopted from Egypt.

From all the foregoing it will now be seen that there is nothing mysterious about the origin of the week, and no need to have recourse to the supernatural to explain it. It is simply a subdivision of a lunar month, and is of four days' duration with some tribes, and five, seven, or ten days' duration among others.

We now come to the question of the origin of sabbaths. We may define a sabbath to be a day sacred to a god, on which it is

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* Ashtoreth, or Astarte, whence the Anglo-Saxon Eostre and Easter.

† The verb *iduare* is probably from the Sanskrit root *indh*, *idh*, to kindle, lighten; whence *indu*, moon; properly, the days of light of the moon (Lewis and Short: art. *Idus*). If so, the word ides would properly be applied to the night of fullest light, that of the full moon; and the meaning "to divide" would be secondary, and would be formed because the ides divided the lunar month.

unlawful for any worshiper of that god to labor. Sabbaths are found everywhere, for it appears to be a general rule throughout the world that gods should have days consecrated to them, and that on those days the followers of those gods may do no work, no matter whether the holy day recurs weekly, monthly, or yearly. The notion appears to be that to refrain from work on a day dedicated to a god is a mode of showing respect. As soon as this view becomes generally accepted, then to work on a holy day is to show want of respect; and as the gods of uncultured peoples are, like uncultured peoples themselves, very sensitive to slights of this nature, the god whose dignity or vanity has been hurt revenges himself by punishing the sabbath-breaker or by punishing his followers at large, because they have not vindicated his honor by punishing the culprit themselves. Then, since to work on the holy day is likely to call down punishment on the individual or on the community, the axiom that it is unlucky to work on that day becomes accepted, and people will not labor or transact business or journey on it.

Bna-da, the second day of the seven-day period of the Tshi tribes, is sacred to the gods of the sea, and is, in consequence, the sabbath of all those who are worshipers of the sea-gods—that is to say, fishermen and those whose vocations take them on the sea. On Bna-da propitiatory offerings are made to the sea-gods, and no one may catch fish. It is the fishermen's day of rest, and, before the colonial government interfered with native customs, any native who violated it by going fishing was put to death, just as was the custom among the Israelites with their own sabbath-breakers (Exodus, xxxi, 14, 15; Numbers, xv, 32). Similarly, the fifth day, Fi-da, is sacred to the gods who preside over agriculture, and is the holy day or sabbath of all persons who cultivate the soil. Here, then, are two cases of sabbaths recurring every seventh day, just as with the Israelites.

The Babylonian Assyrians had the seven-day week and a weekly sabbath. Mr. George Smith says: "In the year 1869 I discovered among other things a curious religious calendar of the Assyrians, in which every month is divided into four weeks, and the seventh days or 'sabbaths' are marked out as days on which no work should be undertaken." * Whether the Assyrian month here referred to was lunar or civil we are not told, but the Rev. A. H. Sayce tells us that, according to the lunar division of the year, "the seventh, fourteenth, nineteenth, twenty-first, and twenty-eighth were days of 'rest,' on which certain works were forbidden," † so that it seems that the Assyrians had subdivided the lunar month in much the same way as the Tshi tribes have.

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* Assyrian Discoveries, p. 12.

† Records of the Past, vol. i, p. 164.

As a rule the institution of the sabbath appears to be primarily due to moon-worship, a form of worship which seems to have been almost universal. With all deference to the opinion of that school which fancies it can trace a solar myth in almost every tradition and folklore tale, we think that moon-worship was and is much more general than sun-worship, and for the simple reason that the regular daily recurrence of the sun is far less likely to excite speculation and wonder in uncivilized man than the varying phases and periodical disappearance and reappearance of the moon.

We imagine that the earliest moon sabbath was a monthly festival, held on the day when the new moon was first seen. The Mendis of Sierra Leone abstain from all work on the day of the new moon, alleging that if they infringed this rule the corn and rice would grow red, the day of the new moon being a "day of blood," from which we may perhaps infer that human sacrifices were once offered to the new moon. The Bechuanas of South Africa also observe the day of twenty-four hours, from the appearance of the new moon at sunset till next evening, as a day of rest, and the people refrain from going to their gardens. Neither the Mendis nor the Bechuanas have subdivided the lunar month into weeks, so here we have examples of peoples who reckon time by lunar months and observe a monthly moon sabbath.

If we suppose this to be the first stage, and the lunar month to be subsequently divided into weeks, then it follows that the first day of the first week will be the festival or sabbath of the new moon, as was the case in Sofala. Then, because the first day of the first week is a moon sabbath, it will naturally happen in some cases, through a connection of ideas, that the first day of each week will be dedicated to the moon, and the moon sabbath will recur as often in the month as the latter contains weeks. We have evidence of this among the Tshi and Gã tribes, among whom moon-worship is no longer found, except in so far that the new moon is always saluted with reverence, but that it used to prevail is shown by the moon's epithet *Bohsŭm*, holy, sacred, or deity. Dyo-da, the name of the first day of the Tshi week, means "day of rest," in the sense of a general day of rest for all people, for the moon was worshiped by all classes, and not, like the gods of the sea and agriculture, by special sections of the community only. Dyo-da was a day of rest for everybody, while Bna-da was only a day of rest for seafaring folk and Fi-da for husbandmen. Dsu, the name of the first day of the Gã week, means "purification," and because it was sacred to the moon Dsu seems to have become a title of the moon, for in the cognate Yoruba and Ewe languages we find the moon called Osu and Dsunu respectively, and in Gã itself the word silver is rendered by *dsu-etei*, moon-substance, or moon-stone. Here, then, are cases of a moon sabbath recurring every seventh day, or four times in a lunar month. Similarly, the first day of the Ibo week of four days is a day of rest, on which no regular work may be done. The first day of the Yoruba five-day week is called *Ako-ojo*, "first day." It is considered unlucky, and no business of importance is ever undertaken on it. On Ako-ojo all the temples are swept out, and it is, properly speaking, a general day of abstention from work, while the other days of the week are only sabbaths for the followers of the gods to which they are dedicated.

When a sabbath recurs every fourth, fifth, or seventh day, the day on which it falls naturally comes in course of time to be called the fourth, fifth, or seventh day, though really properly the first day of the week. Thus Ako-ojo is always called the fifth day, though the words themselves mean "first day." The same change seems to have taken place among the Israelites. On the twenty-ninth day of the moon they began to watch for the new moon, and the day after its appearance was the first day of the new moon or month. Supposing them to have had a seven-day week and a moon sabbath on the day of the new moon, the sabbath would have fallen on the first day of the week, but as people would naturally count from one sabbath to the next, the day after the sabbath would be termed the first day the next, the second, and so on, so that the sabbath itself would come to be called the seventh day. This is, no doubt, the explanation of the sixth-seventh day being sacred to the new-moon festival, as stated in the hymn to Amen-Ra, for the day of the new moon must have been the first day of the lunar month, and also the first day of the week, or subdivision of the lunar month.

Though it is quite possible that the Israelites may have invented a seven-day week and a weekly sabbath spontaneously, like the Tshi and Gã tribes, yet the evidence of the books of the Old Testament goes to show that they borrowed both these institutions from the Babylonian Assyrians during the captivity, and that prior to that epoch they had, like the Mendis, Bechuanas, and Sofalese, only a monthly sabbath, which was the festival of the new moon. No mention of a weekly sabbath is to be found in Joshua, Judges, the books of Samuel, or the first book of Kings. After Deuteronomy, v, 15, no mention of a weekly sabbath is found till we reach II Kings, iv, 23,* and the word sabbath does

* In only two other places in the second book of Kings is it mentioned, viz., xi, 5, and xvi, 18; and, since the older books show that Saul, David, and Solomon knew nothing of a weekly sabbath, we must regard these as interpolations. In II Kings, iv, the Shunamite woman asks her husband to get ready one of the young men and one of the asses, so that she may go to the man of God; and her husband replies (v, 23): "Wherefore wilt thou go to him

not appear either in Psalms or Proverbs. But there is more than a mere omission to mention a weekly sabbath in the old historical books; there is evidence that the institution was unknown, for many occurrences are described by which the weekly sabbath, had it existed, must have been violated. Jericho was encompassed for seven days in succession, which must, therefore, have included one weekly sabbath (Joshua, vi, 13–16). During the events narrated in I Samuel, xxix and xxx, David was on the march for twelve days in succession, without any day of rest being observed; and, since Solomon gave a feast to the people of Israel which lasted fourteen days (I Kings, viii, 65, and II Chronicles, vii, 9), and so must have included two sabbaths, he could have known nothing of the injunction that on the sabbath every man was to abide in his own place (Exodus, xvi, 29). Elijah must likewise have broken the rest of several weekly sabbaths (I Kings, xix, 7, 8). In the article on Marriage and Kinship among the Ancient Israelites * we gave several valid reasons for supposing that the Levitical law was not compiled till about the period of the Babylonian captivity, and this ignorance of the institution of the weekly sabbath on the part of those who must have known about it, had it existed, is an additional reason. We can not suppose that the sabbath rest was willfully broken, for its violation was considered so grave a crime as to be punished with death.

But, while there is a complete silence on the subject of the weekly sabbath in the books we have mentioned, we find moon-worship and the festival of the new moon referred to in more than one place. The passages in I Samuel, xx, 5, 18, 24, and 26 clearly refer to a new-moon festival. Psalm lxxxi, 3, is explicit; it runs: "Blow up the trumpet in the new moon, in the time appointed, on our solemn feast day." Proverbs, vii, 19, 20, implies that the day of the new moon was a day of rest: "For the good man is not at home, he is gone a long journey: he hath taken a bag of money with him, and will come home at the new moon." The passage in Job, xxxi, 26, 27—"If I beheld the sun when it shined, or the moon walking in brightness, and my heart hath been secretly enticed, or my mouth hath kissed my hand"—shows that moon-worship was known, and, according to II Kings, xxi, 3, 5, and xxiii, 5, it was practiced by some of the kings of Judah. Indeed, a new-moon festival could only originate with moon-worship.

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to-day? It is neither new moon nor sabbath." This implies that it was only customary to visit "men of God" on such days; but in Exodus, xvi, 29, we find the injunction, "Let no man go out of his place on the seventh day." The word sabbath in this case must, therefore, either be a later addition to the text, or refer to a holy day different from the sabbath ultimately adopted.

* Popular Science Monthly, January, 1893.

From all this we infer that before coming in contact with the Babylonian Assyrians the Israelites had no weekly sabbath or day of rest recurring every seventh day, but had a festival of the new moon on the first day of the lunar month (I Samuel, xx, 27), which, as we shall show, was observed by them as a day of rest, as it is by other peoples at the present day. After they had adopted the weekly sabbath from the Babylonians, they endeavored, through national vanity, to show that they had always observed it, and to account for it they inserted in their books two traditions of its origin which are fatally at variance. Exodus, xx, 10, 11, says: "For in six days Jahveh made heaven and earth, the sea, and all that therein is, and rested the seventh day; wherefore Jahveh blessed the sabbath day, and hallowed it"; while in Deuteronomy, v, 15, we read: "And remember thou wast a servant in the land of Egypt, and that Jahveh, thy God, brought thee out thence through a mighty hand and a stretched-out arm: therefore Jahveh, thy God, commanded thee to keep the sabbath day."

In the later books, written after contact with the Babylonians, we find sabbaths frequently mentioned and strongly insisted upon, but nearly always in connection with new moons. Thus, in Nehemiah, x, 33, we read, "For the continual burnt offering, of the sabbaths, of the new moons"; in Isaiah, i, 13, "The new moons and sabbaths"; in Isaiah, lxvi, 23, "And it shall come to pass that from one new moon to another, and from one sabbath to another, shall all flesh come to worship before me, saith Jahveh"; in Ezekiel, xlv, 17, "In the feasts, and in the new moons and in the sabbaths"; and in Hosea, ii, 11, "Her feasts, her new moons, and her sabbaths." New moons and sabbaths are also mentioned together in I Maccabees, x, 34; I Esdras, v, 52, and in Judith, viii, 6. In Ezekiel, xlvi, i, we read that the gate of the inner court of the temple was to "be shut the six working days," and opened on the sabbath and the day of the new moon, which shows that the latter was a day of rest. The offering to be made on the day of the new moon was superior to that to be made on the sabbath (v, 4, 5). In Amos, viii, 5, we read: "When will the new moon be gone, that we may sell corn, and the sabbath, that we may set forth wheat?" which again shows that the day of the new moon was a day of rest.*

In no one of these passages is the new-moon festival spoken of as inferior in importance to the sabbath. On the contrary, since the offering was superior, it is to be presumed that the festival was also superior. Each was a day of rest. The explanation doubtless is that, while adopting a seventh-day sabbath from the

* New moons are mentioned alone—that is, without sabbaths—in Ezra, iii, 5. Ezra does not anywhere mention the sabbath.

Babylonians, the Israelites retained their old monthly sabbath, or festival of the new moon, and considered it to be the more important because the more ancient and national. Whether the monthly sabbath was coincident with the first weekly sabbath would depend upon whether the seven-day week, as borrowed from the Babylonians, was a civil period or a true subdivision of a lunar month. That the Israelites did borrow the weekly sabbath from the Babylonians there can scarcely be any doubt. We know that the Babylonians observed the seventh day as a day of rest, and the historical books of the Old Testament show that the Israelites had no knowledge of any such observance till after contact with Babylon.*

TWO LUNG-TESTS.

By F. L. OSWALD.

WHEN the would-be reformer Balmaceda ended his blighted career, a correspondent of the Chili Mercurio consoled himself with the thought that "the ruin of his friend, though in some respects an irreparable loss, had at least an experimental value."

A similar reflection may reconcile American naturalists to the fate of Pat Rooney, the champion chimpanzee of the Cincinnati Zoo. It will be a long time before the pet dealers of this continent get hold of another such marvel, but the manner of his death proves at least the impossibility of preventing lung disorders by habitual indoor life.

Pat's prison was in many respects a model of comfort. He had a rocking-chair and a variety of gymnastic contrivances, a bench and a dinner-table of his own, and could rely on a liberal allowance of well-selected food, served daily at convenient hours. The cage was large enough for extensive romps, and was kept as

* The sabbath is not, as has been said, anywhere mentioned between Deuteronomy, v, 15, and II Kings, iv, 23, but it is mentioned in Chronicles, which refers to some of the same periods. Chronicles is, however, clearly a compilation from the other books, for it contains genealogies from Genesis, and some of the same occurrences as are narrated in Samuel and Kings. The word sabbath occurs in the following passages: I Chronicles, ix, 32, where certain Levites are appointed to prepare the shew-bread every sabbath. This chapter describes the Israelites as dwelling in Jerusalem in the days of Saul, which we know, from II Samuel, v, 5–9, was not the case. In I Chronicles, xxiii, 31, David appoints Levites to offer sacrifices on sabbaths and new moons; in II Chronicles, ii, 4, Solomon says he built the temple for the burnt offerings on the sabbaths and new moons; and in II Chronicles, xxxi, 3, Hezekiah appoints his portion for burnt offerings for the sabbaths and new moons. These are the only cases in which the sabbath is mentioned, and the combinations of sabbaths with new moons, only found in the later books, is additional proof, if further proof be required, that the two books of Chronicles date from post-captivity times.

clean as the model nurseries of the Faubourg St.-Martin. Realizing the disadvantage of a man-ape being alone, the directors of the Zoo had even contrived to get him a helpmeet of his own tribe and age. A wire screen prevented the introduction of improper comestibles—a paradise exempted from the temptation of forbidden fruit.

But the benefit of all these arrangements was neutralized by the same mistake that has doomed millions of city children to a consumptive's grave—an excess of precaution in the exclusion of cool air currents. The entire cage had been inclosed with double sheets of plate glass.

Warm air was introduced by means of register pipes, and a small aperture at the top of the cage established communication with the atmosphere of a hall, which in its turn was roofed and artificially warmed, thus enabling the warden to keep the temperature of the ape prison in a state of uniformity far exceeding that of the equatorial regions. In the forests of the lower Congo the thermal extremes range from 105° F. at 2 P. M. to 55° after a midnight rainstorm, a difference of fifty degrees, but an apparent contrast (allowing for the sudden transition from brooding heat to the blasts of a drenching gale) of something more like eighty degrees.

From October to June, Mr. Rooney's glass house was rarely permitted to get colder than 60°, the average being about 75° and the maximum 80°. In midsummer it got, of course, much warmer, but the supposed delicate constitution of the guest from the tropics was made an argument against every proposition to let him share the romps of his fellow fourhanders in the open-air extension of their cages.

At the time of his arrival at the Zoo, Mr. Rooney attested the soundness of his lungs by gymnastic exploits rarely rivaled outside of a Japanese circus, and seemed indeed almost insensible to fatigue. With one hand, or the finger tips of both hands, clutching the horizontal bar, he would whirl around in a circle till the spectators got dizzy in watching his evolutions. He would turn somersaults all around the walls of his gymnasium, rising higher and higher with every turn, till a climax swing landed him on top of his trapeze, where he would squat with his arms akimbo and with tightly compressed lips, suggesting abundant reserve stores of air in his capacious chest.

But at the end of the third year it was noticed that the self-taught acrobat was getting less active, and about the middle of last summer it could no longer be doubted that his health had been affected in some way or other. His appetite became capricious; there were days when he contented himself with nibbling small samples of his dinner, though an hour later he was apt to swallow substances which no self-respecting chimpanzee would have touched with the tip of his tongue. Instead of noticing the improvements of his gymnasium, he would turn over on his side and stare into the darkest corner of his den for hours together, with the perversity of a fourhanded Schopenhauer, resolved to see only the shady side of things. On extra warm days he became restless, running to and fro as if under the impulse of some unsatisfied desire, or watch the playground of his privileged neighbors like an orphan boy viewing the forbidden paradise through the bars of a poorhouse window, and wondering how he came to deserve his sad predicament. At such times the invalid's face, indeed, often assumed an expression more pathetically human than anything ever observed in his fits of mimicry; he looked haggard and contemplative, but his appearance was ascribed to gastric causes—some transient indigestion, brought on by his dietetic aberration. Yes, it must be dyspepsia; it seemed impossible, with such precautions against cold, that he could have contracted a disorder of the lungs. Were not the glass plates fitted tight all around, almost like the walls of an aquarium? And were they not double?

The sick half-brother sighed when sympathetic visitors crowded around his sweatbox; he evidently guessed their benevolent intentions, but some instinct seemed to tell him that his complaint had passed the remediable stage. Once, in October, and again in January, during a spell of bracing, clear cold weather, the flickering flame burned a little brighter, but the progress of emaciation continued, till the deliquium of the knee-muscles and an almost total loss of appetite marked the beginning of the end. One afternoon Pat astonished his keeper by declining his brandy ration. He sniffed it, but turned away with disgust, looking "life-weary," as a local journalist expressed it, "and anxious to leave a world where a monkey without a tail can not hope to get a fair chance anyhow."

The next morning those expressive eyes had faded into a blind stare, and the directors of the Zoo invited a number of medical men to attend the autopsy. All sorts of diagnostic theories had been advanced, but the first slit through the pleura set those controversies at rest. "Gentlemen, I was mistaken," said the officiating surgeon; "I'm no monkey-doctor: Pat Rooney is just a mass of tubercles."

About the same time when the champion chimpanzee made his *début* at Cincinnati, Ohio, a southern railway official brought a pair of Mangaby apes to Old Fort, North Carolina. They had originally been intended as a present to a resident of Asheville, in the adjoining county, but the addressee having intimated his aversion to zoölogical side shows, the importer sent them to his own home, and after trying in vain to procure a ready-made cage of sufficient size, lodged his guests in a garden house on a hill overlooking the Old Fort railway depot.

Old Fort, near the upper or west end of McDowell County, must have an elevation of at least two thousand feet above sea level. The proximity of Mitchell's Peak has made the little town something of a summer resort, even the dog days being pleasantly cool, but the winter temperature deserves a chillier name, and the railway to Asheville has more than once been blockaded by snow-drift. The locality, in fact, can hardly claim the climate of a perennial pleasure resort for visitors from the African tropics, but Captain T——'s guests were overjoyed to exchange their narrow traveling cage for a roomy pavilion with lattice walls admitting breezes from every quarter of the compass.

In that playground of all the mountain winds the two four-handers have romped about year after year, as happy as hawks in a tower roost, and free from the slightest symptoms of lung disorders.

"Does your brother ever wash himself?" a friend of mine asked the junior relative of a Tennessee ragamuffin. "Yes, sometimes on Sunday," said the youngster; and sometimes on holidays the litter at the bottom of the garden house is raked out and a bundle of clean straw flung in. The bill of fare is what the vegetarians call a "compromise diet"—frugal on the whole, but varied with eggs, hash, and occasional remnants of pork and cheese. Fragments of tobacco, and flasks suggesting the surreptitious visits of contrabandists from the highlands, are now and then found in the litter, but mountain air, like Count Tolstoi's atonement of labor, cancels the debt of such peccadillos. The native land of the Mangaby (*Cercocebus fuliginosus*) is the coast plain of Loango, north of the Congo valley, and immediately south of the equator, and, with the exception of the Gaboon delta, about the most sultry-hot region of the African continent. Captain T——'s pets were not born in captivity, but shipped directly from the mouth of the Congo to New York city, and from New York to western North Carolina, where they arrived in September—i. e., with hardly two months' time for acclimatization to a country with the winter isotherms of northern Maryland. In stress of storms they do now and then avail themselves of their straw bed, but in calm, frosty nights they stick to their top perch with the obstinacy of a pillar saint. The Mangaby is irascible to a grotesque degree, and the mischievous pranks of the local youngsters often throw the two exiles into a delirium of rage that can not fail to aggravate the debilitating effects of confinement and uncongenial food, but an abundant supply of pure (though often ice-cold) air has turned the scales against all these disadvantages, and the two Africans in their lattice prison are to-day probably the stoutest fourhanders with an equal record of long captivity in any country of the temperate zone.

The calorific ingredients of their diet may help them to survive the long winter nights, but a female baboon which escaped from a private menagerie in the neighborhood of Tallulah Falls, Georgia, in the fall of 1886, accomplished the same feat on a *menu* of grass seeds and persimmons, and during a heavy snowfall in December starved like a Mexican school teacher rather than run the risk of forfeiting the luxury of freedom by approaching a farmstead. She was recaptured by a hunter, or rather by his hounds, the next month, but fought like a catamount, and her second escape in March caused an excitement as if the chained beast of the Apocalypse had broken loose. Her peculiar tracks in the snow and in the sand of the river shore (where she used to turn over flat stones in quest of crawfish) often put hounds on her trail, but she always contrived to reach "tall timber" ahead of her pursuers, till she met her Waterloo during a sleet-storm in April, when the combined effects of cold and hunger had modified the prehensile vigor of her four hands. The hounds killed her and ripped her shaggy coat into shreds, but dissection revealed the fact that her lungs were almost as sound as those of a mountain buck, the only mementos of her confinement being three small cysts of atrophied tubercles.

In his native haunts the chimpanzee rivals the vigor of any fourhanded or fourfooted creature of his size, and there can be no doubt that the secret of his failure to survive removal to the higher latitudes is not his sensitiveness to cold air currents, nor his impatience of confinement, but his *expensiveness*, and the consequent reluctance of his jailers to expose him to atmospheric influences which would save his life, but which a deep-rooted delusion still dreads as the harbinger of death.

More than fifty years ago Dr. Friedberger, of Vienna, appears to have suspected that relation of cause and effect in the case of the Duke of Reichstadt, the son of the first Napoleon.

"You have saved so many consumptives," said one of the doctor's colleagues, "don't you see any chance to help poor R.?"

"It's a sadly peculiar case," said the specialist; "as an ordinary mortal he might pull through, but as the son of a demigod I fear he is doomed."

"What! do you think the Government would—"

"Oh, hush! No such idea. But, you see, his life is extra valuable, and for that very reason his ill-advised friends are extra strict in the enforcement of the precautions that will stifle his vital vigor."

STUDIES OF CHILDHOOD.

V.—PSYCHOLOGICAL AND THEOLOGICAL IDEAS.

By JAMES SULLY, M. A., LL. D.,
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WE may now pass to some of the characteristic modes of child-thought about that standing mystery, the self. There is reason to suppose that a good deal of terribly earnest thinking goes on in the childish head respecting the problem of "my" nature, "my" existence, "my" origin.

The date of the first thought about self, the first dim self-awareness, probably varies considerably in the case of different children according to rapidity of mental development and circumstances. The little girl who was afterward to be known as George Sand may be supposed to have had an exceptional development, and the accident to which she refers as having aroused the earliest form of self-consciousness was, of course, exceptional too. There are probably many robust and dull children, knowing little of life's misery, and allowed in general to have their own way, who have little more of self-consciousness than that, say, of a young, well-favored, well-supplied porker.

The earliest idea of self seems to be obtained by the child through an examination with the senses of touch and sight of his own body. A child has been observed to study his fingers attentively in the fourth and fifth months, and this scrutiny goes on all through the second year and even into the third. * Children seem quite early to be impressed by the fact that in laying hold of a part of their body with a hand they get a different kind of experience from that which they obtain when they grasp a foreign object. Through these self-graspings, self-strikings, self-bitings, aided by the very varied and often extremely disagreeable operations of the nurse and others on the surface of their bodies, they probably reach during the first year a dim idea that their body is different from all other things, is "me" in the sense that it is the living seat of pain and pleasure. The growing power of movement of limb, especially when the crawling stage is reached, gives a special significance to the body as that which can be moved, and by the movements of which interesting and highly impressive changes in the environment—e. g., bangs and other noises—can be produced.

* For the facts see Preyer, Die Seele des Kindes, cap. xxii. Tracy, The Psychology of Childhood, p. 47.

It is probable that the first ideas of the bodily self are ill-defined. It is evident that the head and face are not known at first as a *visible* object. The upper extremities, by their movement across the field of vision, would come in for the special notice of the eye. We know that the baby is at an early date wont to watch its hands. On the other hand, the lower limbs seem to receive special attention from the exploring and examining hand.

There is some reason to think, however, that in spite of these advantages the limbs form a less integral and essential part of the bodily self than the trunk. A child in his second year was observed to bite his own finger till he cried with pain. Preyer tells us of a boy of nineteen months who, when asked to give his foot, seized it with both hands and tried to hand it over. The Worcester collection of children's thoughts has a story of a child of three years and a half who, on finding his feet stained by some new stockings, observed, "O mamma, these ain't my feet, these ain't the feet I had this morning!" On the other hand, the boy C—— spoke of his limbs as foreign objects coming in the way of himself—that is, his body.

Probably different influences combine to give this importance to the trunk in the child's conception of the bodily self. The trunk is the larger portion; it is stationary, always at hand, whereas the hands and feet come and go, and may disappear for some time. Much more important, I suspect, is the fact that the child soon begins to localize in a vague way in the trunk the most frequent and important of his feelings of comfort and discomfort, such as the pains of impeded respiration and digestion and the corresponding reliefs. We know that the "vital sense" forms the sensuous basis of self-consciousness in the adult, and it is only reasonable to suppose that in the first years of life, when it fills so large a place in consciousness, it has most to do with determining the idea of the sentient or feeling body. Afterwards the observation of maimed men and animals would confirm the idea that the trunk is the seat and essential portion of the living body. The language of others, too, by identifying "body" and "trunk," would strengthen the tendency.

About this interesting trunk-body and what is inside it, the child speculates vastly. References to bones, stomach, and so forth have to be understood somehow. It would be interesting to get at a child's unadulterated view of his anatomy.

At a later stage of the child's development, no doubt, when he comes to form the idea of a conscious thinking self, the head will become a principal portion of the bodily self. In the evolution of the self-idea in the race, too, we find that the soul was lodged in the trunk long before it was assigned a seat in the head. As is illustrated in C——'s case, children are quite capable of forming a double idea of their bodily self, the trunk and limbs which may die and be put in the ground, and the head the seat of the soul which lives on and passes into heaven. But of this more later on. Nay, more. A child may indulge the fancy—playfully, at least—that the several parts of the body are so many different bodily selves. Laura Bridgman would amuse herself by spelling a word wrong with one hand, slap that hand with the other, and then proceed to spell it right, laughing at her game. Here the offending hand was for the moment personified and given a sort of independent existence.

Very interesting in connection with the formation of the idea of self is the experience of the mirror. It would be absurd to expect a child when first placed before a mirror to recognize his own face. He will smile at the reflection as early as the tenth week, though this is probably merely an expression of pleasure at the sight of a bright object. If held in the nurse's or father's arms to a glass when about six months old, a baby will at once show that he recognizes the image of the familiar face of the latter by turning round to the real face, whereas he does not recognize his own. He appears at first and for some months to take it for a real object, sometimes smiling as to a stranger or even kissing it, and then trying to grasp it with the hand, turning up the glass or putting his hand behind it in order to see what is really there. Darwin has shown that monkeys behave very much in the same way before a mirror. Little by little he gets used to it, and then, by noting certain agreements between his bodily self and the image, as when he notices the reflection of his pinafore or of the movement of his hands as he points—partly, no doubt, by a kind of inference of analogy from the doubling of other things by the mirror—he reaches the idea that the reflection belongs to himself. By the sixtieth week Preyer's boy had associated the name of his mother with her image, pointing to it when asked where she was. By the twenty-first month he did the same thing in the case of his own image.*

An infant will, we know, take a shadow to be a real object and try to touch it. Some children, on first noticing their own and other people's shadows, are afraid as at something uncanny. Here, too, in time the strange phenomenon is taken as a matter of course and referred to the sun.

We know that the phenomena of reflections and shadows, along with those of dreams, had much to do with the development, in the primitive thought of the race, of the animistic conception that everything has a double nature and existence. Do

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* See the very full account of the mirror experiment in Preyer's book (3te Auflage), p. 459 *et seq.*

children form similar ideas? We can see from the autobiography of George Sand how a clever girl, reflecting on the impressive experience of the echo, excogitates such a theory of her double existence; and we know, too, that the boy Hartley Coleridge distinguished among the "Hartleys" a picture Hartley and a shadow Hartley. I have not, however, discovered that children are given to working out and seriously believing a theory of the multiple existence of themselves and other things.

The prominence of the bodily pictorial element in the child's first idea of self is seen in the tendency to confine personal identity within the limits of an unchanged bodily appearance. The child of six, with his shock of curls, refuses to believe that he is the same as the hairless baby whose photograph the mother shows him. How different, how new a being a child feels on a Sunday morning after the extra weekly cleansing and brushing and draping! The bodily appearance is a very big slice of the content of most people's self-consciousness, and to the child it is almost everything.

But in time the conscious self which thinks and suffers and wills comes to be dimly discerned. I have long thought, and nothing that I have read in the way of argument against the idea has shaken my belief, that a real advance toward this true self-consciousness is marked by the appropriation and use of the different forms of language, "I," "me," "mine."*

As long as the bodily aspect is uppermost in the idea of self, so long is it natural for the child to speak of himself in the third person by his proper name, as he would speak of any other object of perception. The use of the first person seems to mark a clearer distinction of the *ego* as subject from its polar opposite the world of objects, and this manifestly involves true self-reflection as distinguished from self-perception—i. e., perception and recognition of the bodily self.

Sometimes the apprehension of a hidden self distinct from the body comes as a sudden revelation, as to little George Sand. Such a swift awakening of self-consciousness is apt to be an epoch-making and memorable moment in the history of the child.

A father sends me the following notes on the development of self-consciousness: "My girl, three years old, makes an extraordinary distinction between her body and herself. Lying in bed, she shut her eyes and said, 'Mother, you can't see me now.' The mother replied, 'Oh, you little goose, I can see you, but you can't see me.'

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* Preyer argues that the child does not at first hear "I," "me," etc., the nurse and mother speaking to him in the third person: "Nurse says so," "Roland must be good," etc. Exactly. But why do the mother and others make the change about this time, and begin to say I and you? Is it not precisely because the child is making the advance, and showing that he can understand the language of adults?

To which she rejoined, 'Oh, yes, I know you can see *my body*, mother, but you can't see *me*.'" This child about the same time was concerned about the reality of her own existence. One day, playing with her dolls, she asked her mother, "Mother, am *I* real, or only a pretend like my dolls?" Here, again, it is plain, the emphasis was laid on something non-corporeal, something that animated the body, and not a mere bit of mechanism put inside it. Two years later she showed a still sharper intellectual differentiation of the visible and the invisible self. Her brother happened to ask her what they fed the bears on at the Zoo. She answered impulsively, "Dead babies and that sort of thing." On this the mother interposed, "Why, F——, you don't think mothers would give their dead babies to the animals?" To this she replied: "Why not, mother? It's only their bodies. I shouldn't mind your giving mine." It is worth noting that this was the same girl who about the same age took compassion on the poor autumn leaves dying on the ground. Her mind was plainly brooding at this time on the conscious side of existence.

The mystery of self-existence has probably been a puzzle to many a thoughtful child. A lady, a well-known writer of fiction, sends me the following recollection of her early thought on this subject: "The existence of other people seemed natural; it was the 'I' that seemed so strange to me. That I should be able to perceive, to think, to cause other people to act, seemed to me quite to be expected, but the power of feeling and acting and moving about myself, under the guidance of some internal self, amazed me continually."

It is, of course, hard to say how exactly the child thinks about this inner self. It seems to me probable that, allowing for the great difference in reflective power, children in general, like primitive man, tend to materialize it, as indeed we all can not help doing, thinking of it dimly as a filmlike, shadowlike likeness of the visible self. The problem is complicated for the child's consciousness by religious instruction with its idea of an undying soul.

As may be seen in the recollections just quoted, this early thought about self is greatly occupied with its action on the body. Among the many things that puzzled the much-questioning little lad already frequently quoted was this: "How do my thoughts come down from my brain to my mouth, and how does my spirit make my legs walk?" C——'s sister, when four years and ten months old, wanted to know how it is we can move our arm and keep it still when we want to, while the curtain can't move except somebody moves it. The first attempts to solve the puzzle are of course materialistic, as may be seen in our little questioner's delightful notion of thoughts traveling through the body and out at the mouth.

Very curious are the directions of the first thoughts about the past self. The idea of personal identity so dear to philosophers does not appear to be fully reached at first. On the contrary, in the case of the boy C——, the past self was divorced from the present under the image of the opposite sex in the odd expression "When I was a little girl." This idea I find is not confined to C——. Another little boy when about three years and a half old asked his mother, "Was I a girl when I was small?" and the little questioner whom I have called our zoölogist was also accustomed to say, "When I was a ickle dirl" (girl). But, funnily enough, this same little boy would also say, "When I was a big man," to describe the state of things long long ago. What does this mean? Is the child apt to think of his life as a series of transformations, of transitions from littleness to bigness and the reverse, and even of transmutation from the one sex into the other? And if so, how does he come by this odd view of life? It seems probable to me that to the child's lively fancy such metamorphoses of the self present themselves as easy and natural. Is not much of his time passed in fancying himself transformed by some wondrous magic into a prince, a fairy, and what not? It may be hard to trace out all the little misapprehensions of language, all the quaint childish inferences, which lie behind such thoughts as these. It is possible, however, after all, that the child does not mean to be taken too literally in this talk about his past self. The little boy's reference to his past girlhood or bigness may be only his bold, figurative way of trying to express the idea of a state very, very different from the present, a phase of his existence which he can not join on to the later and nearer, and which he is forced to regard as another existence.

The difficulty to the child of conceiving of his remote past is surpassed by that of trying to understand the state of things before he was born. The true mystery of birth for the child, the mystery which fascinates and holds his mind, is that of his beginning to be. This was illustrated in C——'s question: "Where was I a hundred years ago? Where was I before I was born?" It remains a mystery to all of us, only that after a time we are wont to put it aside. The child, on the other hand, is stung, so to say, by the puzzle, his whole mind being thrown into energetic movement.

It is curious to note the differences in the attitude of children's minds toward the mystery. The small person accustomed to petting, to be made the center of others' thought and action, may be struck with the blank in the common home life before his arrival. A lady was talking to her little girl H——, aged three years, about something she had done when she was a child. H—— then wanted to know what she was doing then, and was told by her mother, "Oh, you were not here at all." She seemed quite amazed at this, and said: "And what did you do without H——? Did you cry all day for her?" And being informed that this was not the case, she seemed quite unable to realize how her mother could have existed without her. There is something of the charmingly naive egoism of the child here, but there is more, there is the vague expression of the unifying integrating work of love. Lovers, one is told, are wont to think in the same way about the past before they met and became all in all to one another. For this little girl, with her strong sense of human attachment, the idea of a real life without that which gave it warmth and gladness was a contradiction.

Sometimes, again, in the more metaphysical sort of child-head, the puzzle relates to the existence of the outer world of things. We have all been perplexed by the thought of the world's existing before we were, and going on to exist after we cease to be; though here, again, save in the case of the philosopher, perhaps, we get used to the puzzle. Children may be deeply impressed with this apparent contradiction. Jean Ingelow, in her interesting reminiscences, thus writes of her puzzlings on this head: "I went through a world of cogitation as to whether it was really true that anything had been and lived before I was there to see it. . . . I could think there might have been some day when I was very little—as small as the most tiny pebble on the road—but not to have been at all was so very hard to believe." A little boy of five, who was rather given to saying smart things and what looked like a display of his powers, was one day asked by a visitor, who thought to rebuke what she took to be his conceit, "Why, M——, however did the world go round before you came into it?" M—— at once replied: "Why, it *didn't* go round. It only began five years ago." Was this, as perhaps nine persons out of ten would say, merely a bit of dialectic smartness, the evasion of an awkward question by denying the assumed fact? I am disposed to think that there was more, that the virtuous intention of the visitor had chanced to discover a hidden child-thought, for the child is naturally a Berkeleyan, in so far at least that for him the reality of things is reality for his own sense-perceptions. A world existent before he was on the spot to see it seems to the child's intelligence a contradiction. M——'s expression, "It only began five years ago," was merely a particularly audacious way of putting an idea which lurks, I suspect, in the dim region of many little minds that try to think about things.

Children will sometimes use theological ideas as an escape from this puzzle. The myth of babies being brought down from heaven is particularly helpful. The quick young intelligence sees in this pretty idea a way of prolonging his existence backward. The same little boy that was so concerned to know what his mother had done without him happened one day to be passing a street pump with his mother, when he stopped and observed with perfect gravity, "There are no pumps in heaven where I came from." He had evidently thought out the fiction of the God-sent baby to its logical consequences, and after taxing in vain his prenatal memory had arrived at the conclusion that pumps were not of heaven's furniture.

Children appear to have very vague ideas about the past. On the one hand, as in the case of their measurements of space, their standard of time is not ours; an hour, say the first morning at school, may seem an eternity to a child's consciousness. The days, the months, the years seem to fly faster and faster as we get older. On the other hand, as in the case of space-judgment, too, the child, through his inability to represent time on a large scale, is apt to bring the past too near the present. Mothers and young teachers would be surprised if they knew how children interpreted their first historical instruction introduced by the common phrase "Many years ago," or similar expressions. Here is an illustrative anecdote sent in by the aunt of the child, a boy of five years and a half: "H—— was beginning to have English history read to him, and had got past the 'Romans,' as he said. One day he noticed a locket on my watch chain, and desired that it should be opened. It contained the hair of two babies both dead long before. He asked about them. I told him they died before I was born. 'Did father know them?' he asked. 'No, they died below *he* was born.' 'Then who knew them and when did they live?' he asked, and as I hesitated for a moment, seeking how to make the matter plain, 'Was it in the time of the Romans?' he gravely asked." The odd-looking historical perspective here was quite natural. He had to localize the babies' existence somewhere, and he could only do it conjecturally by reference to the one far-off time of which he had heard, and which presumably covered all that was before the lifetime of himself and of those about him.

We may now pass to another group of children's ideas—a group already alluded to—those which have to do with the invisible world, with death and what follows, with God and heaven. Here we find an odd patchwork of thought, the patchwork-look being due to the heterogeneous sources of the child's information, his own observations of the seen world on the one hand and the ideas supplied him by what is called religious instruction on the other. The characteristic activity of the child-mind, so far as we can disengage it, is seen in the attempt to co-ordinate the disparate and seemingly contradictory ideas into something like a coherent system.

Like the beginning of life, its termination, death, is one of the recurring puzzles of childhood. This might be illustrated from almost any autobiographical reminiscences of childhood. Here, indeed, the mystery is made the more impressive and recurrent to consciousness by the element of dread. A little girl of three years and a half asked her mother to put a great stone on her head, because she did not want to die. She was asked how a stone would prevent it, and answered with perfect childish logic, "Because I shall not grow tall if you put a great stone on my head, and people who grow tall get old and then die."

Death seems to be thought of by the unsophisticated child as the body reduced to a motionless state, devoid of breath and unable any longer to feel or think. This is the idea suggested by the sight of dead animals, which but few children, however closely shielded, can escape.

The first way of envisaging death seems to be as a temporary state like sleep, which it so closely resembles. A little boy of two years and a half, on hearing from his mother of the death of a lady friend, at once asked, "Will Mrs. P—— still be dead when we go back to London?"

The knowledge of burial leads the child to think much of the grave. The instinctive tendency to carry on the idea of life and sentience with the buried body is illustrated in C——'s fear lest the earth should be put over his eyes. The following observation from the Worcester collection illustrates the same tendency: "A few days ago H—— (aged four years and four months) came to me and said, 'Did you know they'd taken Deacon W—— to Grafton?' I, 'Yes.' H——: 'Well, I s'pose it's the best thing. His folks' (meaning his children) 'are buried there, and they wouldn't know he was dead if he was buried here.'" This reversion to savage notions of the dead in speaking of a Christian deacon has its humorous aspect. It is strange to notice here the pertinacity of the natural impulse. All thoughts of heaven were forgotten in the absorbing interest in the fate of the body.

Do children, when left to themselves, work out a theory of another life, that of the soul away from the dead deserted body? It is of course difficult to say, all children receiving some instruction at least of a religious character respecting the future. One of the clearest approaches to spontaneous child-thought that I have met with here is supplied by the account of the Boston children. "Many children," writes Prof. Stanley Hall, "locate all that is good and imperfectly known in the country, and nearly a dozen volunteered the statement that good people, when they die, go to the country—even here from Boston." The reference to good people shows that the children are here trying to give concrete definiteness to something that has been said by another. These children had not, one suspects, received much systematic religious instruction. They had perhaps gathered in a casual way the information that good people, when they die, are to go to a nice place. Children pick up much from the talk of their better-instructed companions which they only half understand. In any case it is interesting to note that they placed their heaven in the country, the unknown beautiful region where all sorts of luxuries grow. How like the idea of the happy hunting grounds to which the American Indian consigns his dead chief! One would have been glad to examine these Boston children as to how they combined this belief in going to the country with the burial of the body in the city.

In the case of children who pick up something of orthodox religious creed the idea of going to heaven has somehow to be grasped and put side by side with that of burial. How the child-mind behaves here it is hard to say. It is probable that there are many comfortable and stupid children who are not troubled by any appearance of contradiction. As we saw in the remark of the American child about the deacon, the child-mind may oscillate between the indigenous idea that the man lives on in a sense underground and the imported idea that he has passed into heaven. Yet undoubtedly the more thoughtful kind of child does try to bring the two ideas into agreement. The boy C—— attempted to do this first of all by supposing that the people who went to heaven (the good) were not buried at all; and later by postponing the going to heaven, the true entrance being that of the body by way of the tomb. Other ways of getting a consistent view of things are also hit upon. Thus a little girl of five years, probably starting from the knowledge that it is the body—which she interpreted as the trunk—which is put under ground, and perhaps following the hint given by a drawing of cherub heads, thought that the *head* only passed to heaven. A little boy of six, reflecting the early process of human thought as still registered in such words as spirit (cf. πνεῦμα), held that God took the *breath* to heaven.

In what precise manner children imagine the entrance into heaven to take place I do not feel certain. The legend of being borne by angels through the air probably assists here. It has been suggested to me that the theory entertained by many children that old people shrink and become of the size of children is connected with this thought about going to heaven. Just as we arrive on earth as babies in the arms of angels, so growing small again we are carried back from earth to heaven. This may be so in certain cases, although some of my facts show that the child thinks of old people as getting small without any direct reference to death.

Coming now to ideas of supernatural beings, it is to be noted that children do not wholly depend for their conceptions of these on religious or other instruction. The liveliness of their imagination, and their impulses of dread and trust, push them on to a spontaneous creation of invisible beings. In C——'s haunting belief in the wolf, we see a sort of survival of the tendency of the savage to people the unseen world with monsters in the shape of demons. Another little boy of rather more than two years old who had received no religious instruction acquired a similar haunting dread of "cocky," the name he had given to the cocks and hens when in the country. He localized this evil thing in the bathroom of the house, and he attributed pains in the stomach to the malign influence of "cocky." * Fear created the gods, according to Lucretius, and in this invention of evil beings bent on injuring him the child of a civilized community probably reproduces the process by which man's thoughts were first troubled by the apprehension of invisible and supernatural agents.

On the other hand, we find that the childish impulse to seek aid leads to a belief in a more benign sort of being. C——'s stanch belief in his fairies who could do the most wonderful things for him, and more especially his invention of the rain-god (the Rainer), are a striking illustration of the working of this impulse.

Even here, of course, while we can detect the play of a spontaneous impulse, we have to recognize the influence of instruction. C——'s tutelary deities the fairies were, no doubt, *suggested* by his fairy stories; even though, as in the myth of the Rainer, we see how his active little mind proceeded to work out the hints given him in quite original shapes. This original adaptation shows itself on a large scale where something like systematic religious instruction is supplied. An intelligent child of four or five will in the laboratory of his mind turn the ideas of God and the devil to strange account. It would be interesting, if we could only get it, to have a collection of all the hideous eerie forms by which the young imagination has endeavored to interpret the notion of the devil. His renderings of the idea of God appear to show less of picturesque diversity.†

It is to be noted at the outset that for the child's intelligence the ideas introduced by religious instruction at once graft themselves on to those of fairy lore. Mr. Spencer has somewhere ridiculed our university type of education with its juxtaposition of classical polytheism and Hebrew monotheism. One might perhaps

* See Mind, vol. xi, p. 149.

† According to Prof. Earl Barnes, the Californian children seem to occupy themselves but little with the devil or hell. See his interesting paper, Theological Life of a Californian Child, Pedagogical Seminary, vols. ii, iii, pp. 442 *et seq.*

with still greater reason satirize the mixing up of fairy story and Bible story in the instruction of a child of five. Who can wonder that the little brain should throw together all these wondrous invisible forms, and picture God as an angry or amiable old giant, the angels as fairies, and so forth ? In George Sand's child-romance of Corambé we see how far this blending of the ideas of the two domains of the invisible world can be carried.

For the rest, the child in his almost pathetic effort to catch the drift of this religious instruction proceeds in his characteristic matter-of-fact way by reducing the abstruse symbols to terms of familiar everyday experience. He has to understand, and he can only understand by assimilating these exalted conceptions to homely, terrestrial facts.

Hence, as we all know, the frank, undisguised materialism of the child's theology. God is imaged as a man preternaturally big—as a big blue man, according to one child; as a huge being with limbs spread all over the sky, according to another; as so immensely tall that he could stand with one foot on the ground and touch the clouds, to another; strong like the giant his prototype. He dwells in heaven—that is, just the other side of the blue and white floor, the sky. He is so near the clouds that, according to one small boy (our little friend the zoölogist), the clouds are a sort of pleasance, made up of hills and trees which God has made to saunter in. To other children he seems still lower down; one little girl of five being in the habit of climbing an old apple tree to visit him and tell him what she wanted. With some others, on the contrary, God's abode is put farther away in one of the stars.*

As we have seen, the childish intelligence is apt to envisage God as a citizen properly housed and leading the life of a sort of great lord in a big house or palace. He gets hungry like mortals, and has his regular meals. He has, according to some of the Boston children, birds, children, and Santa Claus living with him; curious company which clearly illustrates how religious instruction is aided by observation and by mythology. By one imaginative boy (our zoölogist) he was said prettily to receive visits from the birds, and to have the nightingales and the other birds to sing to him. The Californian children spoken of by Prof. Earl Barnes appear to beautify heaven spontaneously by making it a kind of park or pleasance with trees, flowers, and birds.

While thus relegated to the sublime regions of the sky God is supposed to be doing things, and of course doing them for us, sending down rain and so forth. What seems to impress children most, especially boys, in the traditional account of God, is his

* I am here quoting largely from the material collected by Prof. Stanley Hall.

power of making things. He is emphatically the artificer, the Demiurgos who not only has made the world, the stars, etc., but is still kept actively employed by human needs. According to the Boston children, he fabricates all sorts of things from babies to money, and the angels work for him. The boy has a great admiration for the maker, and our small zoölogist when three years and ten months old, on seeing a group of workingmen returning from their work, asked his astonished mother, "Mamma, is these gods?" "God," retorted his mother, "why?" "Because," he went on, "they make houses and churches, mamma, same as God makes moons and people and ickle dogs." Another child, watching a man repairing the telegraph wires that rested on a high pole at the top of a lofty house, asked if he was God. In this way the child is apt to think of God descending to earth in order to make things. Indeed, in their prayers children are wont to summon God as a sort of good genius to do something difficult for them. A boy of four years and a half was one day in the kitchen with his mother, and would keep taking up the knives and using them. At last his mother said, "L——, you will cut your fingers, and if you do they won't grow again." He thought for a minute and then said, with a tone of deep conviction: "But God would make them grow. He made *me*, so he could mend my fingers, and if I were to cut the ends off I should say, 'God, God, come to your work,' and he would say, 'All right.'"

While this way of recognizing God as the busy artificer is common, it is not universal. The child's deity, like the man's (as Feuerbach showed), is a projection of himself; and as there are lazy children, so there is a child's God who is a luxurious person, sitting in a lovely armchair all day, and at most putting out (from heaven) the moon and stars at night.

With this admiration of the doer there goes naturally that of skill and practical intelligence. A little boy once said to his mother he would like to go to heaven to see Jesus. Asked why, he replied: "Oh! he's a great conjurer." The child had shortly before seen some human conjuring, and used this experience in a thoroughly childish fashion by envisaging in a new light the New Testament miracle-worker.

The idea of God's omniscience seems to come naturally to children. They are in the way of looking up to older folks as possessing boundless information. C——'s belief in the all-knowingness of the preacher, and his sister's belief in the all-knowingness of the policeman, show how readily the child-mind falls in with the notion.

On the other hand I have heard of the dogma of God's infinite knowledge provoking a skeptical attitude in the child-mind. Our astute little zoölogist, when five years and seven months old, in a talk with his mother, impiously sought to tone down the doctrine of omniscience this way: "I know a ickle more than Kitty, and you know a ickle more than me; and God knows a ickle more than you, I s'pose; then he can't know so very much after all."

Another of the divine attributes does undoubtedly shock the childish intelligence—I mean God's omnipresence. It seems indeed amazing that the so-called instructor of the child should talk to him almost in the same breath about God's inhabiting heaven and his being everywhere present. Here, I think, we see most plainly the superiority of the child's mind to the adult's, in that it does not let contradictory ideas lie peacefully side by side, but makes them face one another. To the child, as we have seen, God lives in the sky, though he is quite capable of coming down to earth when he wishes, or when he is politely asked to do so. Hence he rejects the idea of a diffused ubiquitous existence. The idea apt to be introduced early as a moral instrument, that God can always see the child, is especially resented by that small, sensitive, proud creature, to whom the ever-following eyes of the portrait on the wall seem a persecution. Miss Shinn, a careful American observer of children, has written strongly, yet not too strongly, on the repugnance of the child-mind to this idea of an ever-spying eye.* My observations fully confirm her conclusions here. Miss Shinn speaks of a little girl who, on learning that she was under this constant surveillance, declared that she "would *not* be so tagged." A little English boy of three, on being informed by his older sister that God can see and watch us, while we can not see him, thought awhile, and then in an apologetic tone remarked, "I'm very sorry, dear, I can't (b) elieve you." What the sister —aged fifteen—thought of this is not recorded.

When the idea is accepted odd ideas are excogitated for the purpose of making it intelligible. Thus one child thought of God as a very small person who could easily pass through the keyhole. The idea of God's huge framework illustrated above is probably the result of an attempt to figure the conception of omnipresence. Curious conclusions, too, are sometimes drawn from the supposition. Thus a little girl, of three years and nine months, one day said to her mother in the abrupt childish manner: "Mr. C——" (a gentleman she had known who had just died) "is in this room." Her mother, naturally a good deal startled, answered, "Oh, no!" Whereupon the child resumed: "Yes, he is. You told me he is with God, and you told me God was everywhere; so, as Mr. C—— is with God, he must be in this room." With such trenchant logic does the child's intelligence cut through the tangle of incongruous ideas which we try to pass off as methodical instruction.

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* Overland Monthly, January, 1894, p. 12.

It might easily be supposed that the child's readiness to pray to God is inconsistent with what has just been said. Yet I think there is no real inconsistency. The child's idea of prayer appears to be that of sending a message to some one at a distance. The epistolary manner noticeable in C——'s prayers seems to illustrate this. The mysterious whispering is, I suspect, supposed in some inscrutable fashion, known only to the child, to transmit itself to the divine ear.

Of the child's belief in God's goodness it is needless to say more. For these little worshipers he is emphatically the friend in need who can help them out of their difficulties in a hundred ways. Our small zoölogist thanked God for making "the sea, the holes with crabs in them, and the trees, the fields, and the flowers," and regretted that he did not follow up the making of the animals we eat by doing the cooking also. As their prayers show, he is ever ready to make nice presents, from a fine day to a toy gun, and will do them any kindness if only they ask prettily. Happy the reign of this untroubled optimism! For many children, alas! it is all too short, the color of their life making them lose faith in all kindness and think of God as cross and even as cruel.

One of the real difficulties of theology for the child's intelligence is the doctrine of God's eternity. Puzzled at first with the fact of his own beginning, he comes soon to be troubled with the idea of God's having had no beginning. C—— showed a common trend of childish thought in asking what God was like in his younger days. The question "Who made God?" seems to be one to which all inquiring young minds are led at a certain stage of child-thought. The metaphysical impulse of the child to follow back the chain of events *ad infinitum* finds the ever-existent, unchanging God very much in the way. He wants to get behind this "always was" of God's existence, just as, at an earlier stage of his development, he wanted to get behind the barrier of the blue hills. This is quaintly illustrated in the reasoning of a child observed by M. Egger. Having learned from his mother that before the world there was only God the Creator, he asked, "And before God?" The mother having replied, "Nothing," he at once interpreted her answer by saying, "No, there must have been the place (i. e., the empty space) where God is." So determined is the little mind to get back to the "before," and to find something, if only a prepared place.

Other mysteries of which the child comes to hear find their characteristic solution in the busy little brain. A friend tells me that when a child he was much puzzled by the doctrine of the Trinity. He happened to be an only child, and so he was led to put a meaning into it by assimilating it to the family group, in which the Holy Ghost became the mother.

I have sought to show that children try to bring meaning and a consistent meaning into the jumble of communications about the unseen world to which they are apt to be treated. I agree with Miss Shinn that children about three and four are not disposed to theologize, and are for the most part simply confused by the accounts of God which they receive. Many of the less bright of these small minds may remain untroubled by the incongruities that lurk in the mixture of ideas, half mythological or poetical, half theological, which are thus introduced. Such children are no worse than many adults who have a wonderful power of entertaining contradictory ideas by keeping them safely apart in separate chambers of their brain. The intelligent, thoughtful child, on the other hand, tries at least to reconcile and to combine in an intelligible whole. His mind has not, like that of so many adults, become habituated to the water-tight-compartment arrangement, in which there is no possibility of a leakage of ideas from one group into another. Hence his puzzlings, his questionings, his brave attempts to reduce the chaos to order. I think it is about time to ask whether parents are doing wisely in thus adding to the perplexing problems of early days.

SCHOOL ETHICS.

By H. C. BLACKWOOD COWELL.

THE savage instincts which men, even in the most advanced societies, still retain, are ever prompting them to pursue courses of conduct which their civilized intellects condemn—thus causing them to be at war with themselves. "Do this," suggests the nearsighted savage instinct; "Nay, this," opposes the farseeing civilized intellect; and though much ensuing conduct is in the nature of a compromise, yet the commands of instinct are oftener obeyed than those of reason. Hence the saddest and strangest of all anomalies: men who know what is good and do what is evil. When all savage instincts shall have been supplanted by social ones, will it not seem marvelous to men that their ancestors of the nineteenth century should have persisted in courses of conduct whose evil consequences were well known to them? Even to many of us, who still feel the driving force of savage instincts, it is a matter of wonder that some of the knowledge we possess should affect in so slight a degree our habitual conduct. Daily, science makes some discovery which might be expected to alter our conduct, but we go on acting in much the same way as we did before we had gained the new knowledge. Though to-morrow it should be satisfactorily shown that the effects of use and disuse were not inheritable, how little would such knowledge immediately affect the enacting of laws, the making of marriages, the teaching of morality, the giving of alms! Between old ideas and action the connection is strong; between new ideas and action the connection is weak.

There are two truths, forming part of the inoperative knowledge of the educational world, to which I would here call attention. The first is, that the children of civilized persons possess in a marked degree the characteristics of savages; the second, that as human beings grow old they lose mental, moral, and physical plasticity. And when we consider the facts that children possess much of the nature of savages, that savage natures prompt savage acts, that the frequent performance of savage acts tends to produce savage habits, and that age tends to fix habits by producing rigidity, the difficulty and the need of forming social characters in those of plastic age become apparent. How to supplant savage instincts by social instincts—how to produce moral natures—is the problem which educators of all kinds are called upon to solve. I do not mean to imply that educators can produce moral natures in the sense of manufacturing them, but that they can assist their growth. By imparting ethical knowledge to the young we may realize moral minds, but unfortunately moral minds do not necessitate moral natures. Civilized minds may coexist with savage natures. As the value of any knowledge is in proportion to its beneficial effect on conduct, the knowledge of what constitutes good conduct is certainly of much value, and ethics deserves a more prominent place in our schools than it now occupies. But the doing of what is good does not necessarily follow the knowing of what is good. Good deeds depend much more on the possession of social natures than on the possession of minds stored with ethical knowledge.

The obligation which children are under of obeying parents lapses when they become self-supporting. The obligation to conform to certain social laws never lapses. These laws are binding on adults and children alike. The obligation which pupils are under of observing the rules of the schools which they attend also lapses when school days are over. Obedience to parents and teachers is temporary; obedience to social laws is permanent. Yet disobedience to parents and teachers as such often meets with much severer punishment than infraction of a social law! Nay, even worse than this is true; infractions of social law are countenanced where needless college rules are strictly enforced.

When on a crowded sidewalk two pedestrians accidentally jostle each other, there usually follow mutual apologies. "The right of personal integrity," which Spencer deduces as a corollary of his "law of equal freedom," finds recognition in civilized societies—a violation of it being with us considered a criminal offense. But in the management of schools and colleges, where one expects to meet with complete recognition of the fundamental laws governing societies, there is but little recognition of that which forbids violation of person. Happily, in America, the system of "fagging" does not exist, at least not in that gross form which disgraces the schools of Great Britain and Ireland, where, contrary to their wishes and without remuneration, small boys are compelled to perform menial work for big bullies, who beat them brutally when the work is not satisfactorily accomplished, or sometimes for amusement, as I have myself witnessed—where the analogy between a "fag" and a slave is almost perfect, each doing under compulsion unremunerated labor and being liable to the lash. Happily, I repeat, "fagging" in this form finds little favor in American schools; but, unhappily, hazing does find favor. And nearly every form of "practical joke" practiced in schools and colleges necessitates a violation either of person or property. Newcomers are expected to bear with good humor at the hands of strangers assaults upon their persons and destruction of their property—to smile blandly upon young criminals.

Nor are the crimes of schoolboys which pass as practical jokes confined to crimes against schoolfellows; there are statesmen who, over the walnuts and the wine, tell tales of their "orchard-robbing days."

A significant example of school ethics is the method of settling "difficulties" spontaneously adopted by most schoolboys—namely, the method of physical encounter. He who declines to submit his case to the pugilistic test is branded a coward. The man who covers a crime is regarded as a criminal by society, but the schoolboy who discloses a crime is regarded as a criminal, if not by society at large, at least by his fellows.

Turning from schoolboys to schoolmasters, we find that, even if they do not openly countenance the conduct here condemned, they certainly do not sufficiently oppose it. Moreover, in many schools it is customary to punish the whole school, or a whole class, for offenses presumably committed by one or more of their number whenever the offender or offenders escape detection by the faculty. It is difficult to say which is the more barbarous, the boys' method of deciding questions of justice, or the masters' method of securing the punishment of undetected offenders.

One more example, of school ethics may be given. I am informed that in a few boys' schools and in many girls' schools the head masters or mistresses are authorized, or take it upon themselves, to open letters belonging to their pupils. This is done, as

I am further informed, to preserve the honor of the pupils; but to me it has always seemed like an object lesson in crime.

Both by precept and example must justice be taught in our schools, and its observance strictly enforced, before we may expect to see fair play in the game of life.

THE BAROMETRIC MEASUREMENT OF HEIGHTS.

By J. ELLARD GORE.

THERE are several methods of measuring the heights of mountains and other elevated portions of the earth's surface above the sea level. Of these may be mentioned the following: (1) by actual leveling with an engineer's spirit level and graduated staff; (2) by trigonometrical calculation based on the measurement of the angles of elevation observed at the extremities of a carefully measured base line; (3) by observing the temperature of the boiling point of water; and (4) by reading a barometer at the sea level, and again at the top of the mountain or elevation the height of which is to be determined.

The first of these methods is certainly the most accurate, but it involves a considerable amount of labor, and for very high mountains is sometimes impracticable. The second method is sufficiently accurate if carefully carried out and a nearly level plain is available for the measurement of a base line. The third method is not accurate enough to give reliable results. The fourth is the simplest and most expeditious of all. It is especially useful for finding the difference of level between two points at considerable distances apart, and would be sufficiently accurate if certain difficulties could be successfully surmounted. A consideration of this method and the difficulties to be overcome before its accuracy can be relied upon may prove of interest to the general reader.

The principle of the barometric method is as follows: The barometer measures the weight of the atmosphere. The column of mercury in an ordinary mercurial barometer is equal in weight to a column of air of the same diameter and of a height equal to that of the earth's atmosphere. The densest portion of the atmosphere is that close to the earth's surface, and its density diminishes as we ascend. At the top of a mountain, therefore, the pressure of the atmosphere will balance a shorter column of mercury, and hence the mercury descends in the tube. From the difference in height of the mercury at the level of the sea and on the top of the mountain it is possible to calculate the height we have ascended, as will be shown further on.

There are two forms of barometers—namely, the mercurial barometer and the aneroid. Of mercurial barometers there are two forms, the "cistern" and the "siphon." The cistern form is the one most generally used for scientific observations, and is the best for measuring heights. One of the most approved forms of cistern barometers—known as "Fortin's barometer"—consists of a glass tube closed at one end and filled with mercury, the lower portion of which dips into another tube of larger diameter which contains a reservoir of mercury forming the "cistern." The bottom of the cistern is formed of leather and fitted with an adjusting screw below, for the purpose of adjusting the level of the mercury in the cistern to an ivory index point above, which marks the zero of the graduated scale. By means of this adjusting screw the mercury may also be raised so as to completely fill the cistern and tube, and thus adapt the instrument for traveling.

We need not discuss here the manufacture of barometers and the filling of the tube with mercury, an operation which must be done carefully so as to exclude air from the tube. Suffice it to say that the best method is to fill the tube gradually, and boil the mercury as we proceed by means of a spirit lamp, in order to drive out all bubbles of air which may be contained in the mercury. The tube may be filled without boiling, but the resulting instrument will not be so accurate as one in which the mercury has been boiled.

To determine the difference of elevation between two places with a mercurial barometer, several points must be attended to. In the first place, the temperature of the barometer and the temperature of the air must be noted at each station. As the mercury in a barometer is affected by heat—in the same way that a thermometer is—the temperature at which the barometer is read must be observed. For this purpose a thermometer is usually attached to the barometer. The temperature should be read as accurately as possible, for an error of one degree Fahrenheit would make a difference of about three feet in the resulting altitude. The reading of the attached thermometer should be first noted, and then the height of the barometer. To do this, first bring the surface of the mercury in the cistern accurately to the index point by means of the adjusting screw. Then tap the tube gently near the top of the column in order to get rid of the adhesion between the mercury and the glass. The height of the mercury may then be read by means of the attached scale and vernier. Sometimes the amount of aqueous vapor in the atmosphere is ascertained by another instrument. The above data being known for two stations, we substitute the values found in one of the barometric formulæ, and thus obtain the height, or difference of height, required. Before the barometer readings can be used, this must be reduced to the *same* temperature—usually 32° F.

Various formulæ have been computed by eminent mathematicians and physicists for calculating the difference of height between two points. These formulæ depend on certain assumptions which, however, can not be considered as rigidly true. The most important of these assumptions is that the atmosphere may be supposed to be in a state of statical equilibrium. But owing to the changes constantly taking place, due to differences of temperature, humidity, winds, etc., this assumption can not be considered correct. The result will therefore be only an approximation to the truth. Assuming, however, a statical equilibrium of the atmosphere, a formula can easily be deduced from known principles. For this purpose we must first ascertain the weight of a cubic inch of air and a cubic inch of mercury at a certain temperature and pressure, and in a given latitude, say 45°. Then, by Boyle and Mariotte's law, connecting the weight of a gas and the pressure, the formula can be obtained for determining the height required. There are several elaborate formulæ used for this purpose. These include terms for altitude, latitude, temperature, and humidity. A correction for altitude is theoretically necessary owing to the diminution in the force of gravity—and, therefore, a decrease in the weight of bodies—with increased distance from the center of the earth, but this correction is comparatively very small, and may, for all practical purposes, be neglected. For the same reason a correction for latitude is mathematically required, owing to the spheroidal figure of the earth; but this, too, is very small, and may be safely neglected. The correction for temperature of the *air* is, however, very important. This term is easily computed. It is obtained—for the Fahrenheit scale—by deducting 64 from the sum of the observed temperatures at the upper and lower stations, dividing the difference by 900, and adding unity to the result. A correction for humidity of the air is also necessary; but it is doubtful whether it is desirable to complicate the formula by a correction for atmospheric moisture, the laws of which are so imperfectly understood.

In all the barometric formulæ which have been proposed the first term is constant, and common to all. It is known as the "barometric coefficient," and is $5·744 \frac{m}{a}$, where m is the "weight of a cubic inch of mercury at the sea level in latitude 45° at 30° F. when the barometer reads 29·92 inches," and a the weight of a cubic inch of dry air under the same conditions of latitude, temperature, and pressure. Various values of this constant have been found, depending on the values assumed for m and a. Arago and Biot found $\frac{m}{a} = 10,467$. This makes the "barometric coefficient" 60,122·4 feet. Raymond's value, namely 60,158·6 feet, was found by comparing the values given by the formulæ with the results of actual leveling with a spirit level. His observations were, however, few in number, and, although his coefficient is frequently used, it is probably the least accurate of all the determinations. In Laplace's formula, Raymond's constant is used. Babinet used the constant 60,334, and in Baily's formula the constant is 60,346. In Williamson's formulæ the constant is 60,384, which is the value found by Regnault, and is probably the most accurate of all. Sometimes the coefficient in the formula is given as 10,000 *fathoms*, which is roughly correct.

We will now consider the errors underlying the barometric measurement of heights, which render the method inapplicable in cases where great accuracy is required. The most important of these sources of error is probably that due to what is called the "barometric gradient," a term frequently used in meteorological reports. Taking three points at which the barometric pressure is the same, if the atmosphere was in a state of statical equilibrium these points would lie on the same level plane. But usually this plane is not level, but inclined, and the inclination of the plane is termed the "barometric gradient." For a *number* of points the surface on which they lie would not be a plane at all, but an undulating surface. These surfaces for different heights are never parallel, and frequently slope in opposite directions. Allowance can not be fully made for this disturbing cause, but the error can, to some extent, be eliminated by making a number of simultaneous observations at the two stations, and taking the mean of the results.

Another cause of error is due to variations in the temperature of the air. It is generally assumed that the mean temperature of the column of air between two stations, one vertically over the other, is the mean of the temperatures at the upper and lower stations, but this is not always the case. The error may be partially eliminated by making observations at intermediate stations, but can not be entirely overcome. High winds also cause a variation in the height of the barometer.

In addition to the errors mentioned, there are, of course, errors of observation, and instrumental errors. The former may be caused by imperfect adjustment of the zero point, and erroneous reading of the mercury on the scale. These errors are, however, usually small, and may with care be neglected. The instrumental errors are due chiefly to imperfect graduation of the scales of the barometer and attached thermometer, the impurity of the mercury, and to air in the tube. These errors may be corrected by comparison with a standard instrument.

The form of barometer known as the aneroid is also frequently used for the determination of heights, a graduated scale being added for this purpose. This scale is graduated by means of one of the barometric formulæ already referred to. The aneroid barometer usually consists of a metallic box from which the air has been exhausted, and differences of atmospheric pressure are recorded by a system of levers which act on an index hand which marks the reading on a graduated scale. In some forms of aneroid the box is not completely exhausted of air, and these are called "compensated aneroids," but the name is misleading, some of these instruments being more sensitive to changes of temperature than those not compensated. The aneroid is a very handy instrument and easily used, but for the purpose of measuring heights it is much inferior to the mercurial barometer. In some instruments the altitude scale is fixed at a certain reading, say thirty or thirty-one inches, and in others it is movable, and can be adjusted to any reading required. The latter seems the most convenient plan. In either case it is clear that absolute elevations above the sea level can not be determined with this instrument with any approach to accuracy, as there is no way of making the necessary corrections for variations in pressure, temperature, etc. The aneroid barometer should, therefore, be used only for finding *differences* of elevation, and for this purpose it will give fairly good approximate results in cases where extreme accuracy is not required.

To show the degree of accuracy attainable by the barometric method, two examples may be cited. From readings of a mercurial barometer at the summit of Mont Blanc and at the Geneva Observatory made by MM. Bravais and Martins in the year 1844, the height of the mountain above the level of the sea was computed to be 4,815·9 metres, or 15,800·44 feet. Corabeuf found by trigonometrical measurement a height of 15,783 feet, or 17·44 feet less than that indicated by the barometer.

The height of Mount Washington, in the United States, was found by a spirit level to be 6,293 feet above sea level, while the barometric method gave 6,291·7 feet, a close approximation. In some other cases, however, much larger differences have been found, and the good agreements quoted above may perhaps be considered as accidental.—*Gentleman's Magazine.*

The proper method of using a tent in Albania, according to Mr. W. H. Cozens Hardy, "is to pitch it, and then sleep under a tree three hundred yards away. The tent, and not its owner, is bullet-riddled in the morning."

BABIES AND MONKEYS.

By S. S. BUCKMAN.

IT is still a matter of scientific discussion whether man is descended from catarrhine or platyrrhine monkeys, or from the Lemuroidea; but there is little question that his ancestors were monkeylike, that they were decidedly prognathous, that they were covered with hair, that they had long tails, that they were arboreal, and that they used both the *pedes* and *manus* as hands—the former more than the latter. Man's ancestors, therefore, were very much like monkeys—they were simial or simioid, "monkeylike"; and could he see them at the present day, an unzoölogical critic would probably call them "monkeys" without much cavil.

The Latin word *simus* (Greek σιμός), whence our term "simia, monkey," means literally, "flat or snub nosed." This very feature, so striking in monkeys as to have become a name for all of them, is very remarkable in our babies. Viewed in profile, a baby's nose will appear to make a concave curve, the nostrils being obliquely truncate. The length of the nose is only equal to the breadth across the nostrils, and those are remarkably large, parted by a broad septum. During life nothing changes more than the nose. As the baby grows into a child the length of the nose increases faster than the breadth, so the snub-nosed baby grows into a more or less long-nosed and, it may be, hook-nosed adult. The snub nose remains a marked feature for a longer or shorter period of life—this is a matter of sex and parentage or race; but the change is gradual and imperceptible, generally more expeditious in the male than in the female, correlated with various other characters, such as intellectual attainments or weak constitution, and producing somewhat different results. The change, however, in the shape of the nose is one that continues throughout life. During maturity and senescence the bridge of the nose tends, as it did during childhood, to become more and more prominent: often it will become more and more convex, so that extreme old age may frequently develop an aquiline nose, even in some cases to produce the nut-cracker type of nose-meeting-chin so noticeable in old people.

It is only by a study of the face in profile, and of the face of the same individual at different ages of life, that the above changes can be properly noticed. The three-quarter photographs which we leave behind at the present day, faked up by the photographer's art, will be useless to the men of the future as records to tell what manner of people we were. With lapse of time, the widening of the family circle, and the various incidents of a workaday life, it is doubtful if these pictures will be regarded with any reverence or affection by our posterity from a merely sentimental point of view. But this would be changed if photographs were, as should be all photographs which aim to give a true picture of the face, taken just two ways—profile and full face. They would then be of scientific value; and even a dilettante scientific amateur of the future would esteem a family collection as something of interest for the lessons in evolution or anthropology it might teach: perchance, the theme might be the "Inheritance of Acquired Characters." The want of such photographs at the present day makes it extremely difficult to impress upon the layman or to prove to the scientist how much people change facially during life. Three-quarter views give but a feeble idea of the development. Nothing is more remarkable than a comparison of the same-sized profile views of the same person at six and at thirty years of age: the growth of the nose and the development of the forehead are so great that the jaws appear to have diminished in size; and this is really what the jaws have done, in proportion to the whole face.

It is a fond delusion with visitors and nurses that *the* baby is just like its father or mother. No one who has had that scientific training necessary to proper observation could make such a statement. It is a gross libel, sometimes on the baby, sometimes on the parents. Properly taken photographs show that the proportions of nearly every feature in the face of a baby and an adult are entirely different; but the greatest difference exists in the size and shape of the nose, and the size of the jaws. If, when adult, we had features like our babies, we should have a countenance of a negroid type. Except positive evidence be available, it would hardly be credible that the small-jawed, long and prominent-nosed individual, with high forehead, was in babyhood prognathous, short and snub-nosed, with a remarkably receding forehead. The difference resulting from the change during life as shown by two photographs reduced to the same size, not the same proportion, is greater than the difference between many species; yet the very fact of such metabolism and the possibility of its earlier transmission from generation to generation may be the basis of specific mutation, without calling in the aid of natural, or sexual, or physiological selection to account for that phenomenon.

The prognathism of a child is less noticeable than it should be, because such prognathism, owing to the disposition of weight, alters the whole carriage of the head; and the difference in the method of carrying the head obscures the prognathism to a certain extent. Prognathism is a heritage from quadrupedal ancestors, and is a necessary result of the carriage of the head enforced by a four-footed mode of progression. The attainment of the upright body-position of man tends during the course of his life to reduce prognathism—an adult is far less prognathous than when a baby; and it has tended during phyletic development to the same end—the European, the more developed form, is less prognathous than the negro. Reduction of prognathism leads to a better carriage of the head, because the weight is borne nearer the perpendicular, which is economy. Economy, it may be remarked, is most important to the man whose expenditure and income are too nearly on a par; and this dictum of necessity applies to civilized man, whose income in the shape of physical and nervous energy is much less, and his expenditure far greater, than that of the savage. But there are other factors at work: the civilized man requires the enlargement of the frontal capacity of his skull, and material saved in jaw-making can be utilized in skull-enlargement. Then there is the lessened use of teeth and jaws in mastication, and therefore a smaller demand upon those organs: these and other causes all work to the same end—a reduction of prognathism. If any one will draw to the same size the facial profile of a cat, a monkey, a baby, and an adult man, he will have represented four stages in the reduction of prognathism, and he will begin to understand to what the prognathous baby points. He will learn that in a designed biped the heavy jaw is a piece of faulty construction reflecting no credit on an artificer, whereas it is a necessary accompaniment of a biped developed from a quadrumanous or quadrupedal animal, imperfectly, incompletely, and gradually adapting himself to the bipedal position.

Attention may be called to another feature pointing out the same lesson of alteration and imperfect adaptation. Below the nose runs a furrow parting the upper lip. In the faces of babies and children this furrow is very noticeable: from the evolutionist's point of view it is one of the most remarkable characters of the face. It tends to become obsolete in old age, and it is not seen among the catarrhine monkeys. Among the platyrrhines it is but feebly developed; but in lemurs it is in a more pronounced state—there is a depressed septum to which the two side pieces are joined—the upper lip, in fact, is nearly split in two, but held together by a depressed piece of flesh. In the Marsupialia and Rodentia the lip is practically in two pieces, and each piece is capable of being moved separately. This is the "harelip"; and its method of use may well be noticed in a hare or a rabbit when eating. The furrow, therefore, in a child's lip points to this: that our ancestors possessed, not a single upper lip, as we do now, but two upper lips, one beneath each nostril, both capable of independent movement. In course of time these two lips have, owing to the nonrequirement of independent movement, grown together to form the single lip which we now possess; but the line of junction is not perfect, and so the furrow results; and sometimes there is a distinct scar down the middle of the furrow. The possession of this furrowed upper lip by children is one of the strongest pieces of evidence against the descent of man from any catarrhine, and in favor of his descent from platyrrhines, or from lemurs through the intervention of platyrrhinelike ancestors, of which there are no exact living representatives.

Another feature of a child's face is capable of similar explanation as a vestigial relic of its ancestors' other modes of life. The pouchlike cheeks of a baby are particularly noticeable, and they may be especially remarked in the representation of cherubs adorning ecclesiastical monuments. In such connection it savors of sacrilege to suggest that these inflated baby-cheeks, so much admired by all mothers, and regarded by churchmen as particular features of a hypothetical higher sort of beings—angels—are really the attributes of a lower order, and are the vestiges of cheek-pouches, possessed for storing away food, as in *Cercopithecus*, a monkey in which this habit of storing may be observed at the Zoölogical Gardens, if visitors feed it.

There is no need to enter into embryological or anatomical details concerning the characters for which children are indebted to monkeys. They possess in common with their adults a rudimentary tail hidden beneath the skin; but this is not a fact that every one can verify on the instant. Yet those who have the care of children can easly see for themselves the scar which the loss of the tail has still left on children's bodies—a scar which is curiously similar to what would obtain after amputation of a tail. Just at the base of the vertebral column—exactly where the tail would protrude through the flesh if it were functionally active—is a deep circular depression, sufficient almost for the insertion of the little finger. In young babies it is very noticeable; and nurses, while wondering what purpose it serves, abuse it as a place which is difficult to wash. In older children it gradually becomes shallower; and in those about five or seven years old it may or may not be shown. That it marks the place where a tail formerly protruded in our ancestors there can be no doubt from its shape and its position. I was curious to see if the anthropoid apes, which share with man this loss or rather atrophy of the tail, also exhibited this tail-mark; and I was interested to notice, in an adult female gorilla in the British Museum, that the tail-mark was as large as a florin. Its persistence to the adult stage in the case of the gorilla and its earlier loss in man is probably accounted for by the latter having attained a more perfect upright carriage of the body, and therefore a consequent increase of necessary muscles have occupied the somewhat vacant space.

Other characters, however, tell the same tale of adaptation. The proportion in length between the arms and legs of a baby when first born is very different to what obtains later in life. To use a somewhat incorrect phrase, the legs are in an undeveloped condition, and they have to grow quicker, in proportion, than the arms. The greater development of the arms in proportion to the legs in a newborn infant points to ancestors who used the arms more than the legs for sustaining the weight of their bodies, and this would mean that they lived an arboreal life. Dr. Louis Robinson, in an interesting article,* has fully illustrated the reason for superior arm-power in infants by his experiments on the hanging power of babies.

In the method of using its hands the baby shows to the full its descent from arboreal ancestors. When it wishes to take hold of anything, alike a glass or a flowerpot, it does not, like an adult, put the hand round it, or even put the thumb inside to use as a lever. On the contrary, it places all the fingers inside, makes no use of the thumb, and clasps the rim of the flowerpot between the fingers and the palm of the hand. This is exactly the action which would be acquired from arboreal ancestors: in going from bough to bough they would take their hands palms first, and would strike from above downward, grasping the bough with the fingers. Such is the action of an infant picking up a cup. So little use have some monkeys made of the thumb that abortion has resulted; and in the most arboreal species of monkeys known the fingers have grown together because the whole hand was used merely as a grasping-hook. It is probably from our ancestors' excessive use of the hands in bough-grasping that our babies inherit a certain inability to move the fingers with freedom, or to extend the hand, especially if the least degree cold. The power to extend the fingers perfectly straight is oftentimes not obtained by children at six or seven years of age.

Turning to the characteristics of an infant's feet and its habits of movement therewith, much instruction may be obtained by noticing these matters. Darwin observed the infant's ability to twist the sole sideways in a straight line with the inner part of the leg, a necessary ability to a tree-climbing animal; and he cited it as evidence of monkey ancestry. Considering how little an adult can move his or her toes, the power of movement of these organs by an infant is something remarkable, and it points to some ancestral environment of very different character from that which surrounds man at the present day. The big toe the

* Nineteenth Century, November, 1891, p. 838.

infant can project at an angle from the next toe, and the space between the big toe and the next is really the remnant of a space similar to that seen between our thumb and forefinger, when the toe was used for grasping like a thumb, and was opposable. It is not, as churchmen would have us believe, a relic of sandal-wearing times, and a special provision of a deity for the patriarchs to strap on their sandals: it is a relic of monkey ancestry taken advantage of by the ancients as the most appropriate place for the sandal strap. The big toe further reveals its former thumblike use in the fact that it and the thumb are the only two of the digits in which the last joint can be bent at will and independently of moving others. This can readily be exemplified in the thumb: the baby is fond of showing its power in this direction with its big toe. Further, a baby can move any of its toes independently, and it can move them one from another so as to make a v between any of them. As it grows older it loses this power and also the power of turning its ankle; but that it has such power over its muscles when young points to ancestors who used their feet more than their hands as organs for picking up small objects, and who relied on their arms and hands for supporting their bodies. Now we have reversed this process; we require our feet merely as pedestals, and as such they would be quite as serviceable to us did we possess but one toe. In time we may come to that monodactylous condition, for abortion of the toes is proceeding very rapidly. In a great measure we owe this to boots; and the more we try to hasten, unconsciously perhaps, this process of toe-abortion, the more we shall suffer. We suffer enough as it is in this respect. Certainly the sandal-wearing ancients were not free from encouraging the toe-abortion; for the examination of any old statuary will reveal a very marked abortion of the little toe, as a consequence of the strap-pressure; and there is even a certain amount of elevation of the outside of the foot from the ground, partial atrophy. Though from a hygienic point of view sandals were preferable to boots, nothing at all, except in extreme climatic conditions, would have been preferable to sandals. Boots are a curse to civilization. Every now and then one receives missionary circulars asking for sympathy and pity on behalf of children running about without shoes and stockings, citing it as a terrible proof of poverty. After all, it is the best thing for them; many doctors are prescribing "barefootedness" in cases of limb-weakness; and it is a good thing for all young children. There has been too much fussy meddlesomeness in these respects, particularly among savage races. Thus, Mr. J. Theodore Bent says: "The missionaries who teach and insist on clothing among races accustomed to nudity by heredity are responsible for three evils: firstly, the appearance of lung diseases among them; secondly, the spread of vermin among them; and thirdly, the disappearance from among them of inherent and natural modesty." It is a terrible indictment of the clothes-culture. When shall we be educated enough to know that clothing and decency are not synonymous terms, and that a fig leaf is a greater outrage on good taste than is absolute nudity?

It is remarkable how much unnecessary suffering is inflicted on infants and children because parents fail to recognize the ancestry from "animals,"* and consequently the instincts, different from those of adults, which children have inherited. Thus Dr. Louis Robinson has pointed out that as soon as children are able to shift for themselves in bed, they go to sleep on their stomachs with their limbs curled up under them; and he has rightly traced this to quadrupedal ancestors. Experience shows that if mothers would only recognize this ancestry, and would put their children to bed less enveloped in clothes and less tightly tucked up, so that these children might easily shift into the position which inherited instinct tells them to assume, they (the mothers) would have far more comfortable nights and better-tempered, healthier children.

Even the very manner in which babies are got off to sleep—by rocking in the arms or in a cradle—is an inheritance of arboreal or monkeylike ancestors, because the rocking is an imitation of the to-and-fro swaying of the branches, and such swaying would be the natural accompaniment of sleep with arboreal dwellers. Any rhythmic motion seems to leave a very marked impression on organisms. Thus, sailors after a long voyage complain of their inability to sleep upon land; because the sleep has been too long associated with the rocking of the vessel. More remarkable still, however, is the result of some experiments made by Mr. Francis Darwin and Miss D. Pertz † on The Curvature of Plants. They used an intermittent klinostat, arranged so as to reverse the influence of gravity on a growing shoot or stalk every half hour. When the clock was stopped they found that the rhythmic movement still continued, that the shoot or stalk actually curved in opposition to gravity for the half-hourly interval before finally obeying the impulse to grow downward. In the case of heliotrophic curvature the effect was even more marked. "After the clock was stopped the seedlings curved away from the light for *two* half-hourly intervals separated by one of curvature toward the light, so strongly were they imbued with the artificially induced rhythm." What is remarkable in these cases is

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* "Christians" and "animals" is the popular classification. See, too, Ibsen, An Enemy of the People, interruption in Dr. Stockmann's speech, "We are not animals, doctor" (Act iv).

† Journal of Botany, cit. Natural Science, vol. ii, p. 9.

the effect produced after a very short space of time. It would, therefore, be reasonable to conclude that the effect of thousands of years' association—as in the case of rocking with sleep in arboreal dwellers—would still be found to influence children very long after arboreal life had been abandoned.

It is certainly singular to find that nursery ditties contain reference to matters arboreal, as if there was some lingering tradition in the human race of ancestors who lived in trees. Thus the English mother or nurse in rocking her infant to sleep sings:

> Lullaby baby on the tree top;
> When the wind blows the cradle shall rock;
> When the bough breaks the cradle will fall,
> And down will come baby, cradle, and all.

Somewhat similar is a German nursery ditty:

> Schlafe, schlaf ein, mein Kind.
> Horch! da draussen der Wind;
> Wie das Vöglein im grünen Baum,
> Wiegt er auch dich in süssem Traum.

Nowhere is a stage of a former arboreal life, with its consequent climbing instinct, manifested more conspicuously than in the insane desire of an infant to climb upstairs. As soon as crawling is an accomplishment the climbing of stairs is attempted. Remain on the level and crawl about rooms the child will not; it must make for the nearest stairs to climb with loud crows of delight. Tumbles and consequent bruises have no effect on the child's climbing instinct, and really it regards them far less than the prohibition of its climbing feats by a too fond and foolish mother. It is better to let the child climb. Even a fall down the whole flight of stairs only checks the climbing mania temporarily, in order that the infant may loudly express its disapprobation of its own clumsiness, and may vent its anger in howls. But this episode over, it will, within a quarter of an hour, bravely attack the stairs again, having quite forgotten its late disaster. An instinct held so tenaciously can not be regarded as something fortuitous. Darwin considered that the tree-climbing propensity of boys was a relic of monkey ancestors, but he made no observation on the stair-climbing instinct of infants. Mothers, unfortunately, do not always possess enough scientific calmness to watch an infant climb stairs with every chance of a tumble, so they are apt to cut short such experiments. But if left alone—and that is the best plan—it is remarkable how soon the child learns not to tumble; and then the mother need have no more fear.

The early efforts of a child in learning to walk indicate the habits of an animal to whom the upright position is something strange. The baby is decidedly bowlegged, but this shape of leg would be exactly that necessary for tree-climbing quadrumana. When it is first stood up, the baby puts only the outer parts of its feet to the ground, and turns its toes in. It does not allow its heels to touch the ground. When a monkey walks on a branch it does not allow the homologous part to our heel to touch the branch. When a dog sits, as we call it, to beg, it really brings the same part into contact with the ground as we do in standing. It brings its hocks (heels) flat to the ground, and supports its weight on the hocks and toes. Children are very fond of "sitting on their heels" in the same manner as a dog when it begs. The difference between the begging attitude of a dog and the standing of a child is in the straightening of the knee joints in the latter. As a dog has not the power to straighten the knee joint, because of its quadrupedal habits, it can not stand on its hocks as we can; as soon as it raises its body on its hind legs it elevates the hock from the ground. The power to straighten the knee joint, and so to put the hock to the ground, is not inherent in babies at first; it is only by practice in walking that they are able to acquire it. Why, if babies' ancestors have always been animals walking on their hocks, should these processes have to be gone through?

The movements and habits of a young baby seem so strange to us because they are so different from those made by adults, and because they are so unconsciously performed. Joy is expressed by muscular movements, by wriggling of the hands and toes, or by convulsive beatings of the arms, when it is small; by "jigging," when it is larger. These movements are expressive of joy because to any animal of highly developed muscular energy movement is absolutely essential, and particularly pleasing, while stillness is the reverse. It is muscular excitement, chiefly no doubt electrical, a heritage from ancestors who knew not what it was to be still, that gives that restlessness to children and causes them to find so much pleasure in mere motion and muscular exertion of any kind. Jumping for joy is very literally correct of a child's expression of pleasure. The prospect of a sweet will excite a series of leaps to indicate delight; and they further serve the purpose of relieving the tedium of waiting the half-second necessary to the donation. The pleasure of finding a bird's nest with eggs in it—a pleasure which must have been very real sometimes in the case of hungry monkeys and savage man, but is now only a survival of the instinct thus formed—this pleasure a boy expressed by a series of convulsive leaps into the air; and during the performance not only were the arms and legs moved as much as possible, but the muscles of the stomach and vocal organs had to be utilized to cause accompanying shouts. It may be remarked that in adults, when limb-movements are less active, shouts are, on account of the muscular action involved, a necessary accompaniment of joy, noticeably 'Arry on a bank holiday; while in some cases expletives are symptomatic of joy and not of anger. All these outward signs have had their origin in that nerve excitation inducing muscular action which is a heritage from ancestors who, impelled by hunger, by love, or by war, led more active lives and thereby obtained a desire for motion as a second nature. Children and young lambs are very familiar examples; and so strongly will the latter pursue their gambols and racings that a broken heart is sometimes a cause of death in the middle of a sudden gallop. If children have to be still, it is torture to them—positive torture in some cases—and grown-up people are unaware how much, or they would not thoughtfully inflict it on young children. Muscular ache, the fidgets, growing-pain in the limbs, are all the result of enforced inactivity in children. It is similar with athletes: their muscular excitement is so strong that movement is pleasure, stillness means pain, and they are noted for restlessness.

Another "animal" relic which exists in children is an instinctive desire for stealing, especially for stealing fruit, which, however hard and unripe, seems to give the child pleasure. Stealing certainly points to the time when every animal had to depend on its own exertions for what food it got, and when the readiest method of obtaining such food was to appropriate without question whatever it might come across. The capacity for hard and unripe fruit indicates a necessity which would be incidental to monkeylike life—to times of scarcity, when anything in the shape of fruit, no matter what it might be, was gladly welcomed as food.

With the above another childish trait may advantageously be compared—namely, the habit of taking things to bed, especially such articles as the child may be attached to; but there is also a desire to take things for fear of other children obtaining them; and when a child takes off to bed such articles as a collection of clothes brushes, or an array of old boots, it seems like taking for taking's sake. Thus, one boy was found in bed with sundry drawer handles, unscrewed for the occasion, several pieces of old iron, two hair brushes, and a tobacco tin. Many causes have contributed to form this habit. First, there is the earlier inheritance of the maternal instinct; the mother taking her young to sleep with her, in order to feed and comfort it, would give the idea of taking to bed anything exciting fondness—dolls, toys, etc. Then there is the food instinct—the dragging-food-into-the-lair idea—with which may be associated a particular fondness of children for something to eat when they are in bed; and then there is the proprietary idea, arising from the feeling that to keep possession of articles it is necessary to sleep with them, if not on them. When a young child is trying to resist another taking things away from it, the usual method it pursues is to put the articles between its legs, to push away its assailant with its hands, and to scream loudly. During the scream it brings its mouth into a particular shape to show its canine teeth to the best advantage, and it frequently puts its head forward, especially protruding the chin so that the other animal may have a good view of its canine teeth. This is what the reason was; with a child, of course, it is a case of inherited habit and association, because it has never known how to fight with the canine teeth.

The earlier inheritance of the maternal instinct is worth noticing further; the doll-proclivity of girls is a particular instance of earlier inheritance thereof. Doll-nursing instinct is not shared in the least by any healthy boys, nor can they take to little household duties with the handiness of a girl. Boys' earlier inheritance is all in the way of offensive weapons, of bows, bats, balls, and noise, with a tendency to teasing and bullying, a feature for which the male has been famous, the sufferer who was put upon being the female—the weaker vessel; weaker because the males fought with one another for her; had she fought with her sisters for the males she could have been the stronger and the bigger brained.

The female, however, does inherit a pugnacious instinct, chiefly defensive. She has had to fight on behalf of her young ones, and in such cases the maternal instinct becomes very strong indeed. Children show this character; and I witnessed in one of mine a very curious exhibition of what might be called perverted instinct arising from a conflict of inherited associations. She was quite a little girl and was nursing her doll with all possible expression of affection, loving it, kissing it, and calling it all the endearing names she knew. Up came her brother and began to tease her. In an instant the pugnacious idea was aroused in defense of the doll, but, having no available weapon in hand, she seized the doll by the hind legs and, wheeling it aloft, brought its china head down with resounding force on the cranium of her brother. He retired, howling and discomfited. She, excited with her triumph, returned to the caressing of her doll with redoubled ardor, quite unconscious of the incongruity of her actions, an unconsciousness which heightened the comicality of the incident.

Another habit of children—a sadly destructive habit too—is that of picking at anything loose, any piece of wall-paper especially, so as to tear it off. This habit is a survival of a monkey practice of picking off the bark from trees in order to search for insects. Any loose piece of bark, even the very least displacement, indicates an insect refuge, and immediately suggests live prey; so that with the monkey there is a definite association between loose bark and food. With the child the reason for picking at loose things has been lost, but the instinct to pick remains as a vestigial survival, traceable to a definite food-acquiring instinct of the monkey. There may also have been an association with the monkey habit of picking out one another's parasites, a habit which is very noticeable among them.

To those people, and they are many, who scornfully repudiate their monkey ancestry, it may seem farfetched to notice such a childish habit, and to assert that it had any such origin; but many instances may be cited of habits acquired for some beneficial purpose, or in connection with some particular circumstances of life, persisting both in the life of the individual and also being perpetuated in the race long after the reason for the habit has been forgotten—not unlike superstitious ceremonies and religious observances which survive in a similar way. Thus there is the fear of women for snakes, and the consequent loathing and hatred—feelings which seem so unreasonable to many of the strong-minded people of the present day. We have written evidence that these feelings were subject of comment at a very early age of man's intelligence; and it may readily be surmised that the story of Genesis is only the written account of what had been verbally told for many generations. Mythical as it is, it seems a most ingenious method of accounting for certain observed facts; and that the facts were observed reflects considerable credit on the observers. As mythology it takes high rank; its very *naïveté* adds to its charm. "Whence arise these feelings in respect of snakes?" was the inquiry; and in answer thereto the legend gradually grew up, that "the snake was the tempter; of the presumed mother of all, Eve; he is just such as would be a tempter; his very habits, stealthy, gliding, silent, self-concealing, show at once that he 'is more subtil than any beast of the field.' Because he tempted Eve these feelings have arisen on the part of woman. The Lord God, when he found that Eve fell because of the serpent's temptation, said in his anger, 'I will put enmity between thee and the woman, and between thy seed and her seed.' That accounts for what we observe; it is all very plain." So said the sages of old. It is truly ingenious; but science gives a more simple interpretation, and yet an interpretation which, because it does not pander to the religious self-pride of human beings, in that it does not yield them that distinct rank above all other living things, is less palatable to the majority. Science says that the fear of women for snakes is an inheritance of monkeylike ancestors; that the most terrible foe of the female monkey, the foe most prone to snatch the young one from her, and even to take the mother herself on occasion, was the deadly poisonous snakes. The terror they inspired was so great that there can be no wonder at its survival in the human female of to-day.

Another habit, a relic of what was indulged in for a definite beneficial purpose, remains to the present day—namely, the fondness of children for rolling. It points to the time when our ancestors possessed hairy bodies tenanted by colonies of parasites, and is another example of parasite irritation shaping animals' habits, alluded to above. These hairy bodies were the homes of many parasites, among which the parents of *Pulex irritans* and many another *Pulex*, together with other kinds which need not be specified, were very much in evidence; and then our ancestors, owing to less perfect articulation of joints, or to less perfection in development of the limbs, or to the thick covering of hair, were unable to reach the source of trouble effectively, and could, like horses or donkeys, only alleviate the irritation by rolling. Scratching of the head as a nervous habit, from the association between nervous irritation and actual irritation by parasites. which must also be transmitted to the brain by the nerves, is a relic of similar ancestral parasitically infested animals. It persists now among human beings who are doubtless above suspicion in the matter of unwelcome tenants; and it is a familiar expression of doubt and perplexity among οἱ πολλοί who may not be altogether so guiltless.

According to the Darwinists, the loss of hair from the body, which man has suffered in comparison with simial ancestors, is attributable to the benefit he has derived from being able to get rid of his parasites, or from the greater advantage he obtained in the struggle for existence owing to being less troubled with parasites, whose numbers diminished from want of "cover." Such an idea, however, confuses cause and effect in a most remarkable manner. The diminution of parasites is a *result* of the loss of hair, but it certainly is not the *cause* of the hair being lost. To make it so is similar to saying that the diminution of trees in newly settled countries is *caused* by a decrease in the number of wild beasts. It supposes that the greater freedom from parasites was so important to simial ancestors who lost their hair as to give them immense advantage in the struggle for existence, forgetting that this does not explain the cause of the loss of hair in the first place. With loss of hair once started, some such benefit may be granted; but what caused the loss of hair in the first place? "Spontaneous variation" is no answer at all; what is the cause of the spontaneous variation? This seems too early a stage at which to say *Ignosco* or *Ignoro*.

Then this parasite idea ought to be applied to what is going on at the present day—to the loss of hair from the head—but unfortunately for the parasite theory, it is among "the classes" who are certainly above suspicion so far as parasites are concerned that the loss of hair on the head is most conspicuously shown, while in the case of Hodge, who can not be regarded in the same manner, loss of hair from the head is decidedly rare. An explanation which pretends to account for what has taken place, and yet fails in application to analogous circumstances at the present day, is not one to be accepted. A true explanation of the loss of hair will explain the present-day loss as well as that of the past; the loss of hair from the head as well as that from the body; the loss of hair by the elephant as compared with the mammoth; the loss of hair on the chests of old monkeys; the loss of hair during disease in animals generally; the loss of hair during pregnancy in domestic and other animals; the loss of feathers by penned-up fowls. An explanation which is wholly physiological, and accounts for loss of hair as a pathematic symptom of individual or racial decline, assumes that such loss of hair is an exemplification of a law of reversion, that as progressive ontogenetic or phylogenetic development is, necessarily, progressive acquirement or elaboration, retrogressive development in similar cases is, accordingly, loss or degeneration of character developed during progression. This explanation, together with the assumption warranted by evidence, that the longer any character or particular feature has been transmitted in the race, the longer it will withstand adverse influences, may be applied to all the instances of hair-loss given above.

In connection with the hair it may be noticed that certain peculiarities in its mode of growth had their origin in the habits of monkeylike ancestors. On a child's head the hair grows from the crown to the forehead; but in animals which move head-first on all fours—a rabbit, for instance—it may be noticed that the hair is always directed from front to back, a character acquired by the fact of motion through air in a given direction having imparted a given lie to the hair. Such may be assumed to have been the case with the hair in the ancestors of monkeys; but when it is found, as in *Cebus vellerosus*, that the hair grows the contrary way—namely, from back to front—some cause must have induced the change. The flow of rain may be cited—the head being hung down, so that the crown is the highest part, and the rain flows off in all directions, giving the hair a lie in accordance. Now, flow of rain in the case of quadrupeds, as well as the tendency of hair to grow according to gravity, unless other causes are more potent, has made the hair on their limbs grow from the body to the extremities. In the case of man, however, and certain monkeys, the hair on the forearm grows in just the contrary direction—namely, toward the elbow. Here, again, according to Darwin, rain has been the modifying agent; the habit of clasping the hands over the head during rain has caused the rain to flow from the hands to the elbows, and has given the hair direction in accordance, These, of course, are "acquired characters"—the lie of the hair is in accordance with certain disposing forces of environment. Such causes do not act on us now; but there are no causes acting to the contrary in a sufficiently potent manner. Consequently, we retain by the conservatism of heredity a character acquired in response to the necessities of environment in our prehuman ancestors.

To return to the persistence of habit, the case of sucking may be noticed. Sucking, of course, is the act of childhood—it is one of the most important incidents connected therewith. The baby sucks to satisfy hunger; and associated with sucking are the feelings of warmth, sleep, and comfort. But hunger means distress; and sucking to satisfy hunger means sucking to alleviate a particular distress; consequently, it has developed into sucking to alleviate any distress or pain generally. Thus, when an infant is hurt, it turns in its distress to its mother; it desires to suck, and it forgets its trouble in sucking. All these associations are potent in later life. It may be observed in many children long after they have given up sucking; when they are cross, or when they are teased, or angry, and vexed, they suck their thumbs. Many children in the same way can not go to sleep without sucking something—their thumbs generally being ready implements for the purpose—so persistent is the association of sucking with sleep. In later life children suck the ends of their pens or pencils when in doubt and perplexity over their lessons, from the association of sucking with distress or anxiety; and in still later life the masher, and the young man whose ideas do not flow very readily, suck the ends of their walking-sticks when they are in doubt or anxiety, in conversational or amatorial matters—such act of sucking being a relic of the baby habit acquired by the infant from the asssociation of sucking with alleviation of distress, no matter in what way it was caused. Further, the number of men who suck the ends of their mustaches,* and of women who suck the ends of their crochet or knitting needles, or anything else, whenever they have the least feeling of doubt, annoyance, anxiety, distress, discomfort, or the like, points to the persistence of a youthful habit long after all reason for it has ceased, and forms an instructive lesson in the development of the methods used to express emotions.

In other animals equally curious habits may be noticed, par-

* Apart from the sedative effects of nicotine, the sucking at a pipe may also be soothing from the inherited association. Some nonsmokers suck straws.

ticularly in domesticated animals, because inherent organic conservatism carries into the new state of life habits and instincts useful to the old. The turning round of a dog before it goes to sleep, and what my children call the "kneading-dough" action of a cat when before a warm fire, have been noticed before. But it may be remarked that when a cat takes a piece of meat she invariably gives it a shake—a habit acquired by the wild animal to shake off blood-drops and any adherent grit obtained by the flesh from contact with the ground, but an entirely useless performance in the case of a domestic cat fed on cooked meat in a carpeted room. Ducks which are kept away from a pond will, when it rains, or when they hear the splashing of water, repeatedly raise and lower their heads with a jerking motion—the same action which they use when in the water in order to throw the water over their bodies to wash themselves. Ducks delight in water, and consequently these washing movements are intimately associated with pleasure. Thus they feel pleasure when they are let out after confinement, though they may not be near water; and this pleasure they express by going through the washing movements—in fact, the association is so strong that these movements have become a conventional expression of pleasure of any kind. Young lambs will mount any hillock in a field, because their wild parents were dwellers in mountainous countries. We ourselves, when we wish to express scorn, or contempt, or anger, draw up our lip so as to expose the canine teeth—the weapons with which our monkey ancestors were wont to fight, as has frequently been pointed out. Babies, when they cry—and thus wish to express rage and indignation—draw the mouth into a quadrate shape. This peculiar set of the mouth in a crying infant was noted by Darwin;* but the reason for it does not seem to have been grasped. It arises, however, from the fact that crying is associated with anger, that in anger the fighting instinct is dominant, that the fighting instinct leads to a display of weapons on the *noli-me-tangere* principle, that the weapons of our ancestors were caniniform teeth in the upper and under jaws. It may be observed that the lips of a crying baby's mouth are so disposed as to exactly display the caniniform teeth as much as possible; but here comes the curious part of the whole matter—a young baby shows the quadrate-shaped mouth more remarkably than older children; yet it has no teeth to display, for the teeth are not to be seen in the gums. Here is a habit, acquired for a definite purpose, persisted in afterward when no means are available for fulfilling the purpose, and yet persisted in because of the long association in ancestors of the weapon-display with anger. For a

* Expression of the Emotions, second edition, chapter vi, pp. 155–158.

newly born baby to retract the corners of the lips in order to expose teeth which are still hidden in the gum is a ludicrously futile process; yet it shows in an extraordinary manner that a habit once acquired may remain, polarized, as it might be called, long after all reason for its acquirement and use had passed away.

From sadness to joy is a very welcome transition; and consequently a few remarks upon the method of expressing pleasure will not unsuitably follow those on the expression of pain. To show that they are pleased, human beings frequently draw up and wrinkle the nose the while they elevate the upper lip so as to expose the teeth. The same action may be noticed in terriers to express pleasure, and it is called "grinning": in children it is a remarkably common feature. It is not general among adults; but when it be a regular habit in any individual it leads to the formation of obliquely transverse furrows each side of the nose, and so gives to the face a definite and somewhat amiable expression, which may degenerate into an unfortunate peculiarity.

The origin of this expression does not seem to have been any wish to expose the teeth, but rather a desire to sniff in as much as possible. Animals derive their greatest pleasures from the satisfaction of the sexual and gastric appetites; and all odors associated with such satisfaction would become pleasing, because they would suggest pleasant ideas to the senses. It would be pleasant, then, to inhale such odors, as the odor of a good dinner is pleasant to a hungry man about to enjoy it; and he expresses his satisfaction by sniffs. The rapid repetition of a series of sniffs in succession, necessitating certain convulsive movements of the stomach, may have been the initiation of that expression of delight called "laughter," which consists in a series of quick convulsive stomachic movements coupled with certain guttural cacklings.

What might be called the genesis of our expressions, or their historical development in the phyletic series to which man belongs, opens a very wide field. Darwin has attacked it in his Expression of the Emotions; but, though he has collected a great store of most interesting facts, the theories and conclusions which he formed in connection therewith are sometimes not so satisfactory as they should be. Particularly does this apply to his principle of antithesis, which it is admitted in a note to the second edition (page 52) has not met with much acceptance. This can hardly be wondered at; because it seems so totally opposed to that gradual acquirement and development which the Darwinian doctrine supposes. Space does not allow a further consideration of this subject, more than to say that, like other animals, children's actions when at play show mimic warfare and perverted inheritance of sexual instinct. Love and war, which played such important parts among prehuman ancestors, have left their mark upon children's actions to-day—an influence which can be easily discerned, though it may be sometimes obscured. Even such a matter as the elevation of the eyebrows during astonishment may be traced to the desire of prehuman ancestors to erect the hair, in order to make themselves as big as possible, and therefore formidable to their foes, a habit which animals constantly exhibit when they are suddenly startled. It is the *noli-me-tangere* principle, sometimes practiced with good cause, but at other times being the merest "bluff," a veritable trading under false pretenses. It is to this practice of erecting the hair that we owe the involuntary expression during extreme terror—that of the hair standing on end with fright. By disuse we have lost the voluntary power to control the muscles which perform the function of erecting the hair; but the involuntary power still remains. Such seems to be the explanation; at any rate involuntary erection of the hair during terror is a well-known fact, treated of by Darwin.

Enough has been said to show that the characters and habits of children afford every support to the evolutionist; that what is quite unintelligible and even antagonistic to any idea of special creation becomes significant and full of meaning in the light of the doctrine of gradual development; that the actions of children when rightly interpreted tell their own tale and may fitly be compared to ancient monuments of prehistoric times; lastly, that the human infant is an interesting object of scientific research, and that even a cross baby should be calmly contemplated by the philosophic mind.—*Nineteenth Century*.

ANIMAL TINCTUMUTANTS.

By Dr. JAMES WEIR, Jr.

THE chromatic function—and I use this term to designate the faculty of changing color according to surroundings—is possessed by a number of the lower animals. The chameleon is the best known of all the tinctumutants (*tinctus*, color, and *mutare*, to change), though many other animals possess this faculty in a very marked degree. In order to understand the manner in which these changes or modifications of color take place, one must know the anatomy of the skin, in which structure these phenomena have their origin. The frog is a tinctumutant, and a microscopic study of its skin will clearly demonstrate the structural and physiological changes that take place in the act of tinctumutation. The skin of a frog consists of two distinct layers. The epidermis or superficial layer is composed of pavement epithelium and cylindrical cells. The lower layer, or *cutis*, is made up of fibrous tissue, nerves, blood-vessels, and cavities containing glands and cell elements. The glands contain coloring matter, and the changes of color in the frog's skin are due to the distribution of these pigment cells, and the power they have of shrinking or contracting under nerve irritation. The pigment varies in individuals and in different parts of the body. Brown, black, yellow, green, and red are the colors most frequently observed. The color cells are technically known as *chromatophores.* If the web of a frog's foot be placed on the stage of a microscope and examined with an achromatic lens, the chromatophores can readily be made out. Artificial irritation will immediately occasion them to contract, or, as is frequently the case, when contracted, will occasion them to dilate, and the phenomena of tinctumutation may be observed *in facto.* Under irritation the orange-colored chromatophores, when shrunk, become brown, and the contracted yellow ones, when dilated, become greenish yellow. When all the chromatophores are dilated, a dark color will predominate; when they are contracted, the skin becomes lighter in color. Besides the pigment cells just described, Heincke discovered another kind of chromatophores which were filled with iridescent crystals. They were only visible, as spots of metallic luster, when the cells were in a state of contraction. He observed these latter chromatophores in a fish belonging to *Gobius,* the classical name of which is *Gobius Ruthensparri.* I have seen this kind of color cells in the skin of the gilt catfish, which belongs to a family akin to *Gobius.* The skin of this fish retains its vitality for some time after its removal from the body of the living animal, and the chromatophores will respond to artificial stimulation for quite a while. In making my observations, however, I preferred to dissect up the skin and leave it attached to the body of the fish by a broad base. A few minims of chloroform injected hypodermatically rendered the animal anæsthetic, and I could then proceed at my leisure, without paining it and without being inconvenienced by its movements.

The causation of tinctumutation is not definitely known. Several ingenious hypotheses have been advanced, none of them, however, being completely tenable. The theory that light acts directly on the chromatophoric cells has been proved to be incorrect. Even the theory that light occasions pigmentation is no longer tenable. I have, time and again, reared tadpoles from the eggs in total darkness, yet they differed in no respect from those reared in full daylight. The chromatophores were as abundant and responded to irritation as promptly in the one as in the other. The distinguished Paul Bert declared that the young of the axolotl could not form pigment when reared in a yellow light. Prof. Semper, on the contrary, declares Bert's axolotls to be albinos, and states that albinism is by no means infrequent in the axolotl; also that Prof. Kölliker, of Würtzburg, reared a whole family of white axolotls in a laboratory where there was an abundance of light, and that he (Semper) never succeeded in rearing an albino, though there was less light in his laboratory than in Kölliker's, and his axolotls came from the same stock. Bert made the mistake of confounding albinism with the phenomena of etiolation as observed in plants. In fact, he gives the name etiolation to the albinism noticed in his axolotls.

There is a marked difference between the functions of the chlorophyll bodies found in plants and the chromatophores found in animals. The former play one of the most prominent parts in the drama of plant life, inasmuch as they subserve a vital function, while the latter act a minor part, because they only serve as an instrument or means of protection. Light is of great importance in its influence on chlorophyll, which is a microscopic elementary body on which the vital strength of the plant depends; while it is not at all necessary to the chromatophores, cell bodies secreting pigmentary matter for the purpose of protection. Many animals live in total darkness, yet have an abundance of pigment. I myself have seen black beetles in Mammoth Cave, Kentucky, in the neighborhood of Gorin's Dome, which is a mile or so from the entrance of the cavern. Beetles rarely range over a hundred yards from their place of birth, consequently these beetles must have been reared in darkness. On this occasion I was in search of other data, so made no critical examination of these insects. I am not prepared, therefore, to give an accurate description of them. When speaking of light, I have reference to diffused daylight, which carries no heat rays. Heat is a prominent factor in the production of color; the discussion of this fact, however, does not belong to the subject under consideration. Some experiments made several years ago on newts show that the absence of light does not influence pigmentation. My animals were kept under observation from the extrusion of the eggs until the full maturity of the animals had been reached. Great care was taken to make the experiments as accurate and as conclusive as possible. Those reared in total darkness or in a red light were always dark-colored; those reared in a yellow light were almost, if not quite, as dark as those reared in the red light; while those reared in white ironstone crocks and in diffused daylight were very much lighter, being light pearl-gray in color. This apparent (for the microscope showed that it was only apparent) absence of color in the last-mentioned individuals was due to tinctumutation. Like experiments were made on frogs with the same results. In most viviparous animals the embryo is developed in almost or total darkness, yet when it is born it has bright colors. Kerbert has found in the cutis of the embryonic chick, about the fifteenth day, certain pigment cells. These cells have entirely disappeared by the twenty-third day. It is probable that little, if any, light can reach the chick through the shell and membranes, yet pigment cells develop and disappear again.

A butterfly emerges from the cocoon arrayed in all the colors of the rainbow, yet it was developed, while in the *pupa* state, in total darkness. It is not necessary to mention further instances; we readily see that pigmentation in animals is not necessarily dependent on light. Neither is tinctumutation the result of the direct influence of light on the chromatophores. Light, however, if not the direct, is the indirect cause of this phenomenon. Lister, in 1858, showed that animals with imperfect eyesight were not good tinctumutants, notwithstanding the fact that they had the chromatic function. He showed, by his experiments on frogs, that the activity of the chromatophores depended entirely on the healthy condition of the eyes—that is, so far as the phenomenon of tinctumutation was concerned. So long as the eyes remained intact and connected with the brain by the optic nerve, the light reflected from surrounding objects exerted a powerful influence on the chromatophores. As soon as the optic nerve was severed, the chromatophores ceased to respond to the influence of light and color, no matter how bright and varied they were. The deductions drawn from these experiments are not to be controverted or denied. The chromatophores are influenced by light reflected from objects and transmitted *via* the optic nerve to the brain; from this organ the impression or irritation goes to the nerves governing the contractile fibers of these pigment-holding glands.

Pouchet followed Lister and confirmed his conclusions by experiments on fishes and crabs. He remarked that the plaice, a fish with a white under surface and a particolored back, had the chromatic function highly developed. Among a number of specimens which appeared pale on the white sandy bottom, he met "one single dark-colored fish in which, of course, the chromatophores must have been in a state of relaxation, and this specimen was as distinct from its companions as from the bottom of the aquarium. Closer investigation proved that the creature was totally blind, and thus incapable of assuming the color of the objects around it, the eyes being unable to act as a medium of communication between them and the chromatophores of the skin." Thus far Pouchet had only confirmed Lister's observations, although it is highly probable that he was unaware of Lister's experiments. But he went a step further. There are two ways in which cerebral impressions may be transmitted from the brain to the skin: one, by way of the spinal cord and the pairs of nerves arising from it and known as spinal nerves; the other, by two nerves running close to the vertebral colmmn—the sympathetic nerves. Pouchet cut the spinal cord close to the brain, yet the chromatophores still responded to light impression, showing that they did not receive the message through the cord and spinal nerves. He then divided the sympathetic nerves, and the chromatophores at once lost their power of contraction. Thus he proved that the sympathetic nerves were the transmitters of the optical message and not the cord. This discovery of Pouchet is, psychologically, of the greatest importance, though he failed to recognize it as such. He was satisfied with its anatomical and physiological importance. When we remember that the action of the sympathetic nerve is almost if not entirely reflex in character, we can see at once the psychological importance of this discovery. This fact makes the phenomenon of tinctumutation an involuntary act on the part of the animal possessing the chromatic function, and thus keeps inviolate the fundamental laws of evolution, which, were the facts otherwise, would be broken. By a series of experiments on newts and frogs I have confirmed the conclusions of Pouchet *in toto*. I have gone still further in demonstrating the fact that the sympathetic nerves are the conductors of the optical stimulus. Atropia, to a certain extent, paralyzes the sympathetic. Injections of this drug beneath the skin of a frog render the division of the sympathetic unnecessary. The chromatophores will not respond to light impression if the animal be placed under the influence of atropine.

A large number of the lower animals possess the chromatic function. Several years ago I placed in a large cistern several specimens of the gilt catfish. This is a pond fish and is quite abundant throughout the middle States. It is of a beautiful golden yellow color on the belly and sides, shading into a lustrous greenish yellow on the back and head. Several months after these fish had been placed in the cistern it became necessary to clean it, and the fish were taken out. They were of a dirty drab color when taken out, but soon regained their vivid tints when placed in a white vessel containing clear water. They had evidently changed color in order to harmonize with the black walls and bottom of the cistern. Some katydids are marked tinctumutants. I took one from the dark foliage of an elm tree and placed her on the lighter colored foliage of a locust. She could be easily seen when first placed on the locust. In a few moments, however, she had faded to such an extent that she was scarcely noticeable. I have observed that hte *larvæ* of certain moths, beetles, and butterflies also possess the chromatic function. The chromatophores in the *larva* of *Vanessa* are quite abundant, and this grub is a remarkably successful tinctumutant. The power of changing color so as to resemble, in coloring, surrounding objects is evidently one of Nature's weapons of defense. In some animals it is developed in a wonderful manner. Wherever it is found it becomes to the animal possessing it a powerful means of defense by rendering it inconspicuous, and in some instances wholly unnoticeable.

SCHOOLROOM VENTILATION AS AN INVESTMENT.

By GEORGE HENRY KNIGHT.

THE biographer * Carlyle relates that the father of Frederick the Great scandalized the conventionalism of his day by removing all upholstery from the electoral mansion; an object-lesson in personal cleanliness no doubt so little appreciated by his contemporaries that, if the sturdy elector escaped the nickname of "crank," it was because the word had not then been invented, at least in Brandenburg. Even six generations later it may be doubted whether Friedrich Wilhelm's antipathy to germ-haunts has been realized outside a few modernly equipped infirmary wards. To the sanitarist, however, even such merely tentative application is a hopeful one, because he has learned to accept with equanimity the impossibility of any other than a gradual adoption of ideas greatly in advance of the average public sense, and to recognize the fact that even conservatism has its uses: the keel and the ballast which hold the ship to its course and, perchance, prevent a capsize—nay, sometimes even an anchor cast to windward—may be as necessary as the guiding rudder or the propelling sail. He has, therefore, no controversy with the slowness of the change-drift if mainly in the direction of better conformity with hygienic requirements; he even looks forward to a time when factories, dwellings, lecture rooms, stores, and every other kind of edifice, public and private, will be as well ventilated and be made as absolutely fire, vermin, and dust proof as the best hospital wards.

Public indifference to hygienic requirements was significantly

* "Nothing could exceed his Majesty's simplicity of habitudes; but one loves especially in him his scrupulous attention to cleanliness of person and environment. He washed like a very Mussulman five times a day; loved cleanliness in all things to a superstitious extent, which trait is pleasant in the rugged man, and, indeed, of a piece with the rest of his character. He is gradually changing all his silk and other cloth room-furniture. In his hatred of dust he will not suffer a floor-carpet, even a stuffed chair, but insists on having all of wood, where the dust may be prosecuted to destruction. Wife and womankind, and those that take after them—let such have stuffing and sofas; he, for his part, sits on mere wooden chairs—sits and also thinks and acts, after the manner of a hyperborean Spartan, which he was."—*History of Frederick the Second, called the Great, edition 1858, p. 320, by Thomas Carlyle.*

illustrated lately in a busy manufacturing settlement in the State of Massachusetts. The city of L—— had erected and equipped a costly high-school edifice with a corps of highly paid instructors, to initiate in the more advanced branches of scholarship at the public charge pupils of whom only a minority could hope to utilize these expensive accomplishments in everyday life. All seems to have been regarded with complacency until the charge for an unusually complete ventilating apparatus was encountered. One would have thought that all pupils, whether or not able to solve a problem in differential calculus or to construe a line of Virgil, would have excellent use for their own bodies; but neither this consideration nor the almost infinitesimal magnitude of this particular outlay—an outlay which, including current expenses and interest on capital, was about half a cent per occupant daily,* in comparison with the strictly scholastic expenses—sufficed to reconcile the objectors to such unheard-of extravagance! Poverty of valid arguments was compensated by strength of epithets, and such expressions as "cranky" and "visionary" were freely applied to those who had thought it improper that rooms packed with adolescent humanity and seldom, alas! quite free from victims of contagious diseases, should be unprovided with at least a sufficiency of breathing air. The incident showed that even in cultured New England there was a minority—fortunately, a minority only—not yet emancipated from the mediæval fantasy † which contemned Nature, and which regarded the soul and the body as hostile entities, both indeed corrupt, but the latter only hopelessly so, and fit only to be "mortified" and suppressed. A strange infatuation, surely, to have held its ground for nineteen centuries, in face of the lesson left by the matchless educators of Hellas in the harmonious development of every faculty and every sense! ‡

Communications received within a few months past from various boards of health and of education # have left no doubt in the mind of the writer that the incident at L—— is a typical, not an isolated one; for example, prior to March of this year there was

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* The Annual Report of the School Committee of L—— (p. 211) gives seven mills per capita daily, which the large present attendance reduces to about five mills.

† Of Asiatic origin.

‡ Considering her rude environments and ruder origin, Greece, of the sixth to the fourth centuries before Christ, still presents the most brilliant exemplification of human progress.

With the exception of the United States Bureau of Education publication of the herein-quoted work of Prof. Morrison, the present writer has sought vainly for any Federal statistics bearing on the subject of this paper. Indeed, such would, of course, require a Government appropriation, and schoolroom ventilation does not appear to be a subject of interest in our national councils—either legislative or executive—perhaps because there is supposed to be no "political capital" in it.

not found in a single one of the public-school edifices of the great metropolitan city of New York a complete ventilating equipment, and by the 15th of that month there was but one such.*

Prof. Gilbert B. Morrison, in his book, The Ventilation and Warming of School Buildings, says that—

> The invariable verdict of all investigators of public school ventilation may be epitomized as bad, *bad*, BAD! Some are better than others—or rather some are not so bad as others—but the difference is rather in degree than in kind.†

In a letter to the writer, so late as last February, the same author says:

> I know of no building in America which is properly warmed and ventilated. . . . I fear it will be many years before the principle of proper ventilation will be put into practical application.

That the writer "speaks by the book" in his relation of the incident at L—— would be plain to any one who should care to read the printed report of the school committee of that city. The opponents of adequate ventilation might possibly have carried their point but for the weighty advocacy of the system ultimately adopted by one who is the acknowledged Nestor of the medical faculty of L——. Of Dr. P——'s pregnant address on the occasion of the dedication of the edifice, the space at our disposal permits but a few brief extracts:

> The movement of which I have spoken has not been fully understood or appreciated by the public; but the time can not be far distant when all will recognize its merits; when even those who now deride will join in the general approval, and perhaps, as a means of obtaining popular favor, coolly assert that they themselves were chiefly instrumental in securing its triumph.
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> In the fact that provision has been made for physical exercise we may see another proof that a change is taking place in our ideas concerning the proper scope of school training. Formerly such training was that of the mind alone, bodily conditions being to a large extent ignored. Now the doctrine is generally accepted that, for the purposes of education, the individual is to be regarded not as a dual personality—body and mind—but as a *unit;* complex, indeed, but still a unit; and that the aim of the educator should be to produce a complete and healthy development of all parts.

In the system now adopted—

> The amount of fresh air which can be supplied, if desired, is three thousand cubic feet, or more, per hour, for each occupant of the building. This, according to the estimate of very careful observers, is sufficient to keep the air of the rooms pure. By this device we become independent of the weather, and can

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* Based on a communication to the writer, March 15, 1894, from Dr. A. H. Doty, Chief Inspector of Contagious Diseases, New York Board of Health.

† The Ventilation and Warming of School Buildings. By Gilbert B. Morrison. Edited by the Hon. William T. Harris, A. M., LL. D., United States Commissioner of Education. P. 95.

make sure of our air supply under all the varying conditions of this changeable climate.

Under the old means of ventilation—doors windows, and suction shafts:

The ventilation heretofore has been imperfect, with a great prevalence of cold draughts, annoying and dangerous to teachers and pupils. Unreflecting people, however, will tell you that it was well enough, and all the expenditure that has been made to secure good ventilation in this schoolhouse is unnecessary—a mere waste of money. Those who make this assertion have no arguments based on facts to present for our consideration. They simply give us their opinion, generally accompanying the expression of it with a sneer, or an opprobrious epithet, like that of "crank," hurled at the advocates of free ventilation. Now, if so important a matter as this is to be settled by authority; if any man's *ipse dixit* is to be regarded as final, it should surely be that of a person who has some knowledge of the subject. I am of the opinion that the liberal supply of fresh air which has been provided for this building is necessary to the health of its occupants; and there is not a recent scientific investigator in this field, there is not a well-known writer upon hygiene, there is not an intelligent physician in the world who will not support me in this opinion. Then, what of the cost? Do you care for that, citizens of L——, if it is necessary for the health of your children? I am well assured that you do not. We, who spend our lives in effort to combat disease, can assure you that no other investment of money pays so well as that the income of which is good health; for, in securing this return, we secure with it, as a possibility at least, nearly everything which life can give of enjoyment or usefulness.*

The doctor then proceeded to give an itemized statement of the working cost of this new ventilating arrangement, and showed it to be about seven mills per occupant daily; but, inasmuch as his calculations were based on the previous attendance, and as the present year has witnessed a very notable increase of attendance, even to the extent of requiring utilization for schoolroom of portions of the library space, without increase of the total cost of ventilation, the expense may probably be safely stated as not exceeding half a cent for each occupant daily. Even this slight expenditure (not in excess but instead of that of previous expedients) may, in one sense, be regarded as no expenditure at all, in view of the fact that there is not an intelligent teacher but will testify to a manifest improvement in the result of her labors far in excess of the added cost.

The necessity of ample ventilation is therefore evident, even from the narrow merely scholastic standpoint; and we may be more sure that—as education comes to be recognized in the broader and more proper sense, which includes the full and plenary development of all the physical, mental, and moral faculties—that necessity will become more abundantly manifest.

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* Dedicatory Address at Opening of the High School of the City of L——, p. 210.

CORRELATION OF FACTORS IN ORGANIC GROWTH.

By Herr EDUARD STRASBURGER.

THE uniform co-operation of living cells in the vegetable organism appears less problematical to us when we know that these elements are connected by fine threads of living substance. These protoplasmic threads penetrate the cell walls; they immediately transmit the stimulus from cell to cell, and conduct it to a distance; and the continuity of the living substance in the whole organism is thus preserved. It formerly appeared otherwise, when the single living cell bodies were supposed to be completely separated by their walls, and these cell walls were thought to bring about the transmission. The physiological arrangements of plants have now become very much like those of animals, and nearly approach them in perfection. Very striking among the life expressions of organisms are certain processes which mutually influence and condition one another, and which we call manifestations of correlation. A particular condition in the organism invokes another, so brought about that a general balance in the functions is preserved, and is restored if disturbed.

A red-beech tree growing in the open, where it is immediately exposed to the effects of the light, has small but relatively thick leaves. Red beeches, as undergrowth in the shadow of the woods, are distinguished by considerably larger but thinner leaves. The cause of this variation lies chiefly in the difference in the conditions of transpiration. The growing leaves in the isolated tree give out more vapor to the atmosphere than do those in the shade. The increased evaporation affects the structure of the leaf surfaces, and they are compressed, chiefly because less air space is found between their cells, and partly, also, because the cells turn perpendicularly to the surface instead of increasing in breadth. All this increases the thickness of the leaf at the cost of its superficial diameter. This condition is immediately useful to the plant, because a thin and comparatively broad leaf surface would transpire too rapidly in an open situation, involving the tree in danger of drying out. In the shade, on the other hand, a large surface is necessary to give as much vapor out to the atmosphere as the life processes of the plant require; for evaporation promotes the accession of food-salts from the soil. These salts, dissolved in water, reach the plant, and are retained by it, while the water is evaporated. More rays of light fall upon a large leaf than upon a small one. In this view too, then, an enlargement of the leaf surface is more advantageous and useful in a feebly lighted situation. The intense light which falls upon a fully exposed beech may, in its greater intensity, perform as much or even more work on the smaller leaf as the dimmer light of the shady situation on the larger one. An equivalent gain is realized by the lengthening of all the parts of the branch which takes place in the obscure situation. The leaves are thereby farther separated on the limbs, and do not cover one another. It is different in the isolated tree, where the leaves, even in a compressed situation, do not suffer for want of light. Hence, too, the great difference in the appearance of the conical crown of a solitary beech with its thickly compressed limbs and leaves, and that of the loosely spread out, umbrella-shaped undergrowth which the red beeches form in the shade of the wood.

A dry location promotes the same processes of growth as increased transpiration. The need of a plant in a dry soil is to reduce transpiration, and correlative processes are manifested through which that result is reached. The growing plant is so affected as to acquire a similar structure to that of a plant in a very sunny situation. The correlative operations in many plants take the form of giving a hairy covering to their leaves. A layer of air-retaining hairs diminishes evaporation. Hence the same plant may be hairless in moist ground, and in dry be covered with numerous hairs. The same is the case in plants from which the water supply is taken away. Superfluous growths are produced on the leaves and moderate transpiration. A slimy content is developed in the leaf cells of many plants, and serves to retain the moisture that is present within them. A dry location also generally promotes a greater thickening of the cells on the leaf surfaces, by means of which evaporation is made more difficult and prolonged. In the very cold, long-frozen soil of the arctic tundras plants have difficulty in obtaining the water they require; and in such situations, notwithstanding the real abundance of water, the same correlations in structure are found as in dry soil. The leaves are small and thick, and form slime within, and thicker cell walls on their surface. Similar rules obtain with plants in the saline soils of the steppes and the seashore Diversified conditions thus co-operate to produce the most favorable aggregate of life conditions for the plant.

The processes of transpiration in the plant appear adapted to introduce us into the difficult field of correlation, from the fact that it affords us an easier way than we can find in many other cases of looking into their mechanism. All the numerous instruments which perform the work in the organism interlock, mutually affecting and conditioning one another.

The researches of Julius Wiesner have shown that transpiration is the principal element in controlling the termination of the end bud. The vessels of our woody plants convey only a limited quantity of water to the unfolding leaves in spring. The growth of the leaf ceases at the moment when all the water brought up is claimed by these leaves. Correlative operations then come into play. The leaf parts in process of formation then assume the shape of bud scales, and all further advance in growth is interrupted. Very simple examination will show that this conclusion of the terminal bud is not caused by any deficiency of food. If the growing shoot is brought into a room saturated with moisture, the bud is not formed. Evaporation is arrested in such a room; there is no want of water; and therefore the mechanism is not unloosed which restricts the further development of the bud. Buds already closed may also be started in a new growth in a room saturated with moisture.

The closing of the buds in the axils of the leaves is conditioned on similar causes. These buds may be easily made to expand if the branch is cut off or stripped of leaves. The advantage to the plant of this property of restoring lost leaves is seen after every instance of devastation by caterpillars. If we cut off a young potato stem just above the ground, the parts growing beneath will at once come up out of the earth. They are the threadlike shoots which would otherwise swell at the ends and form potatoes. The want of incoming nourishment acts as a stimulant to the subterranean growth, and excites processes in them by which their nature is completely changed. Instead of, as before, growing straight down into the soil, the sprout directs its end upward, soon appears above the surface, produces green leaves instead of scales, and puts on the appearance of the ordinary leafy shoot. Corresponding in principle with the behavior of this potato plant is that of trees which give their side limbs an upward direction when they have lost their leader.

The internal and external changes which a fir limb has to undergo in order to become a leader are hardly less far-reaching than the transformation of an underground potato shoot into an aërial foliage stem. We perceive that the change of the course of the water and food stuff to the highest limb, which occurs after the removal of the leader, is the correlation force by which the metamorphosis is brought about; for these causes operate as stimuli to produce a change in the relations of light and gravity, by which a doubly differentiated organ is converted into one reacting on all sides alike—in a word, the whole living mechanism is profoundly transformed. When the metamorphosis of the lateral limb into a leader is completed, it can no longer be diverted from its upright position, but returns to it with the same persistency with which it formerly resumed the horizontal position.

Not less striking are other phenomena of correlation connected with the processes of transpiration, but which can be studied only under the microscope. The moisture which plants give out to the atmosphere escapes through special openings in the epidermis, which are called stomata, or breathing pores. These openings are not visible to the naked eye. Fifty of these stomata may be counted on a square millimetre of leaf surface, and the number sometimes rises to five hundred in the same area. Each leaf is therefore provided with several million such openings. They expand or contract according to the necessity, and the correlation is so well adapted that the width of the opening is regulated so as to agree exactly with the existing conditions. They are usually closed at night, when a strong evaporation is not called for, because the salts which the water carries into the leaf can only be elaborated in the light. The transpiration being diminished at night, besides, by the lower temperature and the increased moisture in the air, the stomata can often remain open at that time without injury. This would be the case, for example, when the breathing process—which is likewise carried on through the stomata—is prolonged. The effect of the light is to open the breathing pores at dawn if they are closed, or to expand them. An increase in transpiration is now wanted, and it facilitates the exchange of gases by the assimilation of carbon. The opening fails to respond to the stimulus of the light if there is not enough water for the demands of the plant, when rapid evaporation would promote wilting. The active mechanisms of the plant react upon the external influences, and are in turn affected by them in the manner most advantageous to the plant at the given moment. The fact that the plant is not able to choose its reactions freely causes these reactions always to occur correctly according to the course of the external conditions.—*Translated for The Popular Science Monthly from the Deutsche Rundschau.*

The *Flora Italiana*, begun in 1848 by Filippo Parlatore, and now completed except as to a part of its seventh volume, is, according to Garden and Forest, one of the few floras of large countries or of extensive botanical regions that have come so near their end. The two others of note are Bentham's Flora of Australia and Boissier's Flora of the Orient. The other great floras, including Gray's of North America and Sir Joseph Hooker's of British India, are still unfinished. Notwithstanding the much that has been achieved in learning the characters, relationships, uses, and distribution of plants, our knowledge of them is still fragmentary and often unsatisfactory, and a vast amount of work remains yet to be done by morphological and economic botanists.

"Buckland is persecuted," wrote Baron Bunsen of the eminent geologist to his wife in April, 1839, "by bigots for having asserted that among the fossils there may be a pre-Adamite species. 'How,' say they, 'is not that direct, open infidelity? Did not death come into the world by Adam's sin?' I suppose, then, that the lions known to Adam were originally destined to roar throughout eternity!"

SKETCH OF DENISON OLMSTED.

PROF. OLMSTED, the American Journal of Science said, in its obituary notice of him, "regarded his most appropriate sphere of effort, in the circumstances in which he was placed, not so much to cultivate science as to teach and diffuse it." The circumstances mentioned in this sentence called him to be a teacher, whatever lines of work he may have planned to pursue. Although his mind at different times in his life turned to other occupations and he began to prepare for them, he was as often called back to teaching by agencies outside of himself. He was a successful and superior teacher. But his achievements in independent and original research, for which he seemed to have a natural taste, were not few nor insignificant; and we can not doubt that, if he had been permitted to devote himself to that line, he might have arrived at great distinction in it.

DENISON OLMSTED was born in East Hartford, Conn., June 18, 1791, and died in New Haven May 13, 1859. His father was descended from James Olmsted, one of the first settlers of the colony of Connecticut, who died about four years after Hartford was founded. His mother was a daughter of Denison Kingsbury, of Andover, Conn., from whom he seems to have received his Christian name. His father was a farmer in moderate circumstances. He died when the son was a year old, and the care of the boy's education devolved upon his mother, who is highly spoken of as having been a lady of native strength of mind, sound judgment, and uncommon piety and benevolence. He was early trained to habits of order, diligence, and perseverance, for which he was distinguished throughout his life.

The neighborhood school was not all that was desired, and Mrs. Olmsted, in order to give her son better facilities for instruction, obtained a place for him, when he was about twelve years old, in the family of Governor Treadwell, as a chore boy, with the understanding that he should attend the district school. He was, according to the Rev. Dr. Porter, of Farmington, Conn., a very lovely, intelligent boy, and soon engaged the affections of the family. Governor Treadwell became interested in him, and took pains to help him along in his studies. Only reading, spelling, and writing were taught in the school. A proposition of Governor Treadwell to teach him arithmetic was readily accepted, and the boy made good progress under this sympathetic attention. Young Olmsted was put into a country store at Farmington, in which Governor Treadwell's son was a partner, and then at Burlington, where he had the same employer. When sixteen years old he became desirous of obtaining a liberal education. He had already acquired a considerable knowledge of English literature, and made creditable progress in the elementary mathematics. With the consent of his guardian and his mother he went to Litchfield South Farms, to attend the school of James Morris. He undertook the care of a public district school for a short time; completed his fitting for college under the Rev. Dr. Noah Porter at Farmington, and entered Yale College in 1809. He took rank at once among the best scholars in his class, being apparently nearly equally proficient in all his studies, excelling also in writing, and cultivating a taste for belles-lettres and poetry. He was graduated with the highest honors in 1813, when he was appointed one of the orators in a class of seventy, of which only ten received that distinction. The subject of his graduation address was The Causes of Intellectual Greatness.

After graduation, Mr. Olmsted obtained a position as a teacher in the "Union School" at New London, Conn., a private institution for boys which had been supported by a few families of the place for several generations. In 1815 he was appointed a tutor in Yale College. Here he joined a small class in theology, instructed by Dr. Dwight, with the intention, which he had formed a short time before—having come under strong religious influence—of entering the ministry. Dr. Dwight died within a year, and Mr. Olmsted published a memoir of him in The Portfolio for November, 1817. The theological studies were terminated in 1817 by Mr. Olmsted's appointment to be Professor of Chemistry, Mineralogy, and Geology in the University of North Carolina.

During his tutorship at Yale in 1816, Mr. Olmsted delivered the Master's Oration on the occasion of taking his second degree, taking as his subject The State of Education in Connecticut. In this oration he brought out his plan for a normal school, which, so far as appears, was then a complete novelty, and was wholly original with him. He pointed to "the ignorance and incompetency of schoolmasters" as the primary cause of the low condition of public schools, and appealed to public and private liberality to establish and support institutions of a higher grade, where a better class of teachers might be trained for the lower schools. He has himself, in one of his letters, given an account of the origin of his conception of this scheme of "a school for schoolmasters." It was while engaged in the Union School at New London, where he had pupils of various ages pursuing a great variety of studies; so that, while the number of pupils was small, the classes were many. He discovered, he related, a marked difference in intelligence and capacity between those who were studying the languages and mathematics, preparatory to entering college, and who devoted only a small part of the day to the common rudimentary branches, such as English grammar, geography, reading, writing, and spelling, and those who spent all their time in these elementary studies. "I was surprised to find that the former excelled the latter even in a knowledge of those very studies; they read better, spelt better, wrote better, and were better versed in grammar and geography. One inference I drew from the observation was that an extended course of studies, proceeding far beyond the simple rudiments of an English education, is not inconsistent with acquiring a good knowledge of the rudiments, but is highly favorable to it, since, on account of the superior capacity developed by the higher branches of study, the rudiments may be better learned in less time; and a second inference was that nothing was wanted in order to raise all our common schools to a far higher level, so as to embrace the elements of English literature, of the natural sciences, and of the mathematics, but competent teachers and the necessary books. I was hence led to the idea of a seminary for schoolmasters." His plan was outlined in accordance with this thought. Another encouraging feature in his scheme, as it appeared to him, was that "no sooner would the superior order of schoolmasters commence their labors, than the schools themselves would begin to furnish teachers of a higher order. The schoolmasters previously employed were for the most part such as had received all their education at the common schools, and could only perpetuate the meager system of beggarly elements which they had learned; but it was obvious that schools trained in a more extended course of studies would produce teachers of a corresponding character—that is, if we could once start the machine, it would go on by its own momentum." He was contemplating a series of newspaper articles in advocacy of his plan, and communications concerning it with eminent men interested in education, when he was called to another enterprise. The idea of normal schools was afterward taken up by other men and brought by them before the public under much more favorable circumstances than he could have commanded had he remained in Connecticut and continued his advocacy at that time.

At a later time, as a member of the Board of Commissioners of Common Schools for Connecticut, in 1840, in drafting the annual report, he observed that "wherever normal schools have been established and are adequately sustained, the experiment has uniformly resulted in supplying teachers of a superior order. As in every other art whose principles are reduced to rule and matured into a system, the learner is not limited to the slow and scanty results of his single unaided experience, but is at once invested with the accumulated treasures of all who have labored in the same before him."

Preparatory to going to the professorship of Chemistry in the

University of North Carolina, and after resigning his tutorship at New Haven, Mr. Olmsted engaged in private studies in geology with Prof. Silliman. He found at his new post two of his old friends, Yale men like himself, occupying professorial chairs: Elisha Mitchell, his former classmate, that of Mathematics and Natural Philosophy, and Ethan A. Andrews that of Languages, and here he spent seven happy years.

In 1821 he laid before the Board of Internal Improvements of North Carolina a proposition to undertake a geological survey of the State, offering to perform the entire work himself gratuitously, but suggesting an appropriation of one hundred dollars to defray his necessary expenses in traveling, to be afterward renewed or not at the pleasure of the board. The proposition was declined by the Board of Internal Improvements, but the survey was afterward made under the direction of the State Board of Agriculture. To this board Prof. Olmsted addressed his report, which was published in two parts, in 1824 and 1825, and filled in all about one hundred and forty octavo pages. The American Journal of Science observes of this survey that, regarded especially as the gratuitous vacation work of a single individual, and in view of the state of geological science in this country at the time, it "must certainly be looked upon as creditable in the highest degree both to the enterprise and to the scientific ability of its projector; and it has undoubtedly been of great benefit, not only to the State which authorized it, but to the country and to science generally, by the stimulus which it afforded to similar enterprises in other States." It was the first instance of one of the United States instituting a geological survey.

In the course of his work Prof. Olmsted gave the first geological description of the Deep River coal beds and of the new red sandstone accompanying, and referred the strata correctly to the same age with that of the Richmond coal beds and the Connecticut River sandstones.

Prof. Olmsted began researches to determine the practicability of obtaining illuminating gas from cotton seed, but removed to the North before he had secured definite results.

In 1825 Prof. Olmsted was appointed Professor of Mathematics and Natural Philosophy in Yale College. In 1836 this chair was divided at his request, and the professorship of Mathematics was assigned to A. D. H. Stanley. As a professor in Yale he performed an unbroken service of thirty-four years, till it was interrupted by his illness. His labors as a teacher during the last twenty years of his life consisted, as described by Dr. Woolsey in The New-Englander, "in teaching astronomy by a text-book, and in three courses of lectures—experimental ones on natural philosophy and optics, historical ones on the progress of astronomical discovery, and theoretical ones on meteorology. His colleagues and friends have regarded him as a born teacher, as possessing a most happy union of several powers—the capacity to convey instruction with clearness and evidence, the capacity to impress the pupil with the importance of the branches taught, the disposition to shrink from no labor necessary in preparing himself for teaching, and to require of the student that he master and reproduce the lessons conveyed to him. While many lecturers prepare their lectures once for all, and then cease to improve them, he was constantly revising, elaborating, and almost constructing anew the courses on astronomy and meteorology which he delivered annually to the three upper classes." These lectures were spoken of by Dr. Barnard, in his Journal of Education, as having been characterized "by fullness, clearness of method, and sometimes by eloquence. The course on meteorology was, perhaps, on the whole, the most attractive and useful."

Prof. Olmsted soon became sensible of the deficiency of the text-books on which he had to rely in his department. Enfield's Philosophy was inaccurate and behind the state of science; and the work of Prof. Farrar, of Cambridge, was too extensive and too difficult. He undertook to prepare new books suitable for his classes. His Natural Philosophy appeared in 1831, and his School Philosophy in 1832. His Astronomy, first published in 1839, went through forty or fifty editions. An edition of it was printed in raised letters for the blind, it having been selected by Dr. Howe, according to Dr. Barnard, "for its clear, accurate, comprehensive presentation of the science of which it treats." The Rudiments of Natural Philosophy and Astronomy followed, in 1842. The Letters on Astronomy was a work in more familiar style, cast in the form of letters to a lady, and prepared as a reading book for the school libraries established by the Massachusetts Board of Education.

The great meteoric shower of November, 1833, which was observed over a large part of the American continent and on the ocean, directed Prof. Olmsted's mind to a new and original field of investigation; and several papers upon it were published by him and Prof. A. C. Twining, of West Point, in the American Journal of Science during 1834. The collation of the collected observations brought out the fact that the apparent point of radiation of the meteors was identical with that toward which the earth was tending in space—which indicated a cosmical origin. It was further found that several showers had been observed before within forty years, on the same day of November. In explanation of the phenomenon, Prof. Olmsted supposed, in an article published in the American Journal of Science, that the meteors "consisted of portions of the extreme parts of a nebulous body, which revolves around the sun in an orbit inferior to that of the earth; but little inclined to the plane of the ecliptic; having its aphelion near to the earth's path; and having a periodic time of one hundred and eighty-two days, nearly." Two of the principal features of this theory—those of the cosmical origin of the meteors and their periodicity—are still maintained; but instead of one periodical shower, astronomers now count several; and instead of a single infraterrestrial nebulous body, they connect the several showers each with a particular comet. Priority in putting forth these conceptions was disputed by Chladni, whose claims, however, do not seem to have been so definitely established as those of Prof. Olmsted. Of course, the suggestion of the cosmical origin of meteors, as a suggestion, was never wholly new, for it had been made in general terms by other philosophers, from Anaxagoras down; but the credit is claimed for Prof. Olmsted of having first embodied it in a definite, coherent theory, accompanied with valid evidence; whether or how far Chladni may have anticipated him, his conclusions, as Prof. Silliman well says, were undoubtedly original with himself, and entirely independent of any results of preceding investigations. His work was, furthermore, spoken of in the most complimentary terms by the most distinguished foreign students in those lines of the day. Humboldt referred, in the first volume of his Cosmos, to the excellent description which Prof. Olmsted had given of the shower in November, 1833, and to his brilliant confirmation of Chladni's view that the phenomenon was of cosmical origin. Olbers praised him for his circumstantial description and collection of particulars of the shower, and agreed with him in the conclusion that it came from abroad. Biot, in a communication to the French Academy in 1836, spoke of his "very comprehensive and highly interesting work" in collecting and making known "all the circumstances of position, direction, and periodicity peculiar to the meteors of the 13th of November."

In his first memoir on the shooting stars, Prof. Olmsted suggested that the explanation of the cause of the meteors of November 13th might include that of the zodiacal light. He further published a well-matured thory of the nebulous body represented by the zodiacal light. Biot agreed with him in this view, and recognized his priority in the conception. Astronomy has not yet satisfied itself concerning the nature of this phenomenon. He also studied the aurora borealis, concerning which he contributed articles to the American Journal of Science in 1835 and 1837, and gave at length a theory of cosmical origin and secular period in the eighth volume of the Smithsonian Contributions to Knowledge.

He thus ascribed shooting stars, auroras, and the zodiacal light to substantially the same origin. These views, however, as Prof. Silliman observes, were mostly thrown out only as conjectures, and not as formal theories to be held and defended.

Previous to this, Prof. Olmsted had interested himself in meteorological studies. In 1830 he published in the American Journal of Science a new theory of hailstones, in which he ascribed the origin of those formations to the sudden mingling of large bodies of hot and humid air with air extremely cold, by which the vapor of the former would be rapidly condensed and congealed into hail. These effects, he assumed, would be produced whenever, by means of opposing winds, whirlwinds, or other atmospheric disturbances, hot air should be brought above the line of congelation or cold air brought below it.

He agreed with Redfield in supposing that ocean gales are progressive whirlwinds; and he believed that he had established their laws or modes of action on an impregnable basis. This view of storms as progressive whirlwinds still holds good as a generalization; but his further ascription of the ultimate causes of atmospheric disturbances to the diurnal and orbital motions of the earth has not found an accepted place in science. Prof. Olmsted had a close friendship and a warm sympathy with Mr. Redfield, with whose views respecting the rotatory motions of storms he agreed; and he read an affectionate memorial of him before the American Association, at Montreal, in 1857.

Prof. Olmsted and Prof. Loomis, who was then a tutor in the college, were the first persons of all observers to find Halley's comet on its return in 1835. One of the results of this observation was the awakening of an interest in procuring larger and improved telescopes. It did not bring immediate fruit, it is true. The project already conceived for the establishment of a permanent observatory at Cambridge, to which it gave a new impulse, was not yet to be made real. There were other circumstances, however, than want of interest in astronomy that kept such liberal schemes from being carried out—the country and the universities had not grown up to them, and the needed abundance of money had not yet come—but this was one of the incidents that kept the movement vital and sped it on. Prof. Olmsted also conceived a plan for the establishment of an observatory at Yale College, which should have two departments: one to aid in the instruction of students and the other for the use of scientific observers; but the time had not yet come for this. As another incident of his astronomical work, President Woolsey relates that "for a number of years, until his health forbade it and his eyesight began to fail, he was accustomed to gather his class around him on a bright autumn evening and introduce them to the heavenly bodies. In this way he endeavored to train up a corps of practical observers, whose labors, when they should be scattered abroad in this vast country, should not be lost to science."

In purely practical lines of enterprise he invented an excellent stove which bore his name, and the patent for which brought him considerable profit; and he devised a preparation of lead and rosin for lubricating machinery.

Of his qualities as a teacher Prof. Silliman mentions especially his uniform kindness and courtesy of demeanor and patience in imparting instruction; the excellent moral influence he always exerted, his consistent Christian example, his personal counsels, the genuine friendliness of his disposition, and the unaffected interest he always manifested in the welfare of his pupils. He was ever ready to encourage and assist any who exhibited special fondness for the studies of his department, and it always gave him pleasure when students passed beyond the bounds of ordinary attainment.

He labored to make knowledge more accessible to the people, and science comprehensible and interesting to them. Dr. Barnard, who describes him from the point of view of a teacher, says that he "availed himself at all times of the lyceum and the popular lecture, as well as of the daily press, to apply the principles of science to the explanation of extraordinary phenomena of meteorology and astronomy, as well as to the advancement of domestic comfort and popular improvement generally. In an essay read before the American Association for the Advancement of Education, at New York, in 1835, he showed, in a felicitous manner, that the whole tendency and drift of science, its inventions and institutions, is democratic."

Besides the works already mentioned, Prof. Olmsted published many articles of a scientific or literary character in the leading periodicals of the day—contributing thus to the American Journal of Science, The Transactions of the American Association, The Smithsonian Contributions, The Christian Spectator, and The New-Englander. He was especially fond of biographical composition, and his memoirs of Dr. Dwight, Sir Humphry Davy, Governor Treadwell, Eli Whitney, and William C. Redfield are mentioned by Prof. Silliman as favorable examples.

A young sea lion was born in the *Jardin d'Acclimatation*, Paris, on the 8th of June. It spent its first two days on the rocky platform on which it was born. The third day it imprudently slipped into the water, where it floundered about awkwardly till its mother had to come to the rescue. She took it by the skin of the neck, as a dog or a cat would do, and carried it ashore. The mother takes great care of her offspring, holding her flipper over it, as if to protect it, while it is asleep.

CORRESPONDENCE.

PROFESSOR EDWARDS AND THE UNIVERSITY OF TEXAS.

Editor Popular Science Monthly:

DEAR SIR: Referring to an editorial in your October number, entitled Another Raid on the Doctrine of Evolution, and complaining of the dismissal of Charles L. Edwards from the chair of biology in the University of Texas, I beg leave to say that you have been misinformed in regard to the facts in the case.

Prof. Edwards was not dismissed because he was not a Texan. The policy of the university has been from the beginning, and is now, to get the best men possible, regardless of State lines. Eleven years ago, when the university was organized, all the academic professors were from other States than Texas. At present we have six professors from the North, and the successor of Prof. Edwards was born in Illinois and educated in Indiana, Prof. Edwards's own State, and came to us two weeks ago from De Pauw University.

In dismissing Prof. Edwards the regents did not break their contract. He was employed for three years; but this engagement was subject to the following provision embraced in the organic law of the university: "The regents shall have power to remove any professor, tutor, or other officer connected with the institution, when, in their judgment, the interest of the university shall require it." This provision was and is known to every professor in the university, as it is published in every catalogue. It was known to Prof. Edwards, for he was one of the committee of three that edited the catalogue last year. Prof. Edwards served two years as Professor of Biology, and was then dismissed by the regents, on the ground that "in their judgment the interest of the university required it."

Prof. Edwards was not dismissed because he taught the "doctrine of evolution." He was dismissed because he was the author of an anonymous article in the Austin Evening News of June 18, 1894, libeling a member of the Board of Regents, an officer of that board, and a member of the faculty. Regular written charges were preferred against him, alleging that this publication was evidence that he was not a proper instructor for young men. Prof. Edwards was heard in his own defense, but the charges were sustained, and his summary dismissal followed as a matter of course. The alleged fact, therefore, that he was removed because he was an evolutionist is pure invention.

Yours respectfully,
THOMAS D. WOOTEN,
Pres. Board of Regents.

THOMAS D. WOOTEN, *Chairman*,
T. M. HARWOOD,
Executive Committee.

AUSTIN, *October* 1, 1894.

EDITOR'S TABLE.

THE CASE OF PROFESSOR EDWARDS.

DR. WOOTEN, President of the Board of Regents of the University of Texas, states in a letter which we publish above that Prof. Charles L. Edwards was not dismissed from the chair of biology in that university because he taught the doctrine of evolution, but "because he was the author of an anonymous article libeling a member of the Board of Regents, an officer of that board, and a member of the faculty." Dr. Wooten is, of course, entitled to make this statement if he believes it to be true; but, considering that both in local journals and in press dispatches from Austin, the seat of the university, to papers all over the country it was freely stated that the objection made to Prof. Edwards was that he taught the doctrine of evolution, Dr. Wooten might very properly have explained how that impression got abroad, and why the Board of Regents did not take an earlier opportunity to correct it. We have before us a dispatch from Austin to the Chicago Times, bearing date May 26th last, in which it is expressly stated that the Board of Regents were considering charges made in private and from the pulpit that Prof. Edwards was "teaching the Darwin theory, and not orthodox science of creation as treated in the Bible." If that statement was not true, surely the Board of Regents might, for the credit of the university, have taken the trouble to contradict it. We have before us also the letter in which Prof. Edwards was apprised of his dismissal. There is not a word in it of the now alleged ground of dismissal; simply a statement that in the opinion of the regents "the interest of the university requires your immediate removal." This letter bears date June 21, 1894. Is it not most singular, considering the light in which the matter had previously been represented in the press, that the Board of Regents should not have thought it worth while to put on record in this letter that their action was based not on any objection to the professor's evolutionary views, but on a specific act of personal misconduct, if such was really the case?

Dr. Wooten characterizes as "a pure invention" the statement that Prof. Edwards was removed because he was an evolutionist, but he does not state whether, in point of fact, the teaching of evolution is permitted in the University of Texas. If it can be declared without reserve that the successor of the late professor of biology is perfectly free to teach his class on the lines of evolution, then the statement that Prof. Edwards did not incur loss of office on account of his scientific views will at least have a measure of plausibility. Certainly, judging by the tone of the article in the Austin Daily Statesman from which we quoted in our October number, and of a further article in the same journal replying to our comments, we should judge that the life of an evolutionist professor in the Lone Star State would not be a happy one. The Statesman now says that the article we quoted from in October was only a local one dealing with rumors. We can only say that the style of that article and that of the undoubtedly editorial one now before us are so remarkably similar as to suggest a doubt whether, in the Statesman office, the differentiation of local from general editorial work has yet taken place. If it has, then we must conclude that the local editor of last summer has been promoted, and now occupies the inmost sanctum. The zeal for orthodoxy and the command of picturesque and incoherent language which his earlier article displayed could not well be surpassed; but we think they are equaled in the following extract from the later and strictly editorial article: "We confess that we are not captivated by the historical accuracy of the natural affinity orthodoxy of the monkey and baboon nuptials; and if this periodical's [The Popular Science Monthly's] facts on that subject are not more correct than its representation of the reasons for the resignation of Prof. Edwards, the Texas populace are under no obligations of logic to believe the doctrine of evolution." Texas was evidently waked up too soon, and when people are waked up too soon they are apt to be cross. A few years' more slumbering on that "log" that the Statesman told us about in its former article would about meet the case.

PROGRESSIVE THOUGHT.

In marked contrast to the tone of thought which characterizes some of the educational institutions of this country is that which finds expression in a report that has reached us of the jubilee lately held of Knox College, Toronto, Canada. Knox College, as its name indicates, is a Presbyterian institution, and, if we are rightly informed, is affiliated with the University of Toronto. Be its theological complexion what it may, however, the speeches delivered at its jubilee make it evident that, as a teaching institution, it is prepared to do full justice to the claims of science, instead of making science bend to the requirements of a stereotyped creed. The reverend Principal Grant, of Kingston, Ontario, one of the chief speakers on the occasion in question, expressed himself as follows: "The people are beginning to care less and less for controversial divinity. . . . All colleges now profess to study the Bible scientifically, and the churches therefore must accept conclusions arrived at in accordance with canons of universal validity, or perish morally in the presence of the scientifically educated world. Science is marching on irresistibly because there is no sectarianism in science. There can be none, because reason is *one*." The Rev. Dr. Burwash, President of Victoria College (Methodist), which is also affiliated with Toronto University, spoke with equal boldness. "For my own part," he said, "I have long since ceased to lecture on polemical theology, and have adopted the historical methods of comparative theology, striving from the center of union of all our doctrines to work out into a more perfect grasp of truth than could ever be possible from within the Chinese wall of our own 'ism.' There are men who think that in religion the scientific spirit has no place, and that the dogmatic must reign supreme. . . . What is the scientific spirit? It is the simple, honest desire to get at the truth. It is the candid willingness to accept the truth wherever we find it, and no matter how it may cross our preconceived opinion. Has it come to this that our creeds are more precious than the truth, that we must shut our eyes lest the blazing light of the nineteenth century should reveal some imperfection in the form, or even in the matter, of our historic creeds?"

Principal Grant is a Presbyterian, Dr. Burwash is a Methodist, but both are on the highroad of modern thought; that is to say, both believe in the efficacy of the scientific method for the discovery of truth, and are prepared to accept whatever conclusions a right use of reason may establish. We must congratulate the Canadian public on the support they give to such men, and the liberty they allow them to speak out the best thought that is in them. It is needless to say that the fearless attitude of mind which these two college presidents display is the only safe one for religious teachers. Young men will give them their confidence and yield to their influence, if they see that they are dealing honestly with them, and trying to open their minds to the truth, not to close them against the truth. There has been too much of the latter in times past, and indeed there is too much yet; but a better day is dawning in the educational world, and there is reason to hope that before very long the old strife between theology and science will have worn itself out. In that day science will be left free to discover truth in any and every field of investigation; while religion, inheriting all of value that theology ever possessed, will not only survive, but have its recognized and assured position, as the inextinguishable tendency of man's moral nature to worship the Source of all law, and to shelter itself in the belief in an Infinite Righteousness.

FOOD FOR THE GULLIBLE.

Thibet is a very distant and inaccessible country, and therefore we may expect very remarkable things to happen in it. It is, as we know, the classic land of occultism, the favorite habitat of *mahatmas* and the most convenient place from which to slide into the astral plane. There the enlightened ones read minds just as easily as we plodding Westerns the gigantic lettering on our dead walls, pick up knowledge of all kinds by a simple effort of volition, and not only profess a contempt for time and place but practically prove to the satisfaction of the well-disposed that, so far as they are concerned, the terms have no meaning or application. A very well-disposed person, Heinrich Hensoldt, Ph. D., has given in the columns of a popular magazine, The Arena, an account of an interview with which he was favored with the Dalai Lama, the supreme object of religious veneration in that country. This august person is supposed to be a reincarnation of the original Buddha. He is chosen by the priests at the age of five or six, and dies gently of his own accord when he reaches the age of twelve. Meantime he is filled with all grace and wisdom, and the writer of the article tells how powerfully he himself was impressed with what he heard from the lips of the present Dalai, a youth of about eight. In the first place, the Dalai spoke to his interviewer, who was a German, in the most fluent and idiomatic German, and in the very dialect to which the latter was native. "How," asks the writer, "could the mysterious youth have acquired a knowledge of the German language, and moreover of a dialect which is limited to a small district of the fatherland?" If, instead of asking *us* that question, the interviewer had seized his chance and asked the Dalai himself, he might have got some information. He contented himself, however, after the manner of the faithful, with "pondering a great deal over the problem," and finally arrived at the satisfactory conclusion that it was a kind of mind-reading. The Dalai, launching out thus in German, proceeded to display "an amount of wisdom which I have never since seen equaled in the most famous Oriental or Western thinkers." The samples given us, unfortunately, hardly bear out this eulogium. The learned interviewer was "astonished beyond expression by his detailed knowledge of mineralogy, botany, microscopy, etc.," but he passed by all that to repeat a few sophistical and worn-out arguments which the Dalai worked off on him in regard to the illusoriness of time and space. The idea of time is illusory because degrees of longitude converge toward the pole, and therefore contiguous points near the pole would have the same difference of time as points widely separated at the equator! The interviewer says he "was compelled to admit the force of this logic," but he required further proof before he could accept the Dalai's dictum that "the most stable of our sciences, mathematics," is also wholly based on illusion. The mysterious youth then trotted out the old Greek sophism known to logicians as that of Achilles and the tortoise. If a man had a certain sum of money to pay, and on a certain date paid half of it, then on a later date half the remainder, and then on succeeding dates half of whatever might still be due, he might go on to all eternity paying, but would never have the debt fully discharged. "Does not this," the youth asked triumphantly and yet sadly, "prove the rottenness of the entire fabric, and that your wonderfully exact science is *Maya* or illusion?" Again the learned but well-disposed interviewer bowed in acquiescence. Of course, we might feel delicate about arguing with a reincarnated Buddha; but we feel as if the suggestion might properly have been made that the argument in question, which simply affirmed that, unless you pay a debt in full, a portion will remain unpaid, was eminently in harmony with the whole theory of mathematics, which has always required us to believe that a pint will not fill a quart pot.

"We do not reason out things," said the Dalai, "but see them." And then he proceeded to use the identical ineffectual argument used by Mr. Sinnett to which we referred a month or two ago, claiming that the adepts in occult science were substantially in possession of an extra sense, and that that was why the unenlightened world did not believe in them. The slightest reflection, however, as we pointed out, suffices to satisfy us that any one who was really in possession of an additional sense could not fail to be believed in, seeing that he could at any moment prove his possession of that sense by exercising it, and prove it to the utter confusion of those who denied his special powers. The Dalai may have surprised his visitor by his knowledge of various sciences; but whence has come the scientific knowledge which the world to-day possesses save from the untiring labors of men possessing simply the ordinary equipment of senses and faculties? But what is the use of arguing with those who wish to be deceived? For such the worn-out sophistries of a mystery-monger will carry more weight than all the lessons of human experience, and a few oracularly delivered commonplaces assume the guise of a more than earthly wisdom. But common sense and our common senses win in the long run.

LITERARY NOTICES.

Schools and Masters of Sculpture. By A. G. Radcliffe. New York: D. Appleton & Co. Pp. 593. Price, $3.

Considering the scope of this volume, we may well believe the opening statement of its preface that the difficulties of condensation involved in its preparation have been extreme. Yet there is none of the aridity of condensation noticeable in its pages. It has been the aim of the author "to tell the story of the progress of plastic art clearly, vividly, and accurately, with entire correctness so far as possible, but without needless technicalities"—to give "not only the strict history of sculpture, but some glimpses of the fresh vistas of description lately opened up, of the strange illuminations cast by modern discovery, and of the new promise discernible in modern achievement. Successive schools of sculpture are therefore shown by the flashlight of single chapters, and the personality of the great masters is brought briefly before us." The Egyptian, Assyrian, and Asiatic types of sculpture are treated before the wonderful works of the Greeks are taken up. In no case does the author rest content with a bare enumeration and description of the works named, but adds facts concerning discoveries of ancient sculptures, and bits of mythology or notes on customs connected with them. Five chapters are devoted to Greek sculpture. Its nature and subjects are first discussed, after which the chief known examples of successive periods are described. A single chapter suffices for Roman sculpture, and the same for the early Christian and the Mediæval Cathedral groups. The works of modern times are taken up by countries. Those of Italy are described under the two divisions, the age of the Renaissance and the age of Michael Angelo and his successors. Then follow accounts of the sculptors and sculpture of France, Germany, and England, and of the nineteenth century in general, the last period being brought down to include the exhibits at the Columbian Exposition. Two closing chapters on the study of sculpture in the museums of Europe and in those of America, together with the one that precedes them, are of especial value in pointing out where the masterpieces of art are now to be found, and how we may grow familiar with them. The author's style is concise yet picturesque, and the vivid panorama that is afforded by the text is splendidly re-enforced by the illustrations. There are forty-two full-page engravings, representing all the schools described, and including works by the Americans D. C. French, W. W. Story, and Thomas Crawford.

The Principles of Modern Dairy Practice from a Bacteriological Point of View. By Gösta Grotenfelt, President of Mustiola Agricultural College, Finland. Authorized American Edition by F. W. Woll. With Illustrations. New York: John Wiley & Sons. Price, $2.

As the translator and editor states, few industries have changed more during the past twenty years than has that of the production of milk and its manufacture into butter and cheese. The shallow-setting system of cream-raising has been superseded by the deep-setting system, and the latter by hand or power separators. Better knowledge of butter manufacture and milk preservation have been acquired, together with a fuller understanding of the nature and properties of dairy products and the changes to which they are subject. This volume is intended to substitute knowledge for speculation, and to give the dairyman data whereby he can best utilize his products.

There is a preliminary introduction on bacteria and their relation to dairying, so plainly written that all may comprehend it. With this information as a basis, the author proceeds to consider milk as it is drawn from the udder—properly sterile—and describes the sources of infection in the stable and their prevention. He calls attention to the danger of pouring abnormal milk on the stable floor or of feeding it to swine. Both in Germany and Denmark swine fed on centrifuge milk slime have been found tuberculous.

The author states that milk from tuberculous cows should not be used without being freed from its infectious qualities. This is unfortunate, for there is no certain and safe method of disinfecting such milk, and Prudden's experiments have shown that the sterilized products of tubercle bacilli will produce organic lesions that are severe and permanent. Such milk should never be used for any purpose, and the cow should be killed.

We are glad to note the author's emphasis on better lighting of cow-stables; he might have cited the fact that bright light is inimical to the best growth of micro-organisms. Hesse's experiments, here cited, that in the air of a cow-stable there were one hundred and twenty bacteria and molds while in that of an occupied schoolroom there were only eighty micro-organisms to the litre, only evidences the bad ventilation of each of those places.

In the section on cooling milk he refers to the value of ice to the dairyman, though it is in a subsequent chapter that he calls attention to the fact that the ice should not come in contact with the milk, because ice may contain pathogenic micro-organisms.

It would seem that the objection to the use of soda in cleansing milk-vessels is not well founded. In surgical and other disinfection alkaline water is of value in securing an aseptic condition, and its employment in the cleaning of these vessels seems to us particularly appropriate, though, of course, the vessel should be subsequently scalded with boiling water. A thorough steaming of these vessels is one of the best procedures that can be employed.

The annual cleaning of the stable is a hygienic necessity, and the means of disinfection herein indicated are easily applied.

The difference in the number of bacteria in one cubic centimetre of milk that has been obtained in a pasture and in a barn is striking:

LOCATION.	Immediately after milking.	Half an hour.	Two hours.
Pasture milking.....	10	88	1,530
Barn milking	106	980	3,655

Knopf has found from 60,000 to 100,000 bacteria in one cubic centimetre of recently drawn milk, and the author found in milk from a filthy stable from 670,000 to 780,000 bacteria per cubic centimetre. The investigations made by Sedgwick and Batchelder in Boston showed that milk sold in that city contained from 1,438,000 to 4,577,000 bacteria per cubic centimetre. The author gives a useful review of the various micro-organisms found in milk, and calls attention to the fact that the kinds are more important than the number of organisms.

Due importance is attached to the cleanliness of employees in butter and cheese factories, to their clothing and the cleanness of their hands.

The chapter on milk for city consumption is well written, but State dairy inspectors will have to be much further removed from political influences than they are at present before milk supplied to cities will cease to be a fertile source of causation of tuberculosis.

There is no doubt that properly condensed unsweetened milk is one of the best articles that can be used as a milk foodstuff, because it may be diluted with water as necessary, and it does not contain the pus and blood corpuscles, hair, and manure particles that are in any milk sterilized by heating. Filtration sterilization has not proved practical. A chapter is devoted to milk pasteurization, which the researches of Freeman and others have shown to be so much more satisfactory than sterilization by heating.

The advantages of the centrifugal method for cream separation and pasteurization of cream receive due consideration.

The manufacture and handling of butter

and cream are treated in the same careful manner as the preceding topics, and one can not but wish that the volume would be in the hands of every dairyman in this country.

An Elementary Manual of Chemistry. By F. H. Storer, Professor of Agricultural Chemistry in Harvard University, and W. B. Lindsay, Professor of General and Analytical Chemistry in Dickinson College. New York: American Book Company. Price, $1.20.

The authors state in the preface that this work is the lineal descendant of the Manual of Inorganic Chemistry of Eliot and Storer, and a thorough revision of Eliot, Storer, and Nichols's Elementary Manual of Chemistry. These works have been so well and favorably known that it is scarcely necessary to commend the present volume for the comprehensive and intelligent manner in which the subject is presented.

The experimental and inductive methods are employed to acquaint the student with the main facts and principles of the science, and by such discipline the observing faculties are developed. As a rule, the experiments mentioned are of a simple character, and the directions are so explicit that a novice in chemistry may repeat them before a class. The work is an excellent one for the purposes intended.

Eskimo Life. By Fridtjof Nansen. London and New York: Longmans, Green & Co. Pp. 350. Price, $4.

It is for the most part with genial humor, but now and then in sadness and indignation, that Dr. Nansen describes the life of these hardy children of the North. His knowledge of them was gained mostly in one winter, during which, he says, "I dwelt in their huts, took part in their hunting, and tried, as well as I could, to live their life and learn their language." Their daily life is presented with much fullness of detail; their appearance and dress, their houses for winter and tents for summer, their cookery and what they regard as delicacies, their woman-boats, excursions, etc., receiving due attention. A chapter is given to a careful description, with measurements, of that wonderful boat, the *kaiak*, and the weapons and implements that constitute its outfit, which is followed by a vivid story of a day's hunting in these boats. Some less familiar sides of Eskimo life are presented in the chapter on art, music, and poetry, and in that on the drum dances, which served both as judicial proceedings and as entertainments. Nearly a hundred pages are devoted to religious ideas, in which some curious bits of mythology and folklore are presented. Dr. Nansen represents the character of the Eskimo as gentle and patient. It is seldom that an Eskimo does anything that his own race deems wrong, crimes of violence being especially rare. Some things, however, that he does, deeming them proper, come into our category of immoralities. In his closing chapters on The Introduction of Christianity, Europeans and Natives, What have we achieved? and his Conclusion, Dr. Nansen laments the enervating influence of the civilization that Europeans have inflicted upon the Eskimos. The introduction of firearms has led them to exterminate or scare away their game. The imposition of religious commands and civil laws in a mass too great to be assimilated has driven out the old restraints and obligations and caused the victims of the process to fall between two stools. The ability to read and write has been gained at the expense of diminished skill in the *kaiak*, so that deaths from drowning have largely increased. A long catalogue of this sort could be gleaned from Nansen's pages, and he does not hesitate to urge that his countrymen should entirely withdraw from Greenland. The text is well illustrated with plates and small cuts.

The Penokee Iron-bearing Series of Michigan and Wisconsin. By Roland Duer Irving and Charles Richard Van Hise. (Monographs of the United States Geological Survey.) Washington: Government Printing Office. Pp. 534, with Plates.

This report was designed by Prof. Irving to be the first of a series which should treat each of the important iron-producing districts adjacent to Lake Superior. For a time, in 1885 and 1886, Prof. Irving accompanied the surveying party in person. Mr. Van Hise gave the seasons of 1884, 1885, and the larger part of the following year to the work. When the survey began, the district was one which explorers had but fairly entered, and which was reached by railroad at only one point. The district has since developed into one of the most important iron-producing areas of the country. Before the beginning of the investigation, Prof. Irving had done a large amount of field work upon a portion of the range for the Wisconsin Geological Survey and had prepared a systematic report upon this part of it. He was thus able to direct the more detailed examination of the whole area, so that no loss of time should occur. This is the first of the iron-producing districts of Lake Superior in which the geology has been worked out in detail, and the fundamental conclusions reached are in opposition to those expressed by some geologists. Hence, in order to make the facts fully accessible to those who desire to have them, the descriptions of the formations and their sections are given with especial particularity. The first chapter of the present report was prepared by Prof. Irving; the third, fourth, and fifth chapters were jointly prepared; and the rest is the work of Mr. Van Hise.

Thirteenth Annual Report of the United States Geological Survey, 1891–'92. By J. W. Powell, Director. In Three Parts. Part I, Report of the Director. Washington: Government Printing Office. Pp. 240.

The work of the Geological Survey is the examination of the topography and the preparation of topographical maps showing the distribution and characteristics of the rock formations of the country with their various mineral contents. Usefulness in various other ways than for the geologist is justly claimed for the maps that result from the surveys—such as the location of roads, railways, and canals, for planning towns and extensive manufactories, for drainage and irrigation systems, and for all other works depending on the configuration of the ground. These uses are multiplying, as the resources and industries of the country are developed and increase, with every decade. The geological survey of each district requiring, by reason of the diversity of rocks and resources in the different parts of the country, special knowledge of that district, the work is organized in divisions, each assigned to a particular district or series of formations, in each of which are subdivisions in which work is carried on by independent parties; and there are other divisions of special kinds of work. The topographical surveys of Connecticut, Massachusetts, New Jersey, and Rhode Island are completed. The surveys of this branch during the year covered by the report serve to complete eighty-eight atlas sheets, of which thirty-six are on a scale of 1 : 62,500 (or about one mile to the inch), forty-five are twice as large, and seven are drawn to special scales. The general maps, it is claimed, are among the first to represent with approximate accuracy the relief of any considerable part of the country. A summary of the more important features of the surveys and the administrative reports of the chiefs of divisions, showing in general terms the amount of work done in each, are given in connection with the director's report.

In Part II, Geology (pp. 372, with numerous illustrations and maps, largely swelling the thickness of the volume), are given the full and detailed reports of the second expedition to Mount St. Elias, by I. C. Russell; The Mechanics of Appalachian Structure, by Bailey Willis; The Average Elevation of the United States, by Henry Gannett; The Rensselaer Grit Plateau of New York, by T. N. Dale; The American Tertiary Aphidæ, by S. H. Scudder.

Part III (486 pages, with illustrations and maps) relates to irrigation, and contains papers on Water Supply for Irrigation, by F. H. Newell; American Irrigation Engineering, by H. M. Wilson; Engineering Results of Irrigation Survey, by Mr. Wilson; a report upon the construction of topographic maps and the selection and survey of reservoir sites in the hydrographic basin of the Arkansas River, Colorado, by A. H. Thompson; and a report upon the location and survey of reservoir sites during the fiscal year ending June 30, 1892, by John Thompson.

Clinical Manual for the Study of Diseases of the Throat. By James Walker Downie, M. B. New York: Macmillan & Co. 1894. Pp. xiv + 268. Price, $2.50.

When one recalls the six or eight hundred octavo pages of most of the popular text-books on diseases of the throat, it seems that the author of this manual has undertaken a difficult task to dispose of his topic in such small compass.

The first of the two sections into which the book is divided discusses the systematic examination of the fauces, pharynx, and larynx, and describes the various manifestations of disease of these regions. The second section considers individual diseases and their necessary medical and surgical treatment.

It seems to us that the author would have enhanced the value of his work by referring, if even briefly, to the necessity of examining the nose, especially the posterior nares, which is the starting point for so many of the diseases described in the volume.

The section on diphtheria is too meager. Insufficient directions are given for staining the Klebs-Loeffler bacillus; nothing is said of the importance of determining the latter's presence as an early indication of the character of the disease, nor is the distinction between the true and pseudo bacillus defined. Nothing is said of the antitoxine treatment of diphtheria.

What the author does describe is clearly explained, but it seems that in his effort to write a concise work he has somewhat abridged the complete consideration of his subject.

The Diseases of the Will. By Th. Ribot. Authorized translation by Merwin-Marie Snell. Chicago: The Open Court Publishing Company. 1894. Pp. vi + 134. Price, 75 cents.

The well-known psychological works of this author are sufficient guarantees of the treatment a subject will receive at his hands. In this volume he studies the will from the standpoint of dissolution—that is, he reviews the anomalies of the will, and from these deduces conclusions regarding its normal state.

He classes volitional impairments as defects of impulse, excess of impulse, impairments of voluntary attention, volitional instability, and extinction of will. From his survey of these pathological conditions he concludes that there are two distinct elements in every voluntary act: that state of consciousness, the "I will," that indicates a situation but that has in itself no efficacy, and a very complex psycho-physiological mechanism in which resides the power to act or to restrain. Therefore volition is defined as a final state of consciousness that results from the more or less complex co-ordination of a group of conscious, subconscious, or unconscious states that, united together, express themselves by an action or an inhibition.

He formulates this theory in the words, "The 'I will' testifies to a condition, but does not produce it." He aptly compares it to a jury's verdict that may be the result of a very long criminal examination and of fervid argument, and that will be followed by grave consequences extending over a long future, but that is an effect without being a cause.

The author sedulously avoids any discussion of the problem of free will, but a careful reading of the volume will greatly enlighten the student's mind regarding the scope of that metaphysical entity.

The volume is a readable one, and a most useful contribution to popular scientific literature.

Educational and Industrial System of Drawing. By Langdon S. Thompson. Boston: D. C. Heath & Co. Seven series, thirty-two books, including drawing books and manuals.

The author deduces from a general analysis of the subject that drawing is related to every other department of intellectual education, but has no departmental existence of its own, and should not be treated as an independent subject. In every school or system of schools, therefore, the actual practice in drawing or other art work that is required should depend on the regular course of study. The seven series of which the present system consists are the manual-training, primary and advanced free-hand, model and object, æsthetic, mechanical, and institute series. The order in which these several series should be used is not laid down, but is left to be determined by circumstances. The two books of the manual-training series are not drawing books proper, but are intended to develop the analytical phase of form study. They also treat of form expression in three dimensions. The more advanced manual, No. 2, treats of elementary mechanical drawing, clay modeling in relief, lessons on color, wood-carving, cutting and pasting in design, and working drawings, and is adapted to go with the advanced free-hand series. The four books of the latter series are intended to interest and instruct the mind of the learner, and improve his taste by giving information on the principles of pottery design and the conventionalization of plant forms for purposes of decorative design. The diagrams to be drawn are mostly historical examples of approved form. The model and object series is likewise a free-hand series, but has no drawings to be copied; the cuts and explanation being designed to illustrate the underlying principles of model drawing and the method of procedure, and to send both teacher and pupil directly to the object itself. The manual presents a clear and concise statement of the principles of model and object drawing, and can be used independently of the drawing books. The æsthetic series gives the principal elements of the best known styles of ornament, and explains them in such a way as to enable the learner to recognize those various styles at sight. The drawings are intended not to be copied, but to be studied and to point out the method to be pursued in inventing designs. The mechanical series is wholly instrumental. The institute series, with its primary grade book and grammar grade book, is made especially for teachers' institutes, normal classes, summer schools, and intelligent classes having only a limited time for study. A great elasticity is allowed in the use of these books, in numbers used, length of course, and purpose.

Annual Report of the Board of Regents of the Smithsonian Institution. Showing the Operations, Expenditures, and Condition of the Institution to July, 1893. Washington: Government Printing Office. Pp. 763.

The secretary calls attention to the desirability of securing an appropriation to meet actual outlays incurred in administering Government trusts. These outlays, for matters not equitably chargeable to the fund of James Smithson, are increasing; they are incurred in serving purely governmental interests, and are not met by any of the present appropriations. In the line of research the secretary, Prof. S. P. Langley, has investigated in aërodynamics and astrophysics; aid has been given in Prof. E. W. Mosley's determinations of the density of oxygen and hydrogen; Prof. A. A. Michelson has been assisted in his study of the application of interference methods to spectroscopic measurements; Prof. Holden is engaged in lunar photography; and other investigations are reported upon. Mention is made of Mr. W. W. Rockhill's adventures in Tibet and other explorations described in the Report of the Bureau of Ethnology. Volume XXVIII of the Contributions to Knowledge consists of the memoir of Captain Charles E. Bendire on the Life Histories of North American Birds. Prof. Michelson's memoir on interference methods was also published. The thirty-fourth and thirty-sixth volumes of the miscellaneous collections contain respectively two articles previously published separately, and Dr. H. C. Bolton's new Bibliography of Chemistry. A gift of two hundred thousand dollars has been made to the institution by T. G. Hodgkins, of Setauket, Long Island, for the encouragement of the study of the nature and properties of atmospheric air in connection with the welfare of man. Mr. Hodgkins also made the institution his residuary legatee. The appendix to the report contains a large number of articles on current science, mostly selected.

Human Physiology. By John Thornton, M. A. With 268 Illustrations, some colored. New York: Longmans, Green & Co. 1894. Pp. 436. Price, $1.50.

The scope of this work indicates that it has been prepared for the use of high schools and colleges.

Commencing with histology, excellent ideas of a cell, of karyokinesis, of the properties of protoplasm, and of the various forms of tissue are given. Physiology proper is then taken up and considered in its various phases. The chapters on the blood and circulation are excellent, and that on the brain is especially good in its treatment of our modern knowledge of that nervous center.

The book has been prepared with great care and judgment, and is deserving of wide popularity in the field for which it is intended.

The Amateur Telescopist's Handbook (Longmans, Green & Co., New York) has been prepared by *Frank M. Gibson* for that large number of students of astronomy whose instrumental equipment is not adequate to the satisfactory observation of a considerable proportion of the objects described in Smyth's and Webb's catalogues of celestial objects suited to observations with common telescopes. Those who have equatorially mounted telescopes of more than three or four inches aperture may find these works all they need; but those who have only alt-azimuths of smaller apertures will be liable to embarrassment from the difficulty of locating the objects described in these works, and by the presence in their lists of many that can not be seen at all with those instruments. For the purposes of this work objects are selected which are within the powers of such instruments, and the attempt has been made to describe their location so that they may be easily found without the aid of a map or lantern light. Price, $1.25.

Hermon C. Bumpus has had in mind, in the preparation of his *Laboratory Course in Invertebrate Zoölogy* (Henry Holt & Co., New York, $1), the requirements of a class of students who are pursuing a course of laboratory work on the subject. An effort has been made to direct the work without actually telling the student all that is to be learned from the specimen. An instructor is supposed to be present to assist with the hard points, and to demonstrate what can not well be elucidated by written descriptions. Not always the most typical animals are selected, but forms easily procured and preserved have been looked for. The orders of Protozoa, Cœlenterata, Echinodermata, Vermes, Mollusca, Crustacea, Limulus, Arachnoidea, and Antennata are represented by from two to seven genera each.

The work of Dr. *Hermann Adler* on *Alternating Generations*, based on *A Biological Study of Oak Galls and Gall Flies*, is published by Macmillan & Co., translated with the permission of the author, and edited by *Charles R. Stratton*. The translator became acquainted with the work while studying galls as a branch of comparative pathology, and was struck with its originality and the light it threw upon certain great biological problems. Dr. Adler began his observations of gall flies in 1875, and in the course of his investigation was able to unfold their life history, and to prove that, while many species are linked together in alternate agamous and sexual generations, others are wholly agamous. Since the existence of alternating generations was discovered by Chamisso, fresh instances of like phenomena have accumulated in which the life-cycle of the species may be represented by two or more generations, differing in form and organization, existing under different conditions, and reproducing themselves in different ways. While the galls and their generations are described by Dr. Adler, the translator suggests in the introduction a number of inquiries respecting the philosophy of the phenomenon, and especially concerning the nature and operation of the excitation by which the peculiar fruitlike forms are produced upon the trees as the result of the gall fly's work. Colored illustrations are given of forty-two species of oak galls. Price, $3.25.

Canadian Independence, Annexation, and British Imperial Federation (Putnams, 75 cents) is the amplification of an essay first written for Canadian readers by a Canadian, *James Douglas*, long resident in the United States. The imminence of political change in Canada, independence as an essential factor of imperial federation, annexation as an alternative to independence, Canada's slow progress, the probable effect of annexation on Canadian industries and wages, annexation from the point of view of comparative politics, and annexation from American and Canadian points of view are considered. The author believes that all the advantages expected from annexation can be obtained by reasonable trade arrangements.

An elementary text-book, with the title *Geometry for Grammar Schools*, has been prepared by *E. Hunt*, LL. D. (Heath). Large use of drawing is made in it, and paper cutting and folding are somewhat employed. The problems are an extension of those on mensuration usually found in text-books of arithmetic. Two copies of a protractor are printed in such a manner that the pupils may cut them out and use them in drawing.

Prof. *Dolbear's* book, *Matter, Ether, and Motion*, the first edition of which was noticed in this magazine in 1892, has reached a second edition (Lee & Shepard, $2). Three chapters have been added, dealing respectively with Properties of Matter as Modes of Motion, Implications of Physical Phenomena, and Relations of Physical and Psychical Phenomena. In the first of these he shows how each property of matter could be regarded as a manifestation of energy; in the second he points out the bearing of certain principles of physics upon the probability of various claims of the spiritists and theosophists, while in the third he argues that whatever wonderful things really take place at *séances* are done in conformity with the laws of matter, not in opposition to them.

In the mathematical series for graded schools, by *John H. Walsh*, Part II, or *Intermediate Arithmetic*, comprises Chapters VI to X. The subjects taken up are fractions, decimals, denominate numbers, bills, measurements, and, in the last chapter, algebraic equations. Part III, or *Higher Arithmetic*, completing the series, comprises Chapters XI to XVI, dealing with the various subjects involving percentage computations, with proportion, square root, mensuration, and the metric system. There is also a chapter on algebraic equations and one on elementary constructive geometry. As special features of the series, the author calls attention to its division into half-yearly chapters, instead of by topics, the small number of rules and definitions, the great number and variety of examples, and the use of the equation. (Heath, Part II, 40 cents; Part III, 75 cents.)

The *Complete Graded Arithmetic*, prepared by *George E. Atwood*, begins with a Part I, in which the usual elementary work with integers and the manipulation of fractions are taught. It provides work for two years of three terms each. The author has aimed to incorporate enough review work in each lesson so that the teacher shall not need to do any planning of reviews. The rules and definitions are put at the end of the book and referred to by number. Part II provides exercises for three years, passing from elementary decimals through denominate numbers, the various commercial calculations involving percentage, and ending with mensuration. The making of bills, receipts, notes, drafts, etc., is a feature of the examples. (Heath, Part I, 45 cents; Part II, 85 cents.)

Any one who wishes to know what *Modern Theosophy* is will find an attempt to tell him in a book with the above title, by *Claude Falls Wright* (New England Theosophical Corporation, 24 Mount Vernon Street, Boston, $1). To the strict adherent of modern scientific thought the book will be meaningless, for it is full of assertions unsupported by anything that he is accustomed to regard as evidence—conflicting, in fact, with many things that are so supported. Perhaps not entirely meaningless, for it may serve as an instructive example of the vagaries that the human mind is capable of when not forced to occupy itself with something useful or reasonable.

An *Introduction to the Mathematical Theory of the Stress and Strain of Elastic Solids* has been prepared by *Benjamin Williamson*, a Fellow of Trinity College, Dublin (Longmans, $1.50). The book is small, but its author hopes that "it is sufficient to enable the student to understand the mathematical theory of the internal strains and stresses that arise whenever external forces are applied to solid bodies." The rapid increase in the size of the structures that modern engineers are undertaking makes a thorough understanding of the distribution of stress extremely important.

In *The Science of Vital Force*, by *W. R. Dunham*, M. D. (Damrell), the idea that the author talks about and around seems to be that medicine has no active property, but that disease is cured by vital activity.

Captain *Willard Glazier* has published another book in support of his claim to have discovered the real source of the Mississippi River (Rand, McNally & Co.). It is entitled *Headwaters of the Mississippi*, and describes the adventures of explorers of that river from De Vaca, in 1528, down to the present time. Captain Glazier's expedition which resulted in his discovery of Lake Glazier was made in 1881, and, as the importance of this lake became a matter of controversy, he made a second expedition in 1891, to obtain more convincing proof of his assertions. The story of his second expedition forms the latter part of this volume, and is followed by an appendix of letters and other documents in support of Captain Glazier's position. The volume contains a great deal of descriptive matter concerning persons and places in Minnesota, and is fully illustrated.

The little book on *Gas-lighting and Gas-fitting*, by *William Paul Gerhard* (Van Nostrand, 50 cents), contains specifications and rules for gas piping, hints on the choice of fixtures, burners, globes and globe-holders, on the management of gas, and on the reduction of high gas bills. It also tells how to read a gas meter, how to search for a leak, and how not to search for it, and gives the advantages of cooking and heating by gas, certain historical facts, etc. Its treatment of these and other topics included in its scope is full, clear, and free from technicalities, and, while it is doubtless valuable to all who have to do with gas and gas appliances, it is especially needed by the user of gas, who has little chance to pick up the knowledge it contains in any other way.

A progressive course of *Mechanical Drawing*, arranged by *Walter K. Palmer*, has been issued (Charles B. Palmer, Columbus, O., 80 cents). It comprises projection drawing, isometric and oblique drawing, and the making of working drawings. The successive principles are stated briefly, and the student is expected to verify them with the aid of explanations and illustrations by the teacher. No drawings are shown and as few figures as possible are used, as it is expected that the teacher will supply what is needed to clear up individual difficulties. What shall be drawn under the head of working drawings is left altogether with the teacher. A liberal number of review questions is provided.

A series of newspaper letters under the title *Joint-metallism*, by *Anson Phelps Stokes*, has been published in the Questions of the Day series (Putnam, 75 cents). Mr. Stokes describes "joint-metallism" as "a plan by which gold and silver together, at ratios always based on their relative market values, may be made the metallic basis of a sound, honest, self-regulating, and permanent currency, without frequent recoinage and without danger of one metal driving out the other." In brief, his plan consists in the use of a new silver coin equal in weight to a five-dollar gold piece, which may be named "a standard." The Secretary of the Treasury shall determine at the beginning of each month what whole number of "standards" comes nearest to the value of a five-dollar gold piece, and any payment of ten dollars or over may be made half in gold and half in "standards," at the current ratio fixed by him. This mode of payment shall not apply to debts contracted earlier than six months after the passage of the act authorizing the use of the new coin.

What may be described briefly as a popular account of modern biblical criticism is presented by *Joseph Henry Crooker* under the title *The New Bible and its New Uses* (Ellis). Mr. Crooker shows very clearly how the present Bible has been constructed—by combining two or more versions of the same events, by writing down oral traditions, by mingling history with legend, by writing in prophecies after the event, and by adding various tributes of reverent fancy. He points out numerous errors and contradictions in the Bible, and shows how the Old Testament is misquoted in the New. Having thus demonstrated that the Bible is not the message of an omniscient Deity, he proceeds to show that it does not itself claim to be such. The statements of Jesus concerning the Old Testament writings were those of a man with the limited knowledge of his time. Mr. Crooker does not here raise any doubt that Jesus really said the things that he is reported to have said. Regarding the Scriptures in this light gives us in effect a "new Bible," and the author devotes a closing chapter to a discussion of the proper use of the renovated book. He says that it will be a great gain for humanity to have the surviving misuses of the Bible stopped, as many others have been already. This book must no longer be held superior to reason. But it will not therefore die. To quote from his closing paragraph: "When the bondage of a literal, a textual, and a dogmatic use of Scripture ceases, then we shall rejoice in a use of the Bible that allows reason and sentiment free scope. It is a joy to read the Bible as we would any other book, feeling that no dogmatist is near to club us if we doubt, and no roaring hell yawning for us if we reject a text here and there." The author makes numerous references to modern authorities for support and amplification of his statements.

The *Manual of Topographic Methods*, published by *Henry Gannett*, Chief Topographer, as Volume XXII of the Bulletin of the United States Geological Survey, is intended to present a description of the topographical work, instruments, and methods used by the Geological Survey, primarily for the information of the men engaged in the work. It is not designed to be an elementary treatise upon surveying, as it presupposes a knowledge of the application of mathematics to surveying equivalent to that to be obtained in our professional schools; and it is not intended to be a treatise on topographical work, although it may to a certain extent supply the existing need of such work.

PUBLICATIONS RECEIVED.

Academy of Natural Sciences of Philadelphia. Journal. Second series. Vol. X. Part II. Certain Sand-Mounds of the St. John's River, Florida. By Clarence B. Moore. Philadelphia. Pp. 112, with Plates.

Adams, Henry C. Relation of the State to Industrial Action. American Economic Association. Pp. 85. 75 cents.

Agricultural Experiment Station of Cornell University. Sixth Annual Report, 1893. Albany. Pp. 365.

American Forestry Association. Proceedings at the Tenth, Eleventh, and Twelfth Annual Meetings, etc. Washington. Pp. 44.

Arrowsmith, Robert, and Whicher, G. M. First Latin Readings. American Book Company. Pp. 301. $1.25.

Austen, Prof. Peter T. English Examinations. Pp. 4.—Chemistry at the Polytechnic. Pp. 2.—How shall Young Men be educated in Applied Chemistry? Pp. 8.—How to Purify Drinking-Water. Pp. 4.—A Danger Signal. Pp. 3.—Oldfield Village Sermons. Part III. Pp. 9.

Bailey, L. H. Impressions of the Peach Industry in Western New York. Pp. 24.—Peach Yellows. Pp. 16.

Bardeen, C. W., Publisher, Syracuse, N. Y. Questions and Answers in American History, Civil Government, and School Law. Pp. 80.—The Teacher's Mentor. Pp. 121.—Handbook for School Trustees. Pp. 93. 50 cents.

Barlow, W. H. The Celestial Writing, or the Normal Script Phonetic Writing. Philadelphia: The Stenographer. Pp. 14.

Barnett, Mrs. S. A. The Making of the Body. New York: Longmans, Green & Co. Pp. 208.

Bay, J. Christian, Des Moines, Iowa. On the Study of Yeasts. Pp. 28.—On Compass Plants and Twisting of Leaves. P. 1.—Crystals of Ice on Plants. Pp. 6.—Sachsia (in German). Pp. 8.—A New Infection-needle for Entomological Studies (in German). Pp. 3.

Boston Society of Natural History. Proceedings, November, 1893, to May, 1894. Boston. Pp. 140.

Burt, Edward A. A North American Anthurus: its Structure and Development. Pp. 16, with Plates.

Cannon, G. L., Jr. The Geology of Denver and Vicinity. Pp. 36.

Carus, Paul. The Gospel of Buddha, according to Old Records. Chicago: Open Court Publishing Company. Pp. 275. $1.50.

Cheiro, the Palmist. Cheiro's Language of the Hand. 432 Fifth Avenue, New York. Pp. 193, with 33 Plates. $2.

Commelin, A. O. Of Such is the Kingdom, and Other Poems. New York: Fowler & Wells Co. Pp. 110. $1.50.

Corea, the Hermit Nation. American Book Company. Pp. 16.

Curry, J. L. M. Education of the Negroes since 1860. Baltimore: Trustees of the John F. Slater Fund. Pp. 32.

Davidson, Thomas. The Education of the Greek People and its Influence on Civilization. New York: D. Appleton & Co. Pp. 229.

Davis, Charles H. S., Editor. The Egyptian Book of the Dead. New York: G. P. Putnam's Sons. Pp. 186, with Ninety-nine Plates of Original Texts. $5.

Dawson, G. M. The Progress and Trend of Scientific Investigation in Canada. Pp. 17.

Dickson, W. K. L., and Antonia. The Life and Inventions of Thomas A. Edison. New York: T. Y. Crowell & Co. Pp. 362. $4.50.

Dooner, P. W. The Genesis of Water. Pp. 47.

Fernow, B. E. Report of the Chief of the Division of Forestry for 1893. Washington. Pp. 64.

Fewkes, J. Walter. The Kinship of the Tusayan Indians. Pp. 16.

Flammarion, Camille, and Gore, J. Ellard. Popular Astronomy. New York: D. Appleton & Co. Pp. 686. $4.50.

Free Lance, A. Towards Utopia. Brief Speculations in Social Evolution. New York: D. Appleton & Co. Pp. 252. $1.

Froment, A. Les Merveilles de la Flore Primitive (Wonders of the Primitive Flora). Geneva and Paris. Pp. 145.

Harrington, Mark W. Report of the Chief of the Weather Bureau for 1893. Washington. Pp. 132.

Harvard College Observatory. Observations of the New England Weather Service in the Year 1892. Pp. 32.—Observations made at the Blue Hill Meteorological Observatory, Massachusetts, in 1893, under the Direction of A. L. Roth. Pp. 69, with Plates.—Journal of Zone Observations, by M. A. Ropes. Pp. 272.

Hodgins, J. George, Editor. Work that has been accomplished during Five Years by the Toronto Humane Society, etc. Toronto, Ont. Pp. 112.

Huxley, T. H. Evolution and Ethics and Other Essays. New York: D. Appleton & Co. Pp. 334. $1.25.

Imperial University of Japan. Calendar for 1893-'94. Pp. 265, with Maps.—Journal of the College of Science. Pp. 273, with Plates.

Kennedy, John. Must Greek Go? Syracuse, N. Y.: C. W. Bardeen. Pp. 66. 50 cents.

Locy, W. A. The Mid-brain and the Accessory Optic Vesicles. Pp. 3.

Marshall, A. Milnes. Lectures on the Darwinian Theory. New York: Macmillan & Co. Pp. 236. $2.25.

May, Fanny. Saint and Sinner. New York: J. S. Ogilvie Company. Pp. 216. 50 cents.

Merriam, L. S. Higher Education in Tennessee. United States Bureau of Education. Pp. 287.

Moore, Clarence B. As to Copper from the Mounds of the St. John's River, Florida. Pp. 28, with Plates.

Newth, G. S. A Text-Book of Inorganic Chemistry. New York: Longmans, Green & Co. Pp. 667.

North Dakota Weather and Crop Service Bulletin for September, 1894. Pp. 15.

Ostwald, Wilhelm. Manual of Physico-Chemical Measurements. New York: Macmillan & Co. Pp. 255. $2.25.

Paterson, Arthur. The Daughter of the Nez Percés. New York: G. Gottsberger Peek. Pp. 381. $1.

Rayleigh, Lord. The Theory of Sound. Vol. I. New York: Macmillan & Co. Pp. 480. $4.

Robinson's New Intellectual Arithmetic. American Book Company. Pp. 192. 35 cents.

Sabin, S. B., and Lowry, C. D. Elementary Lessons in Algebra. American Book Company. Pp. 128. 50 cents.

Schorlemmer, Carl. The Rise and Development of Organic Chemistry. New York: Macmillan & Co. Pp. 280. $1.60.

Shufeldt, Dr. R. W. Lectures on Biology. Pp. 102.—On the Osteology of Certain Cranes, Rails, etc. Pp. 14.—Notes on the Steganopodes, and on Fossil Birds' Eggs. Pp. 3.

Shufeldt, R. W., and Miss Audubon. The Last Portrait of Audubon, together with a Letter to his Son. Pp. 5, with Plate

Smith, H. Q. Notes on Eskimo Traditions. Pp. 8.

South Dakota. Report of the State Board of Health for 1892. Pierre. Pp. 57.

Spencer, Herbert. A Rejoinder to Prof. Weismann. New York: D. Appleton & Co. Pp. 27.—Weismannism Once More. London. Pp. 24.

Steiner, B. C. The History of Education in Connecticut. United States Bureau of Education. Pp. 300.

Strike, Report on the Chicago. Washington: Government Printing Office. Pp. 53.

Strike, The, at Pullman. Statements of President G. T. Pullman and Vice-President T. H. Wicks before the United States Strike Commission. Pp. 38.

United States Geological Survey. Geologic Atlas of the United States. Pike's Peak Folio. Pp. 6, and 5 Maps.—Chattanooga Folio, Tennessee. Pp. 4, and 5 Maps.

Walker, General F. A. General Hancock. New York: D. Appleton & Co. Pp 332.

Wallihan, Mr. and Mrs. A. G. Hoofs, Claws, and Antlers of the Rocky Mountains with a Camera. Photographic Reproductions of Wild Game from Life. With an Introduction by the Hon. Theodore Roosevelt. Denver, Col.: Frank S. Thayer.

Ward, L. F. Recent Discoveries of Cycadean Trunks in the Potomac Formation of Maryland. Pp. 9.

Warren, L. Z. Defective Speech and Deafness. New York: G. S. Werner, 108 East Sixteenth Street. Pp. 116.

White, G. R. An Elementary Chemistry. Boston: Ginn & Co. Pp. 272.

Wood, Henry. The Only Practical and Possible Bimetallism. Boston: Lee & Shepard. Pp. 19.

Wright, Carroll D., Commissioner. Ninth Annual Report of the Commissioner of Labor, 1893. Washington. Pp. 719.

Zinet, Alexander. An Elementary Treatise on Theoretical Mechanics. Part III, Kinetics. New York: Macmillan & Co. Pp. 237. $2.25.

POPULAR MISCELLANY.

Decrease of Russian Rivers.—A diminution in the quantity of water in the rivers of eastern Europe, particularly in Russia, has been recognized for a long time. Koeppen began to seek for the cause of it as early as 1830, and the Russian Government is giving attention to the subject. Prince Vassiltchikoff, of the government of Saratov, having observed that the sources of a river on his estate shrunk as the region in which they were situated was dried, planted trees, and succeeded in causing the water to reappear. The experiment seemed to demonstrate incontestably that the removal of the woods was the immediate cause of the disappearance of the springs, and indicated that means might still be found for restoring the dried streams of the valley of the Volga. M. Vermoleff, present Minister of Agriculture of Russia, repeated M. Vassiltchikoff's experiments on a vast scale and with all the precautions to assure success which science could suggest. He dispatched a scientific expedition, composed of specialists, to visit the sources of the Volga and its affluents; and upon their recommendation suitable measures were taken to increase the quantity of water of the sources, and especially to make the flow more regular and less rapid. Thus, after having drained the marshes in some of the governments of Russia, the authorities are seeking means to give others a sufficiency of water.

Mr. Maxim's Flight.—Mr. Maxim, on the 31st of July, achieved a flight through the air, with his flying machine carrying himself and two of his men, of five hundred feet. The machine was held to the earth by a railway, on which it was locked by a device permitting its rising an inch or two, but preventing its soaring to any considerable height. It sailed, lifted from this railway as far as the machinery would permit, at the rate of forty-five miles an hour. The machine, with its four side-sails and aëroplanes set, is more than one hundred feet wide, and is described as looking like a huge white bird with four wings instead of two. It is propelled by two large two-bladed screws, resembling the screw propellers of a ship, driven by two compound engines which are said to be, in proportion to their weight, the most powerful ever made. The whole apparatus weighs about eight thousand pounds, and the engines have a lifting power of about ten thousand pounds.

Progress of Electrical Theory.—Lord Kelvin's address at the recent annual meeting of the Royal Society was largely devoted to a review of the history of the doctrine of the ether, and of light, heat, and electricity, culminating in Hertz's demonstration of its validity. During the fifty-six years, the speaker said at the conclusion of his address, since Faraday first offended physical mathematicians with his curved lines of force, many workers and many thinkers have helped to build up the nineteenth-century school of *plenum*—one ether for light, heat, electricity, magnetism; and the German and English volumes containing Hertz's electrical papers, given to the world in the last decade of the century, will be a splendid monument of the consummation now realized. The Royal Society's Transactions and Proceedings of the last forty years contain, in the communications of Gassiot, Andrews and Tait, Cromwell, Varley, De la Rue and Müller, Spottiswoode, Moulton, Plücker, Crookes, Grove, Robinson, Schuster, J. J. Thomson, and Fleming, almost a complete history of the new province of electrical science, which has grown up largely in virtue of the great modern improvements in practical methods for exhausting air from glass vessels, by which we now have "vacuum tubes" and bulbs containing less than $\frac{1}{100000}$ of the air which would be left in them by all that could be done in the way of exhausting (supposed to be down to one millimetre of mercury) by the best air-pump of fifty years ago. A large part of the fresh discoveries in this province have been made by the authors of these communications, and their references to the discoveries of other workers very nearly complete the history of all that has been done in the way of investigating the transmission of electricity through highly rarefied air and gases since the time of Faraday.

Paleontological Riches of Texas.—In his report to the State Geological Survey on the Invertebrate Paleontology of the Texas Cretaceous, F. W. Cragin characterized the State as a mine of paleontological research, particularly with respect to the extensive and as yet little known faunæ of its Comanche series. The work of the recently deceased Dr. Roemer, the little illustrated but mainly accurate paleontological work of Dr. Shumard, the work of Conrad upon the collections made by the Mexican Boundary Survey, not to mention numerous lesser contributions by Marcou, White, Hill, Giebel Schlueter, and others, all taken together, have only tapped this great mine of knowledge. And this, as regards invertebrate forms alone; for the vertebrates of the Texas Cretaceous, and particularly those vertebrate faunæ which are of the greatest importance as factors of the stratigraphic and taxonomic problems of the lower rocks of the Comanche series, are almost wholly unknown. Of the remains of Cretaceous invertebrate organisms a great wealth of material has been accumulated by the survey, including types of many new forms of exact biological and stratigraphical significance.

Manganese in Alabama.—A report on the geological structure of Murphree's Valley, Alabama, made to the State Geologist by Assistant A. M. Gibson, shows that besides limestone and hematite and limonite iron ores, the estimates of the value of which have been confirmed in the working, it contains manganese ores and beds of fine clays. Half a dozen or more spots are described, all in the same region, where deposits of manganese ores, chiefly pyrolusite, of good quality, have been seen. The discoveries of these deposits have been in the main accidental, and they cover only a very small part of the ground where ores are presumed to exist. It is therefore probable that the larger proportion of the beds still remain undiscovered. The clays comprise brick clays and halloysite or porcelain clay—a similar bed to which has been worked with satisfactory results in De Kalb County—along with which are a honestone grit, sandstones, and honestones suitable for building, and a fireproof conglomerate. Besides two lines of exposure of iron ores and one of carboniferous limestone, this valley is favored with "ample coal accessible on both sides at its very edge."

Arago's Work.—In his address at the unveiling of a statue of Arago, in Paris, June 11th, M. Tisserand said that "Arago introduced physics into astronomy, and gave it a permanent place. Before him, astronomers concerned themselves chiefly with the movements of the stars and the members of our planetary system, seeking to explain them in their minutest details by the law of gravitation. Arago studied the nature of the heavenly bodies, and the character of the phenomena continually exhibited by them. The polariscope showed him that the glaring surface of the sun is gaseous, and gave him important information as to the light of comets. Another application of physical methods furnished him with a precise means for measuring the diameters of planets or determining their magnitude. Nothing is more ingenious than his explanation of the scintillation of stars, based upon the remarkable properties Fresnel found to be possessed by rays of light. Arago ought truly to be considered as the founder of a branch of astronomy—physical astronomy—that has since been remarkably extended, for it was he who pointed out the importance that would accrue from the application of photography to the study of celestial bodies. He was not able to see the day, however, when chemistry would enter into the domain of astronomy, and we should be able to discover their constitution; spectrum analysis has been discovered, in fact, only since the death of Arago." Arago is besides credited with having conceived the idea of drawing a unit of measurement from the light rays—an idea which has been realized by Mr. Michelson, of the American Bureau of Weights and Measures.

Value of the Nasal Index.—In Mr. H. H. Risley's examination of the characteristics of the natives of northern India, the nose, instead of being vaguely described as broad or narrow, is accurately measured, and the proportion of the greatest width to the greatest length (from above downward), or the "nasal index" (which must not be confounded with the nasal index as defined by Broca upon the skull), gives a figure by which the main elements of the composition of this feature in any individual may be accurately described. The average of mean nasal indices of a large number of individuals of any race, tribe, or caste offers means of comparison which bring out most interesting results. By this character alone the Dravidian tribes of India are easily separable from the Aryan. Even more striking is the curiously close correspondence between the gradations of racial type exhibited by the nasal index and certain of the social data ascertained by independent inquiry.

Public Reservations in Massachusetts.—The Trustees of Public Reservations of Massachusetts received no new trusts during 1893, but they are able to record two movements instituted by the State Legislature, at their suggestion, for the better conservation of certain scenery. A bill was passed providing for the acquisition by the people of Provincetown of all the occupied parts of the province lands at the extremity of Cape Cod, and the permanent reservation of all the remaining portion (about two thousand acres) in the charge of the State Commissioners of Harbors and Lands. Another act creates a permanent Metropolitan Park Commission, with the power of eminent domain and authority to spend one million dollars in buying lands, as well as to accept gifts of land or of money to buy them with, lying within the metropolitan district. This commission has already received twelve thousand five hundred dollars from Mrs. Elish Atkins and her son toward the purchase of the "Beaver Brook reservation," in which are included Beaver Brook Falls, celebrated by Lowell in one of his early poems, and the famous "Great Oaks," which the board of trustees had failed to acquire for want of the power of eminent domain.

Importance of Ocean Currents.—The very bulk of the ocean, Captain W. J. L. Wharton remarks, in his geographical address before the British Association, as compared with that of the visible land, gives it an importance possessed by no other feature on the surface of our planet. Mr. John Murray has shown that its cubical extent is probably about fourteen times that of the dry land. The most obvious feature of the ocean is the constant horizontal movement of its surface waters. It may now be safely held that the prime motor of the surface currents is the wind—not the wind that may blow, and even persistently blow, over the portion of water that is moving, more or less rapidly, in any one direction, but the great winds that blow predominently from some general quarter over vast areas. These, combined with deflections from the land, settle the main surface circulation. The trade winds are the prime motors. They cause a surface drift of no great velocity over large areas in the same general direction as that in which they blow. The westerly winds that prevail in higher northern and southern latitudes are next in order in producing great currents. From the shape of the land they in some cases take up and continue the circulation commenced by the trade winds; in others they originate extensive movements of the water. Compared with the great circulation from this source the effect of differences of temperature or of specific gravity is insignificant, though no doubt these play their part, especially in causing slow under circulations, and in a larger degree the vertical mixing of the lower waters.

Progress in Indexing Chemical Literature.—The Committee of the American Association on Indexing Chemical Literature reports the printing during the past year of A. C. Langmuir's Index to the Literature of Didymium, and the second volume of Mr. Trimble's Bibliography of the Tannins. Reports have been received by the committee of progress from several chemists on other works in this line upon which they are engaged. While the annual reports of this committee are properly confined to the productions of Americans, attention is directed to indications of a growing appreciation of the value of special bibliographies on the part of European chemists, confirming by their recent and proposed activities the work begun in America at Prof. Bolton's suggestion more than twelve years ago. The bibliographical work is extending to other branches of science. The International Conference of Geologists at Washington appointed a committee to prepare a list of the geologic bibliographies now in existence. A committee of the Torrey Botanical Club is publishing an index to recent literature relating to American botany. The Smithsonian Institution is publishing a series of bibliographies of aboriginal languages.

Secular Magnetic Changes.—In discussing the problems and conclusions suggested by the Magnetic Survey of the United Kingdom, Prof. A. W. Rücker observed that the question of the cause of the magnetic variations in the earth has entered upon a new stage. It has long been recognized that the earth is not a simple magnet, but that there are in each hemisphere one pole or point at which the dip needle is vertical, and two foci of maximum intensity. A comparison of earlier with later magnetic observations leads to the conclusion that one or both of the foci in each hemisphere is in motion, and that to this motion the secular change in the values of the magnetic elements is due. The observed changes can not be explained by any simple theory of a rotating or oscillating pair of poles; they suggest that secular change is due to waxing and waning of forces apparently exerted by secondary lines or points of attraction or repulsion. New facts lead us to look upon the earth not as magnetically inert, but as itself—at the equator as well as at the poles—producing or profoundly modifying the influences which give rise to secular change. And then, when we push our inquiry further, experience tells the same tale. The earth seems, as it were, alive with magnetic forces, be they due to electric currents or to variations in the state of magnetized matter. We need not now consider the sudden jerks that disturb the diurnal sweeps of the magnet, which are simultaneous at places far apart, and probably originate in causes outside our globe. But the slower secular change, of which the small part that has been observed has taken centuries to accomplish, is apparently also interfered with by some still slower agency, the action of which is confined within narrow limits of space.

The Weather Crop Service.—According to Major H. H. C. Dunwoody, of the National Weather Service, the weather crop service of the national bureau ranks next in importance to the work of making forecasts. The system of gathering reports upon which the weather crop bulletins are based has been greatly perfected in recent years. The crop bulletins of the States have been improved, and are now more complete than at any previous time, and the increased circulation that these bulletins have attained amply attests their value. It is believed that there is no other class of information to which so much space is devoted in the public press to-day. A file of these bulletins for all the States for a year will form the most complete history of the weather conditions attending the growth and development of the several crops throughout the country. More than ten thousand crop correspondents are to-day co-operating with the National Weather Service through the State organizations; three thousand voluntary observers are furnishing monthly reports of daily observations of temperature and rainfall; and over eleven thousand persons assist in the work of distributing the weather forecasts of the National Weather Service. This latter work has been more rapidly pushed during the past year than any other feature of State Weather Service work. With the continuation of the present liberal policy toward these services there will be in a comparatively short time no important agricultural community in the United States, with the proper mail facilities, that will not receive the benefits of the forecasts.

The Nature of Scientific Truth.—The evidence, and the only evidence, to which science appeals or which it admits, said Dr. Brinton in his presidential address before the American Association, is that which it is in the power of every one to judge, that which is furnished directly by the senses. It deals with the actual world about us, its objective realities and present activities, and does not relegate the inquirer to dusty precedents or the moldy maxims of commentators. The only conditions that it enjoins are that the imperfections of the senses shall be corrected as far as possible, and that their observations shall be interpreted by the laws of logical induction. Its aims are distinctly beneficent. Its spirit is that of charity and human kindness. From its peaceful victories it returns laden with richer spoils than ever did warrior of old. Through its discoveries the hungry are fed and the naked are clothed by an improved agriculture and an increased food supply; the dark hours are deprived of their gloom through methods of ampler illumination; man is brought into friendly contact with man through means of rapid transportation; sickness is diminished and pain relieved by the conquests of chemistry and biology; the winter wind is shorn of its sharpness by the geologist's discovery of a mineral fuel; and so on, in a thousand ways, the comfort of our daily lives and the pleasurable employment of our faculties are increased by the administrations of science. Scientific truth has likewise this trait of its own—it is absolutely open to the world; it is as free as air, as visible as light. There is no such thing about it as an inner secret, a mysterious gnosis, shared by the favored few, the select illuminati, concealed from the vulgar horde, or masked to them under ambiguous terms. Wherever you find mystery, concealment, occultism, you may be sure that the spirit of science does not dwell, and, what is more, that it would be an unwelcome intruder. Such pretensions belong to pseudo-science, to science falsely so called, shutting itself out of the light because it is afraid of the light.

A Lesson concerning Epidemics.—An epidemic of typhoid fever which prevailed in Buffalo, N. Y., in March, 1894, is the subject of a contribution by Prof. S. A. Lattimore to the Rochester Academy of Science. A noteworthy feature of the pestilence is that it prevailed in those parts of the city that draw from the water supply, while those parts to which the supply system had not extended and depended on wells were exempt from it. The source of the disease was therefore looked for in the water supply. This is pumped from the Niagara River at such a distance from the shore as is supposed to make sure against contamination by sewage. There is, however, a secondary inlet which sewage may reach, but which is usually closed. During the latter part of February the winds blew in such a way as to force the water of the river back, making it so low at the pumping station that the quantity entering the tunnel was not sufficient for the maintenance of an adequate pressure. The secondary inlet was opened, and the fever began. Upon analysis of the water the typhoid bacillus was found in it. The exclusive supply from the crib in the middle of the river was resumed, the reservoir and pipes were washed out and disinfected, and the epidemic ceased. Prof. Lattimore draws from the incident a forcible lesson on the necessity of avoiding the pollution of lakes and rivers on which cities and districts may be dependent for supplies. "Has a city," he asks, "any more right than a private citizen to render itself a nuisance by discharging its waste upon their [its neighbors'] property, and rendering odious, if not dangerous, the air they must breathe and the water they must drink? Is it a premature question to ask if the time has not almost come when cities shall no longer convert the natural waterways into sewers, and the lakes into reservoirs for their sewage? Methods of sewage disposal and disinfection have been already so far perfected that, in my opinion, at no distant day, compulsory destruction of all offensive and dangerous waste material, of whatsoever kind, may be legally enforced without serious expense or inconvenience. Again, are we quite rational in the relative estimate we place upon our most cherished possessions? Do we not strangely, insanely underrate health and life, and overrate greatly the mere things which possess absolutely no value at all apart from life and health?" These conclusions are strikingly enforced in the lesson of the recent outbreak of typhoid fever at Wesleyan University, that has been traced to the eating of oysters raw which had been exposed to contamination in their temporary storage bed by a drain leading from a house where there was typhoid fever.

The Peopling of America.—In trying to account for the settlement of America by spontaneous migrations, Prof. O. T. Mason postulates that the emigrants would be drawn, in the quest for food, along the lines of most abundant supply and of least resistance. He accepts Morgan's location of the region about the mouth of the Columbia River as the starting point of the migration over the continent. Whence and how did men come to that point? He finds a route from Asia to America that might have been nearly all the way by sea, and continuously used for centuries; and which lies absolutely along a great circle of the earth, the shortest and easiest highway. This great circle route lies mostly through landlocked waters, and embraces, in order, the northeastern Indo-Malayan Archipelago, the South China and Malay Seas, the East China and Yellow Seas, the Japanese and Tartary Seas, the Okhotsk Sea and environs, the Bering Sea with its bays, the Alaskan Sea and inlets, the Tlinget-Haide Sea, the Vancouver Sea, and the Columbia Basin. The same great circle would go on to include the head waters of all the Rocky Mountain streams, the great interior basin, the Pueblo region, Mexico, Central America, Ecuador, and Peru. Along it food is abundant, no point is at a very great distance from land, and all the conditions are as favorable as could be found anywhere to the success of a voyager. Hence Prof. Mason advances the hypothesis that during the centuries in which Europe was working out of its earliest stone age into its renascence, certainly for three thousand years or more, America was being steadily and continuously peopled from Asia by way of its eastern shores and seas from the Indian Ocean. Subsidiary movements in the way of offshoots from this migration, contributions to it, and barriers to its progress took place up and down the rivers and in the seas of India, China, Mongolia, and Siberia. The author disclaims any reliance upon theories of sunken continents, upon voyages across the profound sea without food or motive, the accidental stranding of junks, or the aimless wandering of lost tribes; assumes that there never was known to history a day when the Asiatic and American continents were not intimately associated; and concludes that "when the continent of America was peopled it was done by men and women purposely engaged in what all sensible people are now doing—namely, trying to get all the enjoyment possible out of life for their efforts."

The Critical Faculty in Engineering.—The presidential address of Prof. A. B. W. Kennedy, of the Section of Mechanical Science, in the British Association, was devoted to the critical side of mechanical training—the training to think about a subject, to write upon it, and to come to a rational decision, by exercising a critical sense of proportion which could be best developed by a course of quantitative experimental work in an engineering laboratory. After observing that an engineer was a man who was continually called upon to make up his mind irrevocably in a very short time—generally about one tenth of the time which he would like to give to the subject—the author pointed out that there was an essential difference between the problems of the mathematician and those of the engineer. In pure science and mathematics there was little room for the critical faculty—the result was either right or wrong. In engineering there might be many solutions, and the critical faculty must be rapidly supplied to the problems, their statement, their condition, and all the possible solutions. The literary faculty, the power of expression, was also of great importance, as it necessitated clear thinking and a grasp of the environment of the question, with a due sense of the proportion of its component parts, and of the forces affecting it.

Arabs of the Hadramaut.—Mr. Theodore Bent read a paper in the British Association on the Natives of the Hadramaut in South Arabia. He began by giving a brief sketch of the ancient history of this valley in the interior of Arabia, and showed how it was the great center from which frankincense and myrrh were exported to Europe by caravan routes across the desert, particulars concerning which are given us by Ptolemy and Pliny. He then went on to describe the modern inhabitants of this district, showing how the Bedouins here were distinct from those of northern Arabia, and in all probability formed an aboriginal race, with curious customs and a religion of their own. He then spoke of the extreme fanaticism of the Arabs in the Hadramaut, a fanaticism fostered by the Sayyids and Sherifs, who claim direct descent from Mohammed and form a sort of hierarchical nobility in the country, and who have hitherto succeeded in keeping foreigners out of their territory. The Arabs not of this noble family could not intermarry with them. The Sayyids never engaged in commerce or industry, but the other Arabs were very commercial, and frequently made fortunes in India and the Straits Settlements. Mr. Bent gave a minute account of the men and women of the Hadramaut and their peculiar customs and dress, stating that he hoped to return again next winter to continue his researches.

Economics as a Branch of Education.—It is highly desirable, said Prof. C. F. Bastable, in his British Association address, that certain professions—law, journalism, and public administration may be mentioned—should have economics as a part of the training necessary for their exercise. To accomplish this object, its combination with jurisprudence, political and administrative science in a common group seems the best way. The strictly professional students would obtain a better and more suitable training, and it might be reasonably expected that some with genuinely scientific tastes would be ready to take up social science as a regular pursuit and contribute to its progress. But it is in dealing with the practical problems that this wider mode of treatment is most essential. Is it not true that commercial policy must largely depend on political and legal conditions? Even in carrying out the thoroughly wise and sound principle of free trade, the British Government finds itself involved in many curious complications. Treaties and administrative regulations have to be taken into account. The political forces that guide the tariff policies of nations have their decided effects; and whether we desire merely to estimate the actual character of any particular policy, to form a rational forecast of the course that nations will take in the future, or to give advice as to what should be done, we can not limit ourselves to abstract economic theory, or even to economic considerations. This is equally true of the currency question. The weightiest arguments for and against bimetallism are political rather than economic while such social influences as habit and custom powerfully affect the possibilities of action that purely deductive reasoning from economic premises might appear to suggest.

The Insane Kings of the Bible.—In a paper on the Insane Kings of the Bible, Dr. D. R. Burrell publishes a study of the cases of Saul and Nebuchadnezzar, in the light of modern science. Of Saul's case he finds that "his insanity was recognized, but, at a time when secondary causes were ignored, it was called 'an evil spirit from the Lord.' Judged in the light of the present, it was but the natural outcome of his character, a character made up of unstable elements easily and unfavorably affected by attending circumstances. In justice to him, it should be remembered that he was merely a herdsman's son, upon whom were thrust royal dignity, authority, and responsibility, without precedent or guide, for he was 'the first king in Israel.'" Nebuchadnezzar's insanity may have been caused partly by overwork. His treatment, in view of the sacredness of his person, his delusions, the climate and the private parks of Babylon, and the ideas of nudity, was of the best. "It challenges our treatment of to-day, for it gave out-of-door life without stint, permitted the greatest activity, and employed neither mechanical, chemical, nor manual restraint. . . . Nothing could be truer to Nature and the daily manifestations of the insane than the account of the recovery of the king; the coming out of chaos or self-absorption; the looking upon things about him and seeing them gradually assume their correct proportions; the return of the understanding; the full return of reason; and then a heart overflowing with thankfulness, thankfulness that only those feel who have walked long in the valley of the shadow of death. If we take this chapter from the sacred canon, and study it with some knowledge of the far-off past, and in the light of insanity as manifested to us to-day, we shall discover that it is one of the most beautiful and concise descriptions of the premonition, the onset, the course, and the termination of a case of insanity that is recorded in any language."

Aluminum Violins.—Describing the aluminum violins before the American Association, Mr. Alfred Springer said that the sound-boards from that metal are analogous to those made of wood, and differ from the sound-boards made from other metals. They are analogous to wood, because they do not produce secondary tones that are not in harmony with the prime tones. Such secondary tones are found largest in elastic metals of fine uniform consistence, because the mass of such metals gives them a tendency to continue in any particular state of motion. The author had found that his experience with aluminum during the past three years was attended with many difficulties. For instance, he could find no satisfactory solder with which to fasten the plates, and was obliged to resort to rivets. In order to overcome the essential condition of uneven thicknesses of belly and back he was obliged to resort to sheet metal, ribbed and arched, and he found that in the aluminum instruments there were not the uncertainty and lack of individuality to be observed in those manufactured of wood. The wooden ones, however, were superior, and the reason the old wooden instruments were better than new ones was not in the elasticity of the wood or the composition of the varnish, but in the peculiar warping of the wood to a higher arch. He never saw a good old instrument that was not warped. Immediately after the lecture an aluminum violin was produced and played on. The tones were very full and resonant.

NOTES.

We owe our readers an apology for the absence of the illustration from the article on Pithecoid Man, printed in the December Monthly. The writer of the article sent a photograph with his manuscript from Germany, and after the number was printed we discovered that the picture had been copyrighted in this country. The owner of the copyright refusing to permit us to publish the illustration on any terms, we were obliged to throw it out, and through an oversight the needed correction was not made on the cover of the magazine.

The importance of forestry is urged by Prof. W. T. Thiselton Dyer on account of the probability that the supply of timber may be exhausted before that of coal. It further appears in view of our complete dependence upon the products of the vegetable kingdom for the necessaries of our existence.

Five genera of mammals living in the south of France are named by M. Mingaud to the Scientific Society of Nîmes as nearly extinct. They are the wolf, the genet, the beaver, and the thoroughbred horses and cattle of Camargue; the last two species being in course of breeding out by crossing. The author considers it important that the natural history museums provide their collections with typical specimens of these animals.

The programme of the winter's lectures of the Franklin Institute, Philadelphia, for the season now beginning, promises a lecture on every Friday evening from November 2d to April 5th. The subjects are various, and the lecturers are masters of them. They include illustrations of travel, bacteriology, the coal mine, the photochromatoscope, watch manufacture, the relation of forests to the surface of the country, the metallurgy of aluminum, electricity and its applications to different arts, the mineral resources of the United States, sanitary engineering, and other topics.

M. Forel recently showed the Scientific Society of Lausanne some curious balls of animal hair which had been agglomerated by the waves, and were scattered over the beach of the Gulf of Morges, near the great tanneries. In some places these balls are numerous enough to form a continuous stratum under the ground. If these products of the activity of the lake were buried under the soil, they might produce very singular fossils, which would be puzzling enough to geologists of the future.

Certain school studies are described by Superintendent H. P. Emerson, of Buffalo, in a paper read before the Thirty second University Convocation, as those which are of least educational value, but are yet necessary because they are the tools for acquiring further knowledge, such as reading, spelling, writing, drawing, and the most of number work or arithmetic. Here children learn the signs or symbols of knowledge rather than knowledge itself. One of the great mistakes of education in the past has been that these vehicles of knowledge have been so exalted as to occupy the most important place and to be regarded as ends in themselves.

In a paper on Corean Children's Games, read in the American Association, Mr. Stewart Curlin said the Corean games agreed in general with the children's games in modern use, but more closely with those of the neighboring countries of China and Japan. Although they have departed somewhat from the dramatic and divinistic forms to which they can ultimately be traced, yet these early sacred associations are more apparent in them than in the children's games of other countries of eastern Asia. Toys are looked upon as sacred things. Mr. Culin spoke of the common Corean games, such as the "tug of war," in which villagers oppose villagers at either end of a rope of straw, the archery contest, the game with slaves, and others. The Chinese names of a large portion of the children's games indicate their Chinese origin. Respect for literature and the written character is seen in the literary amusements, something like the familiar word-games in America. The hatred of Japan and the Japanese which permeates Corea is well illustrated by the simple game of "fighting violets," which the children call "*o-ran ka got*"—i. e., "barbarian head-cutting."

A "Deseret professorship of Geology" has been established in Salt Lake City, Utah, endowed with sixty thousand dollars by Salt Lake City, and Dr. J. K. Talmage has been chosen and installed professor in it. The university, although not technically its owner, will enjoy the advantages of the Deseret Museum of the Academy.

Prof. Büchner has shown in a series of experiments that the direct rays of the sun act efficiently in destroying microbes in small quantities of water, and that diffused sunlight also has no insignificant power in the matter. The experiments made to determine the depth to which this action of sunlight penetrates showed that it diminishes very fast between a metre and a half and two metres and a half, at which depth it is hardly perceptible. From this result, Prof. G. C. Frankland infers that the influence of light in purifying water (that is, large bodies) can not be regarded as of much importance; and it would hardly be safe to depend on its operation in the "self-purification" of rivers. Other experiments indicate that microbes thrive in the dark and multiply in the night, under favorable conditions of temperature.

A monument to Quatrefages was unveiled at Valleraugues, France, August 20th, in the presence of a deputation of the most eminent scientific men of the country. The scientific career of Quatrefages was described in the addresses of MM. Milne-Edwards, Hamy, Geoffroy Saint-Hilaire, and Brongniart, of whom M. Hamy declared him the creator of anthropology. The monument consists of a bust in bronze of Quatrefages, placed upon a pedestal of stone, on the principal face of which is the statue of a young native of the Cevennes presenting a crown to the eminent naturalist.

Attention is called by the English Dr. Welply to a danger which has so far escaped public notice. Creameries receive their milk from a number of farms. After the cream has been removed, some of the skim milk is sent back to the farms for consumption. The milk being all mixed together, a means is thus afforded for conveying typhoid fever or other disease existing on one of the farms to all the others, and for creating fresh disease centers. An instance where this really occurred is cited by the author. This affords a fresh argument for always boiling milk before using.

A new style of bottle for poisons is figured in the Lancet. It has the neck on one side, and is otherwise described as of such a shape that it will not stand up, and should always be lying down in such a position that the word "poison" and the label shall be in view; "and this peculiarity is as readily to be distinguished in the dark as in the light. A particular grip is necessary in handling it, for the fingers have to touch the table when lifting it. The peculiarity of the neck can not be overlooked when corking or uncorking." It is as cheap as an ordinary bottle.

The work of preserving the White Mountain forests has made some progress in spite of selfish legislation. One step forward has been the designation of the Appalachian Club as a trustee to receive funds for the purchase of forest lands.

According to the German journal *Die Natur*, a German chemist has discovered a substance possessing the singular properties of solidifying under the influence of heat and becoming liquid at temperatures below the freezing point of water. It is obtained by mixing equal parts of phenol, camphor, and saponine, with a very small quantity of turpentine, and has been named *cryostaz*, or in English *cryostace*. This is the first substance known having the properties described; for, although albumen solidifies at a high temperature, it can never again be restored to the liquid condition.

The Board of Regents of the University of California have decided to establish a course of anthropology at that institution.

Extracts from various authorities are quoted in a paper by H. H. Clayton to show that there has been a gradual evolution in the definitions of clouds since Howard. Thus a distinction has been established between high and low cirro-stratus and high and low cirro-cumulus. The stratus has been separated into fog and low sheet clouds, and two distinct forms of rain cloud have been recognized. The author agrees that ten terms, all compounded of Howard's four fundamental types, would fully meet the requirements of practical meteorology.

Dr. Karl Grossman and Dr. Cahnheim in their journey across Iceland (1893), visited the lava cavern Surtshellir. They explored this cavern and photographed by means of magnesium light the wonderful ice cave which exists in its farthest recess. On their return journey they made a second descent, with a view of searching for the coins deposited there by previous travelers. Successful in their efforts, they took two of the oldest coins, after leaving new ones in their places. It was their intention to restore the old coins to their former resting place on the occasion of their next visit.

An important work now in hand, under the auspices of the Anthropological Section of the British Association, is the organization of an ethnographical survey of the United Kingdom, based upon scientific principles. It is proposed to record in a systematic and uniform character for certain typical villages and the neighboring districts: 1, The physical types of the inhabitants; 2, their current traditions and beliefs; 3, peculiarities of dialect; 4, monumental and other remains of ancient culture; and, 5, historical evidence as to continuity of race.

OBITUARY NOTES.

Colonel Garrick Mallery, of the United States Army, retired, an esteemed contributor to The Popular Science Monthly, died in Washington, October 24th, aged sixty-three years. He was born at Wilkesbarre, Pa., and was educated at Yale. In 1861 he entered the volunteer service, and for gallantry in action was promoted four times, finally rising to the rank of lieutenant-colonel. He was one of the Libby prisoners. He was in charge of the Signal-Service Bureau from 1870 to 1876, and then was ordered to Dakota. His investigations into Indian sign and gesture language, concerning which he published valuable papers in the Smithsonian series and in scientific journals, gave him a high scientific reputation. He was President of the Cosmos Club of Washington.

Dr. Terrien de Lacouperie, at one time Professor of the Comparative Philology of Southeastern Asia at University College, died in Fulham, England, October 11th. To him belongs the credit of having determined the origin of the Chinese writing and early civilization. He was of Norman descent and began life as a merchant, but was drawn away to science and particularly to comparative philology. Having studied the early writing of China, he compared it with the cuneiform characters of Babylonia, and found evidence that some of the characters had been borrowed from the ancient Akkadian. Tracing out other affinities, he found a like correspondence between the civilization of the Chinese and those of Elam and Chaldea. He discovered the key to the puzzling Yih-king, or Book of Changes, of the Chinese, determining that it consists of old fragments of early times in China, mostly of a lexical character. He was author of the books: The Early History of Chinese Civilization, The Languages of China before the Chinese, A Catalogue of Chinese Coins from the Seventh Century B. C. to A. D. 621, and The Western Origin of the Early Chinese Civilization, from 2300 B. C. to 200 A. D.

William Topley, F. R. S., an industrious English working geologist, died in Croydon, September 30th, of gastritis contracted during a geological visit to Algeria. He was a special student of the geology of the Weald, on various aspects of which he contributed several papers, and of the bearings of geology on other branches of knowledge. One of his papers treated of the relation of parish boundaries to great physical features. His most important work was The Geological Survey Memoir of the Weald. He was Secretary of the Geological Section of the British Association for fifteen years, was Secretary of the Committee on Coast Erosion, and was President of the Geologists' Association from 1885 to 1887. He took part in most of the international geological congresses, and was for a time a sub-editor, and afterward editor, on the Geological Record.

Prof. N. Pringsheim, an eminent German botanist, died October 6th, in the seventy-second year of his age. He wrote especially on the processes of fructification and germination in the *Algæ*. He was Professor of Botany at Jena from 1864 to 1868, and founded there the first Institute for Vegetable Physiology. He returned to Berlin in the latter year, and established a private laboratory, in which he carried out valuable investigations on the sexual life of the lowest vegetable organisms.

CHARLES ALEXANDRE LESUEUR.

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STUDIES OF CHILDHOOD.

VI.—FIRST ATTACKS ON THE MOTHER TONGUE.

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IN the following paper I shall pass by the first stage of infant phonation, the babbling or singing of the first year which precedes and prepares the way for true baby-speech. A full account of this pre-linguistic articulation will be found in Preyer's well-known volume.

This learning of the mother tongue is one of the most instructive and, one may add, the most entertaining chapters in the history of the child's education. The brave efforts to understand and follow, the characteristic and quaint errors that often result, the frequent outbursts of originality in bold attempts to enrich our vocabulary and our linguistic forms—all this will repay the most serious study while it will provide ample amusement.

As pointed out above, the learning of the mother tongue is essentially the work of imitation. The process is roughly as follows: The child hears a particular sound used by another, and gradually associates it with the object, the occurrence, the situation, with which it again and again occurs. When this stage is reached he can understand the word-sound as used by another, though he can not as yet use it. Later (by a considerable interval) he learns to connect the particular sound with the appropriate vocal action required for its production. As soon as this connection is formed, his sign-making impulse imitatively appropriates it by repeating it in circumstances similar to those in which he has heard others employ it.

The imitation of others' articulate sounds begins very early, and long before the sign-making impulse appropriates them as true words. The impulse to imitate others' movements seems first to come into play about the end of the fourth month, and traces of imitative movements of the mouth in articulation are said to have been observed in certain cases about this time. But it is only in the second half year that the imitation of sounds becomes clearly marked. At first this imitation is rather of tone, rise and fall of voice, apportioning of stress or accent, than of articulate quality; but gradually the imitation takes on a more definite and complete character.*

Toward the end of the year in favorable cases true linguistic imitation commences—that is to say, word-sounds gathered from others are used as such. Thus a boy of ten months would correctly name his mother "mamma," his aunt "addie" (aunty), and a person called Maggie "Aggie." † This imitative reproduction of others' words synchronizes roughly at least with the first onomatopoetic imitation of natural sounds.

As is well known, the first tentatives in the use of the common speech forms are very rough. The child, in reproducing, transforms, and these transformations are often curious and sufficiently puzzling.

The most obvious thing about these first infantile renderings of the adult's language is that they are a simplification. To begin with, a child is at first incapable of reproducing the complex sound structures which we call a word. He tends to cut it down. At the start, indeed, it seems almost a general rule that the word is reduced to a monosyllabic form. Thus biscuit becomes "bik," candles "ka," bread and butter "bup" or "bu," and so forth.

The formidable word periwinkle was shortened to "pinkle," and the no less difficult handkerchief was reduced by the eldest child of a family to "hancisch," by the next two to "hamfisch," and by the last two to "hanky."

There seems to be no simple law governing these reductions of verbal masses. The accentuated syllable, by calling for most attention, is commonly the one reproduced, as when nasturtium became "turtium." The initial and final sounds seem to have an advantage in this competition of sounds, the former as being the first (compare the way in which we note and remember the initial sound of a name), the latter as the last heard and therefore best retained. The lingual facility of the several sound-combinations, and the consequent interest of a quasi-æsthetic kind in

* Preyer's boy gave the first distinct imitative response to articulate sound in the eleventh month. This is, so far as I can ascertain, behind the average attainment.

† Tracy. The Psychology of Childhood, p. 71.

these combinations, probably have an influence in determining what look like the capricious preferences of the child.*

Such simplification of word-forms is soon opposed and largely counteracted by the growth of a feeling for the general form of the word, including the degree of its syllabic complexity, as well as the distribution of accent and the accompanying modulations of tone or pitch. The child's first imitations of the sounds, e. g., "all gone" by "a-a," or "a-ga," with rising and falling inflection, illustrate the co-operation of this feeling. Hence we find, in general, an attempt to reproduce the number of syllables with the proper distribution of accent. Thus biscuit becomes "bítchic"; cellar, "sítto"; umbrella, "nobélla"; elephant, "étteno" or (by a German child) "ewebón"; kangaroo, "kógglegoo"; hippopotamus, "ippen-pótany"; and so forth.†

Along with the cutting down of the syllabic series there goes from the first a considerable alteration of the single constituent sounds. The vowel sounds are rarely omitted, yet they may be greatly modified, and these modifications occur regularly enough to suggest that the child finds certain nuances of vowel sounds comparatively hard to reproduce. Thus the short *ă* in hat and the long *i* (*ai*) seem to be acquired only after considerable practice. Many of the consonantal sounds, as the sibilants *s*, *sh*, the liquids *l*, *r*, the aspirates *h*, *th*, and others, as *j* and, in rare cases at least, *g*, appear to cause difficulty at the beginning of the speech period. Such sounds are frequently dropped, no other sound being substituted, and this holds good especially when the difficult sound is in combination with another which can be articulated. Thus in the early stages poor becomes "poo"; look, "ook"; stair, "tair"; trocken (German), "tokko"; dance (sibilant), "dan"; schlafen (German), "lafen." Along with these omissions there go curious substitutions, presumably of easier sounds, but not necessarily of sounds which strike our ear as similar. Thus drum is changed into "gum," whereas by another child gum is given as "dam"; thread is given as "shad"; trop (French) as "crop"; pussie as "poofee"; sleepy as "feepy"; Lampe (German) as "Bampe"; bannisters as "bannicars." ‡

These substitutions illustrate the growing feeling for sound-

* Recent psychological experiments show that similar influences are at work when a person attempts to repeat a long series of verbal sounds, say ten or twelve nonsense syllables.

† Here again we see a similarity between a child's repetition of a name heard and an adult's attempt to repeat a long series of syllabic sounds. In the latter case also there is a general tendency to preserve the length and form of the whole.

‡ It has been noted by Sir F. Pollock that sometimes a consonantal sound is introduced where there was none in order to assist in the pronunciation of an initial vowel sound which by itself would be difficult.

form, that is, for the length of the sound-names and the number of principal sound-elements, together with the distribution of voice-stress or accent. Little heed is paid at first to the articulate quality of the sounds. Thus certain sounds, as the labials, are used as drudges and made to stand for a great diversity of sound. Sometimes a guttural sound, as *k*, is put to a like general vicarious service.

How much more important is the general form of the sound-name than the particular order of sounds is seen in the fact that after articulation has become differentiated and the several sounds are repeated with an approach to accuracy, the order is frequently altered. An early example of such transposition noted in the case of one child was the use of "hoogshur" for sugar.

One very interesting feature in these transformations is the strong tendency to reduplication. We notice the tendency to repeat sounds in the first "la-la" stage of articulation, and a like tendency shows itself in the later linguistic stage. Monosyllables are frequently doubled, as in the familiar "gee-gee," "ba-ba," "ni-ni" (nice thing). Some children frequently turn monosyllables into reduplications, making book "boom-boom," and so forth. It is, however, in attempting dissyllables that the reduplication is most common. Thus naughty becomes "na-na"; faster, "fa-fa"; Julia, "dum-dum," and so forth, where, the repeated syllable serves to retain something of the original word-form. In some cases the second and unaccented syllable is selected for reduplication, as in the instance quoted by Perez—"peau-peau" for chapeau.

These early reduplications, which, as is well known, have their parallel in many of the names of the languages of savage tribes,* are sometimes said to be the result of a kind of physiological inertia, the tendency to go on doing what has been begun. But it is probable that the repetition of a sound gives pleasure to the child as a form of sound-harmony or assonance. This supposition is borne out by the fact that the child, in repeating the words uttered by others, frequently assimilates two sounds. Thus he will sometimes alter the first of two sounds so as to assimilate it to the second. In one case thick was pronounced as "kik," and the name Anna received an initial consonant so as to become the reduplication "Na-na." In some cases assonance is secured by altering the final sound. "If" (writes a mother) "a word began with a labial, he generally concluded it with a labial, making bird, for example, 'bom.' In certain instances even the vowel sounds will be modified so as to produce a kind of assonance, as when 'bonnie Dundee' was rendered by 'bun dun.'"

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* See Tylor, Primitive Culture, vol. i, p. 198.

Along with this tendency to reduplication we see a disposition to use particular syllabic sounds, as the final "ie." Thus sugar becomes "sugie"; picture, "pickie"; and so forth. One child was so much in love with this syllable as to prefer it to the common repetition of sound in onomatopoetic imitation, naming the hen not "tuck-tuck," as one might expect, but "tuckie."

I have here given only a very rough account of children's first tentatives in the use of their mother tongue. As yet the facts do not admit of an exact general description. As already suggested, the seizing of the precise shade of an infantile vowel or consonant requires the finely trained ear, and probably a good deal of this part of child observation will have to be reconsidered.*

The facts being as yet but imperfectly observed and classified, it would be premature to offer anything in the way of a complete and final explanation. A difficulty here arises from the circumstance already noted that, according to Preyer, the child in his spontaneous babbling produces most if not all of our common language sounds and others too. This may turn out to be an exaggeration; yet at any rate it is a fact that certain sounds, as *l* and *r*, which occur in the first impulsive babbling, appear to give difficulty later on. How comes this to pass? In order to open up the way to an answer we must look for a moment a little more closely at the process of imitative speech. The later linguistic utterance of a sound differs from and is a much more complex affair than the earlier and impulsive utterance. It is the result of a volition which involves a mental association between the ear's impression of a particular sound, or the idea answering to this, with the idea of the required vocal or articulatory action. Thus a child could not say "poo," in imitation of his nurse's "poo," till the hearing of this sound had got connected, by means of nervous attachments in the brain, with an idea or representation of what its larynx and lips have to do in uttering this sound "poo." Nor could he utter it alone in order to name an object until the *idea* of the sound had entered into this connection.

Now a child might go on hearing the sounds of others forever and never be able to speak, unless he happened by some fortunate circumstance to produce the requisite articulate movements and so find out how the several varieties of sound are obtained. And this is precisely what the early aimless and largely emotional babbling effects. It makes the child acquainted with his own articulate powers, their modifications, and the particular sound-effects which respectively follow these.

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* One of the most painstaking attempts to describe infantile sounds with scientific exactness is that of Sir F. Pollock in his notes On an Infant's Progress in Language. Mind, vol. iii, p. 392 *seq.*

This being so, the reason why a child imitates some of our language sounds correctly, others not, is somewhat doubtful. Thus it may arise because the articulatory apparatus has lost a part of its primordial skill; or because among the sounds which have to be reproduced and which prompt and guide the articulatory movements, some are better singled out and remembered than others; or again, because, owing to the unequal frequency of occurrence of certain sounds, the central nervous connections and corresponding mental association involved are established more quickly in the case of certain sounds than of others. It seems to be commonly held that the first is at all events the main reason, and this conclusion is supported by the fact that all children alike appear to find certain sounds (the labials) easy and others difficult. At the same time it is pretty certain that the environment lends material help in determining unknowingly what sounds shall be first grasped and reproduced. It may be added that the child's preferential interest in certain sounds and sound combinations, as well as in certain objects, as nurse, the dog, which it especially wants to name, plays a subordinate part in determining the common order of lingual progress as well as its variations in the case of different children. A lady writes to say that she is often surprised at the appearance of difficult sound combinations in the talk of her boy. When twenty-two months old he mastered the formidable task of saying "scissors," no doubt, as she remarks, owing to the special interest he had developed about this time in cutting up paper.

As already suggested, the liberties which the child allows himself in using our speech are of philological interest. The subject has been touched on by more than one writer. The phonetic reductions, substitutions, and transpositions of baby-language appear to have their counterpart in the changes which go on in the history of languages. Thus M. Egger points out that when a child says "crop" for "trop," "cravailler" for "travailler," he is reproducing the change which Latin words have undergone in becoming French, as when "tremere" is transmuted into "craindre." Pollock reminds us that when his daughter uses *d* for the unmanageable *r*, she is reversing the process by which the Bengalee transforms the Sanskrit *d* into an *r* sound. The reduplications again, and the use of certain final syllables, as the caressing diminutive "ie," appear to reflect habits of adult language. A further working out of those analogies belongs to the sciences of phonetics and linguistics.*

* Children's defective pronunciation has been elaborately compared by Preyer with abnormal speech defects (*op. cit.*, 18 cap.). There seems, no doubt, to be a certain resemblance between the two; yet Preyer's attempts to show a complete parallelism are somewhat forced.

As I have dwelt at some length on children's defective articulation, I should like to say that their early performances, so far from being a discredit to them, are very much to their credit. I, at least, have often been struck with the sudden bringing forth without any preparatory trial of difficult combinations, and with a wonderful degree of accuracy. Indeed, the precision which a child, even in the second year, will often give to our vocables is quite surprising, and reminds me of the admirable exactness which, as I have observed, other strangers to our language, and more especially perhaps Russians, introduce into their articulation, putting our own loose treatment of our language to the blush. This precision, acquired without, as it would seem, any tentative practice, points, I suspect, to a good deal of silent rehearsal, nascent graspings of muscular actions, which are not carried far enough to produce sound.

The gradual development of the child's articulative powers, as represented partly by the precision of the sounds formed, as also by their differentiation and multiplication, is a matter of great interest. At the beginning, when the child is able to reproduce only a small portion of a vocable, there is, of course, but little differentiation. Thus it has been remarked by more than one observer that one and the same sound (so far, at least, as our ears can judge) will stand for different lingual signs, "ba" standing in the case of one child for both basket and sheep ("ba," lamb), and "bo" for box and bottle. Little by little the sounds grow differentiated into a more definite and perfect form; and it is curious to note the process of gradual evolution by which the first rude attempt at articulate form gets improved and refined. Thus writes a mother: "At eighteen to twenty months 'milk' was 'gink,' at twenty-one months it was 'ming,' and at soon after two years it was a sound between 'mik' and 'milk.'" The same child, in learning to say "lion," went through the stages "un" (one year and eight months), "ion" (two years), and "lion" (two years and eight months). Again, to quote one of Preyer's examples, "grosspapa" (grandpapa) began as "opapa," this passed into "gropapa," and this again into "grosspapa." In another case given by Schultze the word "wasser" (pronounced "vasser") went through the following stages: first, "vavaff"; second, "fafaff"; third, "vaffvaff"; "fourth, "vasse"; and fifth, "vasser." In this last we have an interesting illustration of a struggle between the imitative impulse to reproduce the exact sound and the impulse to reduplicate or repeat the sound, this last being very apparent in the introduction of the second *v* and the *ff* in the first stage, in the substitution of the *f*'s for *v*'s under the influence of the dominant final sound in the second stage. The student of the early stages of language-growth might, one imagines, find many suggestive parallels in these developmental changes in children's articulation.

The rapidity of articulatory progress might be measured by a careful noting of the increase in the number of vocables mastered from month to month. Although Preyer and others have given lists of vocables used at particular ages and parents have sent me lists, I have met with no methodical record of the gradual extension of the articulate field. It is obvious that any observations under this head, save in the very early stages, can only be very rough. No observer of a talkative child, however attentive, can make sure of all the word-sounds used. It is to be noted, too, as I have been assured by parents, that a child will sometimes show that he can master a sound, and will even make temporary use of it, without retaining it as a part of the permanent linguistic stock.*

It is now time to pass from the mechanical to the logical side of this early child-language, to the meanings which the small linguist gives to his articulate sounds, and the way in which he modifies these meanings. The growth of child-speech means a concurrent progress in the mastery of word-form and in the acquisition of ideas. In this each of the two factors aids the other, the advance of ideas pushing the child to new uses of sounds, and the growing facility in word-formation reacting powerfully on the ideas, giving them definition of outline and fixity of structure. I shall not attempt here to give a complete account of the process, but content myself with touching on one or two of its more interesting aspects.

I have pointed out that a child, in imitating the speech of others, does so by associating the sound heard with the object, situation, or action in connection with which others are observed to use it. But the first imitation of words does not show that the little mind has seized their full and precise meaning. A clear and exact apprehension of meaning comes but slowly, and only as the result of many hard thought-processes, comparisons, and discriminations.

It is now recognized that a child's first imitative talk, which might be described as monepic or single-worded—as "wow-wow," "dow" (down)—is essentially vague in so far as the word-sound used covers a number of our meanings. Thus "wow-wow" may mean "the dog is there," or "the dog is doing something," or "I

* As samples of the observations the following may be taken: A friend tells me his boy, when one year old, used just fifty vocables. The performances vary greatly. One American girl of twenty-two months had sixty-nine, whereas another, about the same age, had one hundred and thirty-six—just twice the number. A German girl, eighteen months old, is said by Preyer to have used one hundred and nineteen words, and to have raised this to four hundred and thirty-five in the next six months. The composition of these early vocabularies will occupy us presently.

want (or, possibly, don't want) the dog." These words are "sentence-words"—that is, they are meant to convey a whole process of thought. Only the thought is as yet only half formed or germinal in the degree of its differentiation. Thus it is fairly certain that when the child wants you to sit down and says "dow," it does not clearly realize the relation which you and I understand under that word, but merely has a mental picture of you in the position of sitter.

In these first attempts to use our speech the child's mind is innocent of grammatical distinctions. These arise out of the particular uses of words in sentence structure, and of this structure the child has as yet no inkling. If, then, following a common practice, I speak of a child of twelve or fifteen months as *naming* an object, the reader must not suppose that I am ascribing to the baby mind a clear grasp of the function of what grammarians call nouns (substantives). All that is implied in this way of speaking is that the infant's first words are used mainly as recognition signs. There is from the first, I conceive, even in the gesture of pointing and saying "da!" a germ of this naming process.

The progress of this first rude naming or articulate recognition is very interesting. The names first learned are either those of individuals, what we call proper names, as mamma, nurse, or those which, like "bath," "wow-wow," are at first applied to one particular object. It is often supposed that a child uses these as true singular names, recognizing individual objects as such; but this is pretty certainly an error. He has no clear idea of an individual thing as yet; and he will, as occasion arises, quite spontaneously extend his names to other individuals, as we see in his lumping together other men with his sire under the name "papa."

This extension of names or generalizing process proceeds primarily and mainly by the discovery of the likenesses among things, though, as we shall see presently, their connections of time and place afford a second and subordinate means of expansion. The transference of a name from object to object through the discovery of a likeness or analogy has been touched on in another chapter. It moves along thoroughly childish lines, and constitutes one of the most striking and interesting of the manifestations of precocious originality. Yet, if unconventional in its mode of operation, it is essentially thought activity, a connecting of like with like, and a rudimentary grouping of things in classes.

This tendency to comprehend like things or situations under a single articulate sign is seen already in the use of the early indicative sign "atta" (all gone). It was used by Preyer's child to mark not only the departure of a thing, but the putting out of a flame; later on, for an empty glass with nothing in it. By another child it was extended to the ending of music, the closing of a drawer, and so on. Here, however, the various applications probably answer to a common feeling, that of "all over," and do not involve a proper process of intellectual assimilation or apprehension of likeness.

Coming to what we should call names, we find that the child will often extend a recognition sign from one object to a second, and to our thinking widely dissimilar, object through a vague feeling of analogy. Such extension, moving rather along poetic lines than those of our logical classification, is apt to wear a quaint metaphorical aspect. A star, for example, looked at, I suppose, as a small bright spot, was called by a child an "eye." Dr. Romanes's child extended the word "star," the first vocable learned after "mamma" and "papa," to bright objects generally—candles, gas, flames, etc. Here we have plainly a rudimentary process of classification. Taine speaks of a child of one year who, after first applying the word "fafer" (from "*chemin de fer*") to railway engines, went on to transfer it to a steaming coffee-pot and everything that hissed or smoked or made a noise. Any point of likeness, provided it is of sufficient interest to strike the attention, may thus secure the extension of the name.

As with names of things, so with those of actions. The crackling noise of the fire was called by one child "barking," and the barking of a dog was named by another "coughing." We see from this that the particular line of analogical extension followed by a child will depend on the nature of the first impressions or experiences which serve as his starting point.

A like originality is apt to show itself in the first crude attempt to seize and name the relations of things. The child C—— called dipping bread in gravy, "ba"—bath. Another child extended the word "door" to "everything that stopped up an opening or prevented an exit, including the cork of a bottle and the little table that fastened him in his high chair." The extension of the word "mend" to making and keeping whole or right, which I find to be common among children, is another quaint example of how the child mind first essays to set forth the relations wholeness and its opposite.

In this last instance we see an example of childish concretism, as it has been called—viz., the tendency to make use of a concrete idea in order to express a more abstract idea. Children frequently express the contrast big, little, by the pretty figurative language "mamma" and "baby." Thus a small coin was called by an American child a "baby dollar." Romanes's daughter, named Ilda, pointed out the sheep in a picture as "mamma-ba," and the lambs as "Ilda-ba." It is somewhat the same process when the child extends an idea obtained from the most impressive experience of childish difficulty—viz., "too big," so as to make it express the abstract notion "too difficult" in general.

In this extension of language by the child we may discern, along with this play of the feeling for similarity, the working of association. This is illustrated by the case of Darwin's grandchild, who, when just beginning to speak, used the common sign "quack" for duck, then extended it to water; following up this associative transference by a double process of generalization, using the sound so as to include all birds and insects on the one hand and all fluid substances on the other.* The transference of the name from the animal to the water is a striking example of the tendency of the young mind to view things which are presented together as belonging one to another and in a manner identical. Another curious instance is given by Prof. Minto, in which a child who applied the word "mambro" to her nurse went on to extend it by associative transference to the nurse's sewing machine, then by analogy applied it to a hand-organ in the street, then through an association of hand-organ with monkey to its India-rubber monkey, and so forth. Here we have a whole history of changes of word-meaning, illustrating in curious equal measure the play of assimilation and of association, and falling within a period of two years.†

There seems to be a like impulse to identify things which are closely conjoined in experience, as the extension of the word "spend" by the boy C—— so as to make it cover the idea of "costing." In like manner a child has been known to use "learn" for teach. In other cases we see a similar tendency to transfer a name from cause to effect, and *vice versa*. Thus, a little girl of four called her parasol when blown by the wind "windy," and the stone that made her hand sore a "very sore stone." In all these cases of transference it is evident that we have to do with two parts of a whole process, two aspects of one relation.

Here, again, one suspects the child is illustrating a common tendency in the growth of language. The etymological connection between the words teach and learn in German (*lehren, lernen*) shows that the human mind is apt to give a common name to closely related things. A west-of-England yokel still talks of "learning me"—i. e., "teaching me."

There is much, indeed, in the whole of these changes introduced by the child into our language which may remind one of the changes which go on in the growth of languages in commu-

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* Quoted by Romanes, Mental Evolution in Man, p. 283.

† Logic (University Extension Manuals), pp. 83, 84.

nities. Thus the child's metaphorical use of words, his setting forth of an abstract by some analogous concrete image, has its counterpart, as we all know, in the early stages of human language. Tribes which have no abstract signs employ a metaphor exactly as the child does. Our own language preserves the traces of this early figurative use of words; as in the "imbecile" (weak), which originally meant leaning on a staff, and so forth.* Similarly we may trace in the development of languages the counterpart of these processes by which children spontaneously broaden out the denotation of their names. The word "sun" has only quite recently undergone this kind of extension by being applied to other centers of systems besides our familiar sun. The multiplicity of meanings of certain words, as "post," "stock," and so forth, point to the double process of assimilative and associative extension which we saw illustrated in the use of the child's word "mambro."

The changes here touched upon have to do with what philologists call generalization. As supplementary to these there is in the case of the growth of a community language a process of specialization, as when "physician," from meaning a student of Nature, has come to mean one who has acquired and can practically apply one branch of Nature-knowledge. In the case of the child we have an analogue of this in the gradual limitation of such a sound as "papa" to one individual. The mental process underlying specialization of words—viz., the gradual differentiation or marking off of narrower classes—shows itself in a very interesting feature of child and savage language, viz., the invention of new compound words.

These new compounds are open metaphors. Thus in the case already mentioned the calling of an eyelid an eye-curtain is a metaphorical way of speaking of the lid by likening it to a curtain. Another example is the compound "foot-wing" invented by the child C—— to describe the limb of a seal. A slightly different kind of metaphoric formation is the pretty name tell-wind, which a boy of four years and eight months hit upon as a name for a weather vane.

In these and similar cases there is at once an analogical transference of meaning (e. g., from curtain to lid) or process of generalization, and a limitation of meaning by the appended or qualifying word ("eye")—that is to say, a process of specialization.

In certain cases the analogical extension gives place to ordinary classing. One child, for example, knowing the word steamship, and wanting the name sailing ship, invented the form "wind ship."

* See Trench's account of poetry in words. On the Study of Words, lecture vi.

It might be supposed that the qualifying or determining word might come just as naturally after the generic name as before it, as in the French *moulin à vent, cygne noir*. I have heard of one child who used the form "mill-wind" in preference to "windmill." It would be worth while to note any similar instances.

In these inventions, again, we may detect a close resemblance between children's language and that of savages. In presence of a new object a savage behaves very much as a child; he shapes a new name out of familiar ones, a name that commonly has much of the metaphorical character. Thus the Aztecs called a boat a "water house"; and the Vancouver islanders, when they saw a screw steamer, called it the "kick-kicke." *

A somewhat different class of word inventions is that in which a child frames a new word on the analogy of known words. The more common case is the invention of new substantives from verbs after the pattern of other substantives. The results are often quaint enough. Sometimes it is the agent who is named by the new word, as when the boy C—— talked of the "Rainer," or the fairy who makes rain. Sometimes it is the product of the action, as when the same child C—— and the deaf-mute Laura Bridgman both invented the form "thinks" for "thoughts." Similarly, a boy of three called the holes which he dug in his garden his "digs." The reverse process, the formation of a verb from a substantive, also occurs. Thus one child invented the form "dag" for striking with a dagger; and Preyer's boy, when two years and two months old, formed the verb "*messen*," to express "cut," from the substantive *Messer* (a knife). This readiness to form verbs from substantives, and *vice versa*, which is abundantly illustrated in the development of community language, is without doubt connected with the primitive and natural mode of thinking. The object is of greatest interest to a child as to primitive man as an agent, or as the last stage or result of an action.

In certain of these original formations we may detect a fine feeling for verbal analogy. Thus, a French boy, after killing the *limaces* (snails) which were eating the plants in the garden, dignified his office by styling himself a "*limacier*," where the inventive faculty was no doubt led by the analogy of *voiturier* formed from *voiture*. †

In certain cases these original constructions are of a more clumsy order, and due to a partial forgetfulness of a word and an effort to complete it. The same little boy who talked of his

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* Tylor, Anthropology, chapter v. In the case of the Chinese and of every savage language, the specific or "attributive" word precedes and does not follow the generic or substantive word.

† Compayré, *op. cit.*, page 249, where other examples are given.

"digs," used the word "magnicious" for magnificent. This is a choice example of word transformation. Very probably the child was led by the feeling for the dignity of this termination in other "grand" words, as "ambitious." Possibly, too, he might have heard the form "magnesia" and been influenced by a reminiscence of this sound-complex. The talk of "Jeames," with which Mr. Punch makes us acquainted, is full of just such delightful missings of the mark in trying to reproduce big words.

A DAY'S HUNTING AMONG THE ESKIMOS.*

By FRIDTJOF NANSEN.

KAIAK hunting has many dangers.

Though his father may have perished at sea, and very likely his brother and his friend as well, the Eskimo nevertheless goes quietly about his daily work, in storm no less than in calm. If the weather is too terrible, he may be chary of putting to sea; experience has taught him that in such weather many perish; but when once he is out he goes ahead as though it were all the most indifferent thing in the world.

Let us follow the Eskimo on a day's hunting.

Several hours before dawn he stands upon the outlook rock over the village, and scans the sea to ascertain whether the weather is going to be favorable. Having assured himself on this point, he comes slowly down to his house and gets out his kaiak jacket. His breakfast in the good old days consisted of a drink of water; now that European effeminacy has reached him too, it is generally one or two cups of strong coffee. He eats nothing in the morning; he declares that it makes him uneasy in the kaiak, and that he has more endurance without it. Nor does he take any food with him—only a quid of tobacco.

When the kaiak is carried down to the beach and the hunting weapons are ranged in their places, he slips into the kaiak hole, makes fast his jacket over the ring, and puts out to sea. From other houses in the village his neighbors are also putting forth at the same time. It is the bladder-nose that they are after to-day, and the hunting ground is on some banks nine miles out to the open sea.

It is calm, the smooth sea heaves in a long swell toward the rocky islets that fringe the shore, a light haze still lies over the

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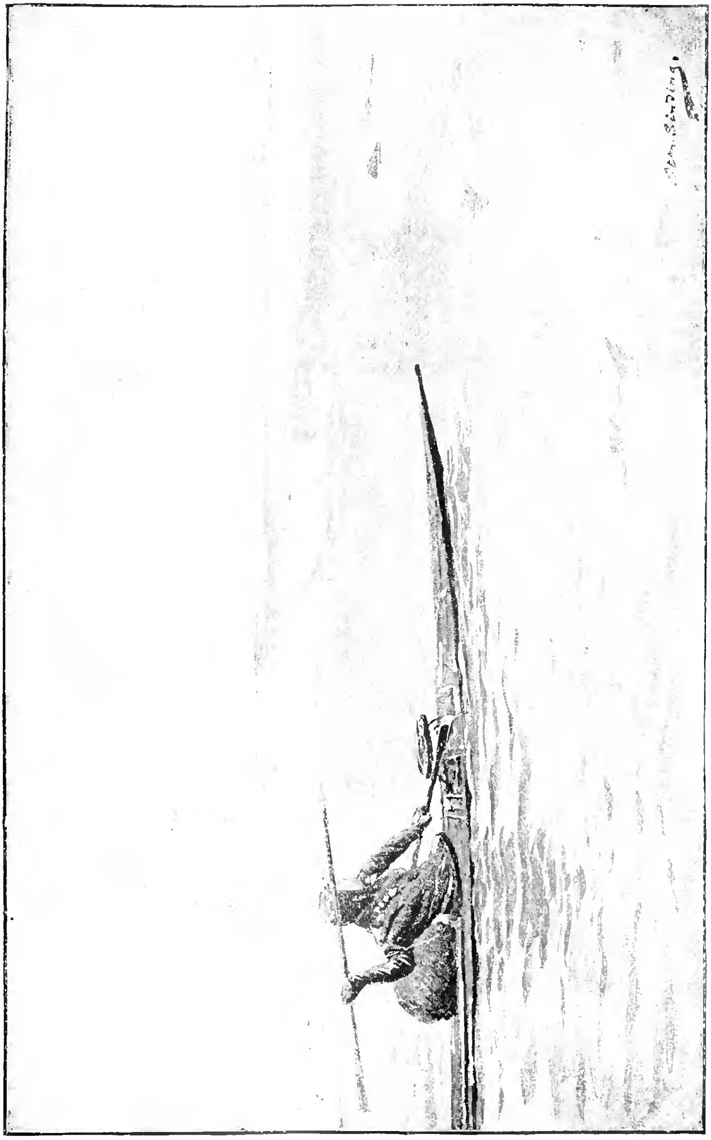
* Both the illustrations and the text of this article are reprinted from Eskimo Life, by Dr. Fridtjof Nansen, with the kind permission of the publishers, Messrs. Longmans, Green & Co.

sounds between them, and the sea birds floating on the surface seem double their natural size. The kaiaks cut their way forward, side by side, making only a silent ripple; the paddles swing in an even rhythm, while the men keep up an unbroken stream



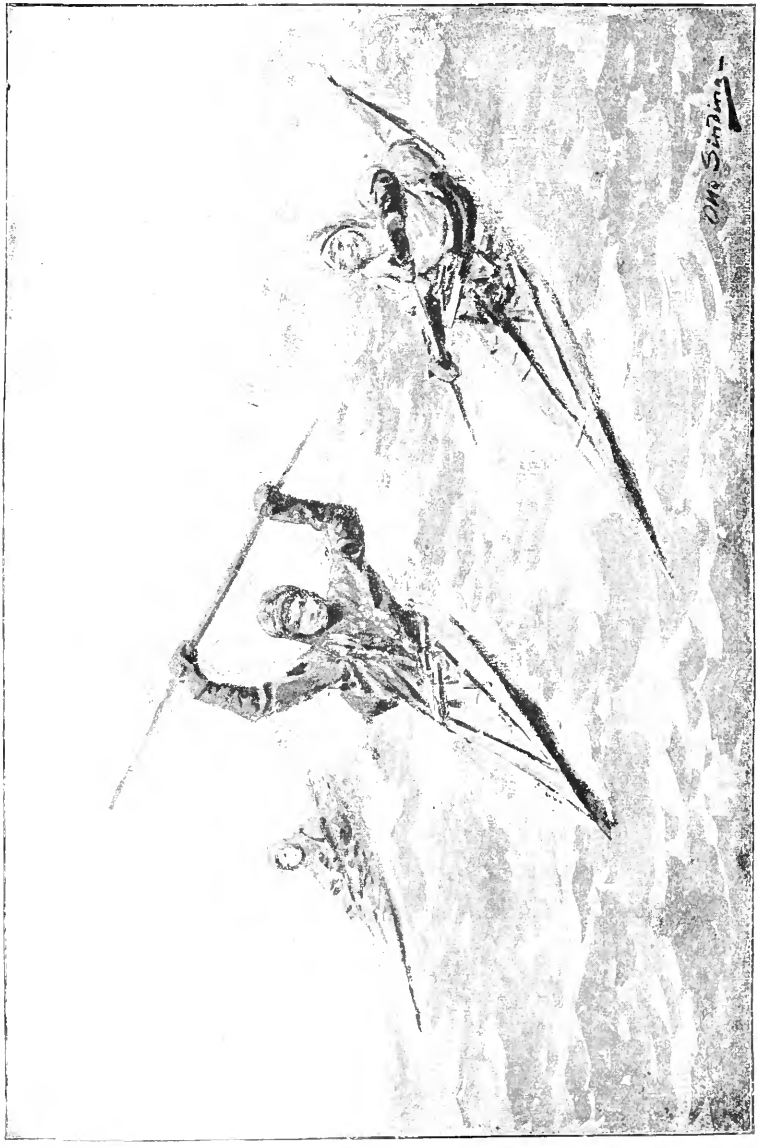
SEAL-HUNTING.

of conversation, and now and then burst out into merry laughter. Bird-darts are thrown in sport, now by one, now by another, in order to keep eye and hand in practice. Presently an auk comes within range of one of them; the dart speeds through the air, and the bird, transfixed, attempts, with much flapping of wings, to dive, but is held up next moment upon the point of the dart. The point is pulled out, the hunter seizes the bird's beak between his teeth, and with a strong twitch breaks its neck, then fastens it to the back part of the kaiak.

They soon leave the sounds and islets behind them and put straight out to the open sea.

After some hours' paddling, they have at last reached the hunting ground. Great seal heads are seen peering over the water in many directions, and the hunters scatter in search of their prey.

Boas, one of the best hunters of the village, has seen a large he-seal far off, and has paddled toward it; but it has dived, and he lies and waits for its reappearance. There! a little way before him its round black head pops up. He bends well forward, while with noiseless and wary strokes he urges the kaiak toward the seal, which lies peaceful and undisturbed, stretching its neck and rocking up and down upon the swell. But suddenly it is on the alert; it has caught a glimpse of the flashing paddle blade, and now looks straight at him with its great round eyes. He instantly stops paddling and sits motionless, while the way on the kaiak carries it noiselessly forward. The seal discovers nothing new to be alarmed at, and resumes its former quietude. It throws its head backward, holds its snout straight up in the air, and bathes in the morning sun which gleams upon its black, wet skin. In the meantime the kaiak is rapidly nearing; every time the seal looks in that direction, Boas sits still and moves no muscle; but as soon as it turns its head away again, he shoots forward like a flash of lightning. He is coming within range; he gets his harpoon clear, sees that the line is properly coiled upon the stand; one stroke more and it is time to throw—when the seal quietly disappears under the water. It was not frightened, and will consequently come up again at no great distance. He lies still and waits. But the minutes drag on; a seal can remain under water an incredible time, and it seems even longer to one who is waiting for his prey. But the Eskimo is gifted with admirable patience; he lies absolutely motionless except for his head, with which he keeps watch on every side. At last the seal's head once more appears over the water a little way off and to one side. He cautiously turns the kaiak, unobserved by his prey, and once more he shoots toward it over the mirrorlike sea. But suddenly it catches sight of him again, looks at him sharply for a moment, and dives. He knows its habits, however, and at full speed he dashes toward the spot where it disappeared. Before many moments have passed it pops up its head again to look around. Now he is within range: the harpoon is seized and carried back over his shoulder, then with a strong movement, as if hurled from a steel spring, it rushes whistling from the throwing stick, whirling the line behind it. The seal gives a violent plunge, but at the moment it arches its back to dive, the harpoon sinks into its



Before the Wind.

side and buries itself up to the shaft. A few convulsive strokes of its tail churn the water into foam, and away it goes, dragging the harpoon line behind it toward the depths. In the meantime Boas has seized the throwing stick between his teeth and, quicker than thought, has thrown the bladder out of the kaiak behind him. It dances away over the surface of the sea, now and then seeming on the point of disappearing, as indeed it finally does. Before long, however, it again comes in sight, and he chases after it as quickly as his paddle can take him, snapping up on his way his harpoon shaft which has floated to the surface. The lance is laid ready for use. Next moment the seal comes up; infuriated at its inability to escape, it turns upon its pursuer, attacks first the bladder, which it tears to pieces, and then goes straight for the kaiak. Again Boas is within range; the animal arches its back and hurls itself forward with gaping maw, so that the water foams around it. A miss may now cost him his life; but he calmly raises his lance and sends it speeding with terrible force through the seal's mouth and out at the back of its neck. A shudder runs through it, and its head sinks; but the next moment it raises itself perpendicularly in the water, the blood pours frothing from its mouth, it gapes wildly and utters a smothered roar, while the hood over its nose is inflated to an astounding size. It shakes its head so that the lance shaft quivers and waves to and fro; but it does not succeed in breaking it or getting free from it. A moment more and Boas's second lance has pierced through one of its fore flappers into its lungs; the seal collapses and the fight is over. He paddles up to its side, and, as it still moves a little, he gives it a finishing stab with his long-handled knife. Then he sets quietly about pulling out his lances and replacing them in the kaiak, takes out his towing line and blows up his towing bladder, which he fastens to the seal, cuts the harpoon head out and once more makes it fast to the shaft, coils the line on the stand, and takes out a new bladder and places it behind him. Next, the seal's flappers are lashed close to its body with the thong designed for that purpose, and the animal is attached by means of the towing line to one side of the kaiak, so that it can easily be towed along, its head being fastened to the foremost pair of thongs on the deck and its tail to the hindmost. Now Boas is ready to look about him for more game. He is lucky, and has not paddled far before he catches sight of another seal. In an instant he has cast loose the one already killed, which is kept afloat by the towing bladder, while he again sets off in pursuit. This one, too, he kills, after some wary stalking and eager waiting; he takes it in tow and returns for his first prey. The two great animals are fastened one on each side of the kaiak. He has now a good cargo, and can not get very quickly through the water; but that does not prevent him from increasing his bag. As soon as another seal comes in sight those already secured are cast loose, and when the next one is killed it is fastened behind the others. In this way one man will sometimes come towing as many as four seals, or even more at a pinch.

Tobias, in the meantime, another of the best hunters of the village, has not been quite so fortunate as Boas. He began by chasing a seal which dived and did not come up again within sight. Then he set off after another; but as he is skimming over the sea toward it, the huge head of a hooded seal * suddenly pops up right in front of the kaiak, and is harpooned in an instant. It makes a frightful wallowing and dives, the harpoon line whirls out, but suddenly gets fouled under the bird-dart throwing stick; the bow of the kaiak is drawn under with an irresistible rush, and before Tobias knows where he is, the water is up to his armpits, and nothing can be seen of him but his head and shoulders and the stern of the kaiak, which sticks right up into the air. It looks as if it were all over with him; those who are near him paddle with all their might to his assistance, but with scant hope of arriving in time to save him. Tobias, however, is a first-rate kaiak man. In spite of his difficult position, he keeps upon even keel while he is dragged through the water by the seal, which does all it can to get him entirely under. At last it comes up again, and in a moment he has seized his lance and, with a deadly aim, has pierced it right through the head. A feeble movement, and it is dead. The others come up in time to find Tobias busy making his booty fast, and to get their pieces of blubber from it.† They can not restrain their admiration for his coolness and skill, and speak of it long afterward. Tobias and Boas, however, are the best hunters of the village. It is related of them that, in their younger days, they were such masters of their craft that they even disdained the use of bladders. They made fast the harpoon line round their own waist or round the kaiak ring, and when the harpooned seal was not killed at the first stroke they let it drag themselves and the kaiak after it instead of the bladder. This is looked upon by the Greenlanders as the summit of possible achievement, but there are very few who attain such mastery.

The hunting is often more dangerous than that described above. It will easily be understood that from his constrained position in the kaiak, which does not permit of much turning, the hunter can not throw backward or to the right. If, then, a wounded seal suddenly attacks him from these quarters, it requires both skill and presence of mind to elude it or to turn so quickly as to aim a fatal throw at it before it has time to do him

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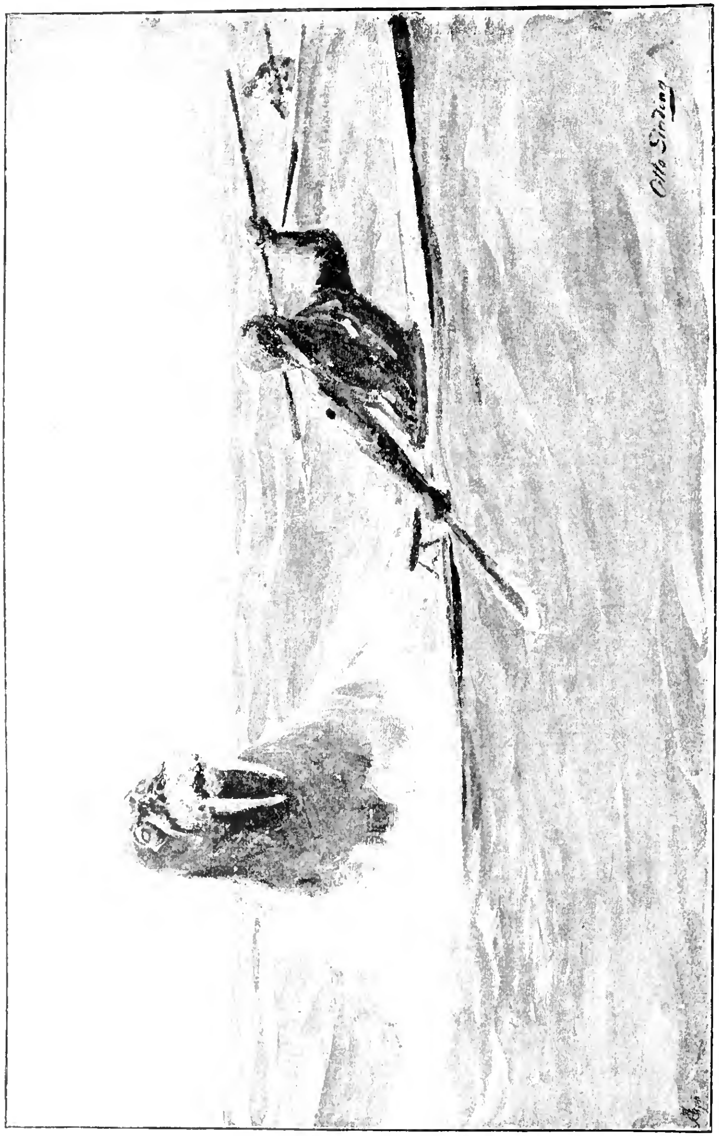
* *Hættesæl*, the full-grown male of the *Klapmyts* (bladder-nose). It has a hood over its nose, which it can inflate enormously.

† When a seal is killed, each of the kaiak men in the neighborhood receives a piece of its blubber, which he generally devours forthwith.

damage. It is just as bad when he is attacked from below, or when the animal suddenly shoots up close at his side, for it is lightninglike in its movements, and lacks neither courage nor strength. If it once gets up on the kaiak and capsizes it, there is



A KAIAK MAN ATTACKED BY A WALRUS.

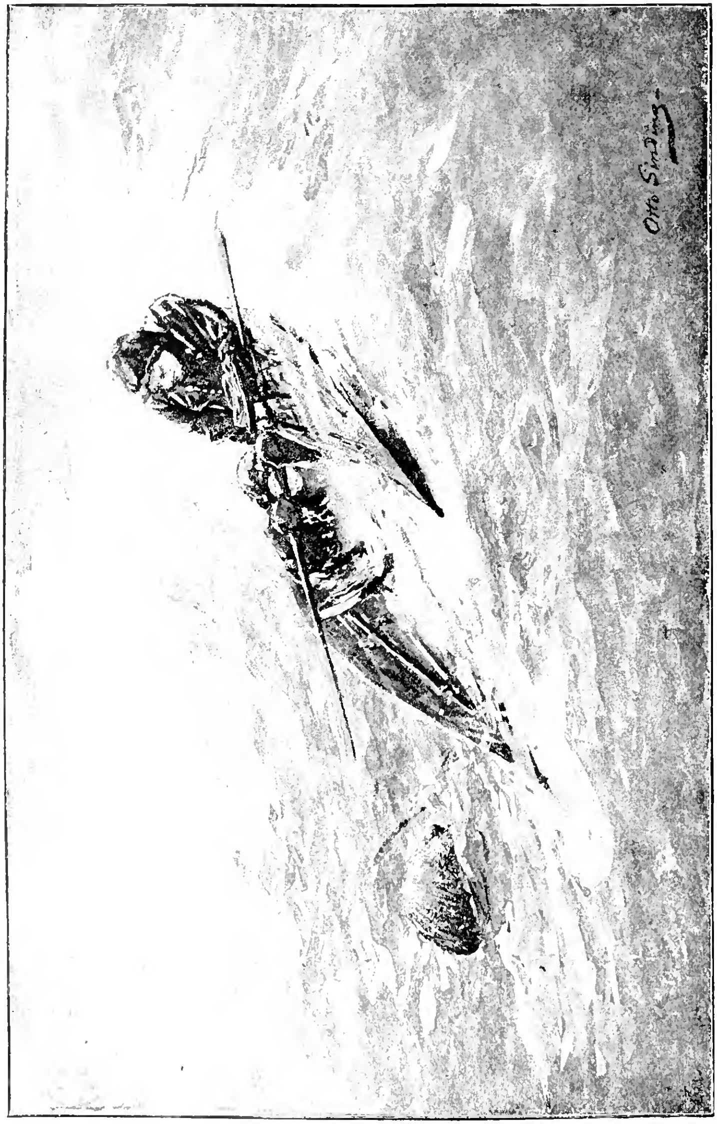
little hope of rescue. It will often attack the hunter under water, or throw itself upon the bottom of the kaiak and tear holes in it. In such a predicament it needs very unusual self-mastery to preserve the coolness necessary for recovering one's self upon even keel and renewing the fight with the furious adversary. And yet it sometimes happens that after being thus capsized the kaiak man brings the seal home in triumph.

A still more terrible adversary is the walrus; therefore there are generally several in company when they go walrus-hunting, so that one can stand by another if anything should happen. But often enough, too, a single hunter will attack and overcome this monster.

Hitherto the weather has been fine, the glassy surface of the sea has been heaving softly under the rising sun. But in the course of the last hour or two black and threatening banks of clouds have begun to draw up over the southern horizon. Just as Tobias has made fast his seal, a distant roar is heard and a sort of steam can be seen rising over the sea to the southward. It is a storm approaching, and the steam is the flying spray which it drives before it. Of all winds, the Greenlanders fear the south wind (*nigek*) most, for it is always violent and sets up a heavy sea.

The thing is now to get under the land as quickly as possible. Those who have no seals in tow have the best of it, yet they try to keep with the others. One relieves Boas of one of his seals. They have not paddled far before the storm is upon them; it thrashes the water to foam as it approaches, and the kaiak men feel it on their backs, like a giant lifting and hurling them forward. The sport has now turned to earnest; the seas soon tower into mountains of water and break and welter down upon them. They are making for the land with the wind nearly abeam; but they are still far off, they can see nothing around them for the spray, and almost every wave buries them so that only a few heads, arms, and ends of paddles can be seen above the combs of froth.

Here comes a gigantic roller—they can see it shining black and white in the far distance. It towers aloft so that the sky is almost hidden. In a moment they have stuck their paddles under the thongs on the windward side and bent their bodies forward so that the crest of the wave breaks upon their backs. For a second almost everything has disappeared; those who are farther a-lee await their turn in anxiety; then the billow passes, and once more the kaiaks skim forward as before. But such a sea does not come singly; the next will be worse. They hold their paddles flat to the deck and projecting to windward, bend their bodies forward, and at the moment when the white cataract thunders down upon them they hurl themselves into its very jaws, thus somewhat breaking its force. For a moment they have again disappeared—then one kaiak comes up on even keel, and presently another appears bottom upward. It is Pedersuak (i. e., the big Peter) who has capsized. His comrade speeds to his side, but at the same moment the third wave breaks over them and he must look out for himself. It is too late—the two kaiaks lie heaving bottom upward. The second manages to right himself, and his first thought is for his comrade, to whose assistance he once more



A Kaiak Man rescuing a Comrade.

hastens. He runs his kaiak alongside of the other, lays his paddle across both, bends down so that he gets hold under the water of his comrade's arm, and with a jerk drags him up upon his side, so that he too can get hold of the paddle and in an instant raise himself upon even keel. The water-tight jacket has come a little loose from the ring on one side and some water has got in; not so much, however, but that he can still keep afloat. The others have in the meantime come up; they get hold of the lost paddle, and all can again push forward.

It grows worse and worse for those who have seals in tow; they lag far behind, and the great beasts lie heaving and jarring against the sides of the kaiaks. They think of sacrificing their prey, but one difficult sea passes after another, and they will still try to hang on for a while. The proudest moments in a hunter's life are those in which he comes home towing his prey, and sees his wife's, his daughter's, and his handmaiden's happy faces beaming upon him from the shore. Far out at sea he already sees them in his mind's eye, and rejoices like a child. No wonder that he will not cast loose his prey save at the direst pinch of need.

After passing through many ugly rollers, they have at last got under the land. Here they are somewhat protected by a group of islands lying far to the southward. The seas become less violent, and as they gradually get farther in they push on more quickly for home over the smoother water.

In the meantime the women at home have been in the greatest anxiety. When the storm arose they ran up to the outlook rock or out upon the headlands, and stood there in groups gazing eagerly over the angry sea for their sons, husbands, fathers, and brothers. So they stand watching and shivering, until, with eyes rendered keener by anxiety, they at last discern what seem like black specks approaching from the horizon, and the whole village echoes to one glad shout: "They are coming! They are coming!" They begin to count how many there are; two are missing! No, there is one of them! No, they are all there! They are all there!

They soon begin to recognize individuals, partly by their method of paddling, partly by the kaiaks, although as yet they are little more than tiny dots. Suddenly there sounds a wild shout of joy: "Boase kaligpok!" ("Boas is towing")—him they easily identify by his size. This joyful intelligence passes from house to house, the children rush around and shout it in through the windows, and the groups upon the rocks dance for joy. Then comes a new shout: "Ama Tobiase kaligpok!" ("Tobias too is towing"); and this news likewise passes from house to house. Next is heard: "Ama Simo kaligpok!" "Ama David kaligpok!" And now again comes another swarm of women out of the houses and up to the rocks to look out over the sea breaking white against the islets and cliffs, where eleven black dots can now and then be seen far out amid the rolling masses of water, moving slowly nearer.

At last the leading kaiaks shoot into the little bight in front of the village. They are those who have no seals. Lightly and with assured aim one after the other dashes up on the flat beach, carried high upon the crest of the waves. The women stand ready to receive them and to draw them farther up.

Then come those who have seals in tow; they must proceed somewhat more cautiously. First, they cast loose their prey and see that it comes to the hands of the women on shore. Then they themselves make for the land. When once they have got out of the kaiak they, like the first comers, pay no heed to anything but themselves and their weapons, which they carry to their places above high-water mark. They do not even look at their prey as it lies on the shore. From this time forward all work in connection with the "take" falls to the share of the women.

The men go to their homes, take off their wet clothes, and put on their indoor dress, which, as we have seen, was in the heathen times exceedingly airy, but has now become more visible.

Then at last comes the first meal of the day; but it does not begin in earnest till the day's "take" is boiled and served up in a huge dish placed in the middle of the floor. Then there disappear incredible quantities of flesh and raw blubber.

When hunger is appeased, the women always set themselves to some household work, sewing or the like, while the men give themselves up to well-earned laziness, or attend a little to their weapons, hang up the harpoon line to dry, and so forth.

NATURE'S TRIUMPH.

By JAMES RODWAY, F. L. S.

IN the temperate regions of the world man overcomes Nature, but in the tropics he makes little or no impression. The Indian has lived in the great forest of South America for ages, yet hardly a trace of his presence can be found. The ordinary traveler sees no sign of him for perhaps a hundred miles, and would be inclined to say that nothing but a desolate wilderness had ever existed. Yet, if we believe the early travelers, the coast from the river Orinoco to the Amazon was once fairly well peopled. The powerful Carib—the savage of "Robinson Crusoe"—was guardian of the coast, and strong enough to repel every invasion of the Spaniard, while the gentle Arawak—"Man Friday"—occupied the upper reaches of every little creek.

Even where the country is not deserted the Indian villages are still hid away in the virgin forest, the inhabitants and their palm-covered shelters harmonizing with everything around. Unlike the clearing of a plantation, they make no impression on the forest; they form a part of one great whole, every portion of which has accommodated itself to every other. Tropical man does not rule Nature, but is himself a part of her great domain.

The old Dutch sugar planter with his slaves made little more impression on the forest than the savage. True, his clearing was larger and lasted as long as his struggle with Nature was kept up; but when, finding out the superior fertility of the coast lands, he abandoned it and retired, the forest quickly incorporated it with herself. For about a hundred miles up the Berbice and Demerara Rivers the banks were once lined with plantations; now, beyond some ten miles, every one of these has reverted to dense forest, here and there only a few negro huts indicating that man still lives there, like the Indian, without making any real impression.

The stages in the onward march of the forest over a clearing are most interesting. Perhaps two or three hundred acres had been planted with sugar canes, and fifty in plantains, vegetables, and fruit. There would be a fair-sized dwelling house, a water or cattle sugar mill, huts for the negroes, and a wharf on the river bank. The planter decided to give up the place, as he had an offer of a more fertile piece of land on the coast. Taking away everything portable, including the machinery of his mill, he abandoned the rest, carried away his negroes, and left the clearing to Nature.

Let us look upon the plantation a year later. Already a thicket has grown up which is only penetrable by the constant use of a cutlass. After a great deal of labor we reach the borders of the once tidy clearing. What a wonderful sight! Along the line of forest trees a dense wall of creepers rises sixty to a hundred feet high, forming an effective veil to the dark arcades beyond. From these stretch out long ropes, twining vegetable serpents, and giants' fingers, all moving toward what was once the open space. Some are hundreds of yards long, rooting at the joints, whence other branches radiate and form the dense obstruction we have cut through.

The creepers, twiners, and scramblers have not yet reached the house, but Nature is at work there also. Round it was once an orchard of oranges, limes, star apples, and other tropical fruit, with a few flowering shrubs. Most of these are now overrun with the blood-sucking loranths—vegetable leeches—which are continually draining their juices and evidently fattening on the spoil. These exotic bushes and trees have no business here; they are intruders. If man protects them and destroys their enemies they can thrive, but if he abandons them they must perish. Perhaps you are thirsty and look for an orange, but among a dozen trees not a single fruit can be found, and never will be again.

Under these trees tall, sturdy grasses rise up to your shoulders and with great straggling bushes do their best to prevent the fruit trees from gaining a living for themselves, much less for the parasites that swarm over their branches.

The house itself is almost hidden in foliage. On the brick pillars wild figs have germinated and already insinuated their aërial roots into every crevice, while their glossy stems and leaves almost cover the sides of the building. Then, that rampant creeper, the cissus (*C. sicyoides*), is running up the walls and over the roof, which it covers entirely. Clearing away the vegetation which blocks the entrance, you find the stairs falling to pieces, and only by climbing can you reach what was once the front door. After hacking with the cutlass, room is made to push through and you enter. But don't be in a hurry; take care of the flooring; hold on to the creepers until you have sounded the boards, or you may fall through. Crash! There goes one foot through the first board. Draw it up and try another. It cracks but does not yield, and as your eyes become accustomed to the half light a dark cave with brown stalactites is dimly seen. These stalactites are the aërial roots of the cissus, which have been thrown straight down through holes in the roof, and now spread great masses of fibers over the floor, some finding their way into cracks and joints and thence to the earth below. In the corners of the rooms are great oval brown masses, the nests of termites or wood ants, the inhabitants of which are hard at work tunneling every board and rafter until they will become so brittle as to almost fall to pieces by their own weight. Ultimately, when the house frame is thus weakened, the structure will be only kept in shape by its wild figs and creeper stems, the roof will fall in, and the whole become an intricate jungle of interlacing stems.

A few years later trees have grown up to smother the creepers, and only an expert can say that a clearing once existed here.

If an estate of several hundred acres can be so easily effaced, what shall we say of the ordinary squatter's clearing? On the upper Demerara River are hundreds of little settlements in the possession of negroes and half-Indians. Some are crowded with fruit trees struggling with a thick and almost impregnable undergrowth, which is partly cleared now and then to admit of picking the fruit. Near the river stands the dwelling house—a shed thatched with palm leaves—on either side of which will be one or two calabash trees to supply the substitute for plates and dishes which is so indispensable. On these grow scarlet rodriguezias and other small orchids, while even a specimen of the "baboon's throat" (*Coryanthes*) or "thick-leaf parasite" (*Oncidium lanceanum*) may have been put up in the forks. If there are any young girls in the house, there will probably be a few dracænas, crotons, or perhaps a hibiscus planted beside the path from the river.

Immediately behind is the forest, reaching out its hands, as it were, to embrace the little half-clearing. Whiplike extensions of scrambling vines stretch over the fruit trees and bring one after another under their canopy. The occupier of this little paradise sees little of what is going on and cares less. Like the Indian, he considers weeding a part of the woman's duties, while the creole woman has very loose ideas on this matter. If there are children, they crave for fruit, and are disappointed when none is to be obtained; but even if they knew the reason they could hardly be expected to do anything. The man at last begins to see how the jungle is advancing, and looks on helplessly. To fight with such a tangle is too hard for the man of the tropics; he would rather make a fresh clearing. At last the house is surrounded and the creepers run over the thatch. Probably the uprights have already been attacked by wood ants and threaten to give way. A new house must be built, and this can be done better on a fresh clearing; so the place is abandoned, and Nature again triumphs. A few months later and the landing is choked, the house fallen, and the jungle impenetrable.

The plantations before mentioned belonged to the upper districts, and were abandoned a century or more ago. There have been, however, many large estates near the mouths of the rivers and along the coasts given up during the last fifty years. No matter how large the clearing, if it is in the forest region, it must ultimately be obliterated. Here and there a brick chimney is seen peeping above the level of the forest, but otherwise there is not the slightest appearance from outside that this was once a flourishing sugar plantation. Examine it carefully, however, and you will find what at first sight appeared to be virgin forest only "second growth." This consists of fast-growing, soft-wooded trees, which in the struggle for life have outstripped the more hard timber trees of the forest proper.

Cut a way through the dense jungle on the river side, and if you are a skillful bushman the site of the house and buildings may be found. Above everything else stands the brick chimney, but what a transformation! It is so covered with wild fig roots as to be almost indistinguishable, while the top is decorated with an immense bush which will ultimately develop into a tree. Around the base of the shaft the remains of boilers and other ironwork have colored the soil, and among these may be seen broken bricks, slates, and glass. Look round carefully, and perhaps you may find the family burying place. Here are tombs with marble slabs, cracked and broken by the slow but powerful leverage of the fig roots, and by putting the pieces together you may perhaps read that *Hier legt begraven den Wel Edele Gestrenge Heer* ——. The despotic owner of all he surveyed—land, animals, men, women, and children—is now gone, and Nature has spurned his handiwork under her feet.

Outside the forest region and near the coast is a line of swamps, and on the rich alluvium reclaimed from these the sugar, cotton, and coffee plantations of the present century were established. Several hundred have been abandoned at different times, but these do not become incorporated with the forest. From the swamp they were reclaimed, and to that state they have mostly returned.

When in cultivation the estate is walled in, as it were, with earthen dams on every side, those at the back and front being most important. By means of the former the swamp water is kept out and by the latter the sea, while the inclosed area is freed from the heavy rainfall by means of sluices and draining engines. When abandoned these arrangements soon get out of order. The outfalls are choked, the dams are perforated by crabs or broken down by floods, and soon the ground becomes more and more sodden. The sugar-cane plants which were left in the ground sprout freely, but, as they now have to compete with a rampant host of weeds, they are unable to cover the ground, but grow in isolated patches. This, of course, allows their enemies all the more scope, and the competition soon becomes serious. The delicate Bahama grass (*Cynodon dactylon*) comes first and overruns the surface, but this has soon to give way to a lot of wiry, prickly shrubs which are fitted to grow almost anywhere. These include black sage (*Varronia curassavica*), prickly solanums, sensitive plants, and wild indigo. As they steal their nourishment from the soil, the canes never become strong enough to smother them, but languish more and more until obliged to succumb. By this time the seeds of a number of straggling bushes and trees have found their opportunity, and the clammy cherry (*Cordia*), hog-plum (*Spondias*), and wild fig come up here and there, growing very quickly and partly ousting out the smaller plants. Alongside the draining canals thickets of prickly shrubs and scrambling vines soon make their appearance, and, as they grow, obstruct the outflow of water more and more. Then, as the water rises after a day's rainfall of perhaps seven or eight inches, the front dam is washed away and the sea comes over at the next spring tide, filling the trenches in front with brackish water. The courida (*Avicennia*) and mangrove (*Rhizophora*) which guard the shore now advance, and with them an army of beach weeds, including that triply armed invader, the nicker (*Guilandina bonducella*). Soon crabs perforate every part of the sea dam, and the whole front becomes a great mangrove swamp.

While this transformation has been taking place in front, Nature has not been inactive behind. There is a large body of water in the swamps always trying to find an exit, and it is only by strict attention to the slightest breach that the planter keeps his estate from getting inundated. Now, of course, there is no one to attend to this matter, and when the heavy rains fall the flood carries down the weakened dam and makes a greater inundation behind than there is in front. The canes, which have hitherto managed to exist after a fashion, now rot, and with them go the Bahama grass and some of the other weeds which only live on comparatively dry land. These, however, are soon replaced by a host of sedges, grasses, and marsh shrubs which make as impenetrable a jungle as the others. Now the vegetation forms two distinct zones, that in front comprising littoral plants; and behind, those of the fresh-water savanna.

Rarely, however, is an estate on the coast allowed to revert entirely to its pristine condition, as there is generally a public road to be kept up which necessitates a proper sea dam. It follows, therefore, that the mangrove swamp is kept outside the boundary line and the abandoned plantation is partially drained to prevent danger to the road from floods aback. In such cases the vegetation is not so rampant, but it is still far beyond anything seen in temperate climates. Every trench is filled with water plants, and the land is overrun with sour grass (*Paspalum conjugatum*). This grass, which is the pest of every pasture in the wet season, covers a waterlogged plantation almost to the exclusion of everything else. During the rains it is ahead of everything, and it is only during a drought that it languishes a little. Then, the Bahama grass and a few other weeds find room for a small show, to be again vanquished, however, as the next wet season sets in. Where once was the battlefield of man and Nature is now the scene of an annual struggle between two great armies of plants. Man fought against both, and they maintained a most gallant defense, only retiring inch by inch. Now they have both rushed in to fight each other for the mastery.

For some time after the plantation has been abandoned the lines of the draining trenches, and even the geometrical shape of the cane beds, can still be traced, but when there is nothing in the way of the flood, either in front or behind, these soon fill up or sink to one uniform level. It is, however, sometimes possible to find relics of the plantation buildings, as the *débris* often rises above the level of other portions of the estate. The bricks and all other materials of any value were removed prior to its abandonment, but there were always heaps of rubbish not worth carting away, and these remain, covered with weeds, to tell the investigator of some future age what manner of people lived here. Even if the whole plantation has become a swamp, these heaps form little islands amid the ooze, and, in a very dry season, when the savanna has been burned, they stand up like the mounds of the Caribs, to which they are somewhat analogous.

To understand this analogy, we must go back to some past age long before the discovery of America. The original coast line of British Guiana is now some twenty miles inland; but ages ago, no doubt, the present sand-reefs were washed by the ocean. The great rivers brought down sand, mud, and vegetable matter in solution, as they do to-day. These suspended and dissolved substances were deposited in the shape of sandbanks and shoals and became little islands. To these the cannibals retired from all enemies, and enjoyed their horrible feasts in seclusion and without fear, in the way so well described by Defoe.

Under mounds of sand, covered with forest trees, the remains of the Carib's feast can still be found and recognized. These mounds are most common in the northwestern district of British Guiana—the *Canibalor Terra* of the early voyagers and the *Caribana* of Raleigh. Some are situated several miles from the present coast line, and were probably occupied for many years, as the heaps of shells, bits of pottery, stone weapons, and, most horrible of all, human bones broken for the marrow, must have taken a long time to accumulate. Now they are hidden in the virgin forest, and only by accident have a few been discovered. Nature has triumphed, and the Carib is virtually extinct.

In one respect the savage leaves a more lasting record of his former presence than the white man. The steel knife or axe crumbles away under the influence of heat and moisture, and even the great iron sugar pan throws off thick flakes of oxide until it falls into dust. But the stone axe of the Indian is as lasting as the rock itself, and might be safely said to be an imperishable record. Gold-diggers not infrequently come upon them at depths of six or eight feet in our river bottoms, and they are found in canal excavations as well as in the cannibal mounds. In Guiana they are not necessarily ancient, as they were in use everywhere up to three centuries ago, and are still utilized in shaping pottery. Even a century ago it would not have been hard to find some of them put to their proper use—i. e., to scrape away the charred portions of wood in excavating a canoe.

Besides the mounds and stone implements, the educated eye sees other evidences of the Indian's presence at some former time. The Arawak in the past, as in the present, generally made his settlement on a sand reef, and hardly a creek is without indications of his former presence. A stranger is so bewildered with the great tangle of vegetation, and the variety of form and color in leaf and flower, that he can hardly perceive these traces; but the naturalist's attention is arrested at once.

From the creek there is a gentle ascent to a slight elevation, where the aspect of the vegetation differs somewhat from its surroundings. Here is a clump of pineapples, and close by an impenetrable thicket of krattee, the material from which hammock and bow strings were made. Look a little closer, and perhaps a few variegated caladiums or scarlet-flowered belladonna lilies (*Hippeastrum equestre*), or even a specimen of the giant reed (*Gynerium saccharoides*), may be seen. A stranger, seeing the beauty of form and color, might wonder how they came there; but the naturalist can say at once that here, in some past time, was an Indian settlement, and these are his footprints.

It might also be thought from these relics of the red man's presence that he understood the decorative value of plants and flowers. Such, however, is not the case; for, although he formerly painted his skin with red, dark blue, and white pigments, and, like a child, was fond of staring colors, he did not grow these handsome leaves and flowers to satisfy such a taste. He does not wear garlands, although he undoubtedly has a most delicate taste in the arrangement of feathers for his headdress and waist-belt. As for his women, they—with the exception of a bead apron, on which is worked a pretty geometrical pattern—never decorate themselves in any way. Why, then, do they grow these lilies and caladiums? The answer shows one of the most interesting sides of the Indian character.

They are *beenas*, or charms, to make them good hunters, fishermen, or shooters. The beena notion pervades the Indian's whole life, as providing meat is his duty above everything else. There seems to be no rule in regard to the choice of beenas, except that their use must always be painful. The most universal, and that which seems to have a general application, is the nose beena, a whip made of *eta* fiber, which is put up one of the nostrils and drawn through the back of the mouth. This is used when a boy reaches manhood, to make him skillful in all his operations. Then there are particular beenas for every animal—the jaguar, tapir, peccary, labba, and even birds and fishes. The beautiful suffused crimson variety of *Caladium bicolor* is the jaguar beena, and other blotched and spotted kinds and the lilies are used for different quadrupeds. If the Indian hunter fails in shooting a particular animal and returns home without meat, he is dejected, and appears to think some virtue has gone out of him. The beast has got the better of the man, and he must renew his strength. To do this, he digs up a root of caladium or lily, and, after slashing himself with a knife on breast and arms, rubs the acrid juice into the wounds. Of course, the operation is very painful, but he does not mind that; the more excruciating the torture the better the charm is working. Next day he goes forth into the forest with renewed confidence, and is likely to be more successful on that account alone.

However, we are wandering away from our subject, and must return to the traces of man's presence in the forest. If the little spot on the sand hill has been recently abandoned, a dark patch of humus shows where the *benab* or hut once stood, and this will be covered with prickly solanums and other weeds, from which the bare white sand in the neighborhood is entirely free. Sometimes narrow paths into the forest or down to the creek can still be discerned by the careful observer, even after very long periods, as the comparatively barren sand reef does not obliterate every trace so quickly as does the forest. It may be possible even to find the way to what was once the cassava field—now either an impenetrable jungle or apparently virgin forest. It winds through and under the trees, where a little light has been able to penetrate, obstructed by young trees or crossed by bush-ropes, but fairly conspicuous in the darker arcades. If you succeed in finding the field, and it has been abandoned for only two or three years, the jungle is impenetrable; while after twenty, except for the absence of very large trees, it is unrecognizable.

The plants we have mentioned as indicators of man's presence at some former period are never found truly wild in the forest. They have been—we were going to say cultivated, but that would be a misstatement—grown by the Indians for ages, and are now so thoroughly naturalized as to exist apart from his presence. If the top of a pineapple is thrown down beside the path, it will be sure to grow if there is sufficient light and the soil is porous. It thus becomes an indicator of old tracks over the sand reefs, and will sometimes enable the lost wanderer to retrace his footsteps. Even the forest itself is intersected with tracks which often lead the hunter astray, and give him great trouble to find the right way on his return. Some are almost effaced, others conspicuous for a short distance, and then blocked by some great tree. The path is older than the tree, and yet can be discerned in certain lights, although easily missed when looked for from a different point. Even in returning by the same track the difference in direction will often cause hesitation and doubt.

The ground in the forest is undulating, and if we follow an old track it is always obliterated in the gullies, but may be recovered on the opposite slope. Creeks and small watercourses cross it, or perhaps it stops entirely at the little stream where formerly the Indian embarked in his canoe to reach the great river. No canoe can pass now, and perhaps there is not in existence a single descendant of his tribe. Yet the track is visible, and above on the hill are pineapples and other relics of his former presence.

On the savannas of the far interior we can also find a few traces of the red man of the past. Here there are no trees, but only a low, scrubby vegetation. Slight elevations here and there are still dotted by the circular dwellings of Macusis, Wapisianos, and Arecunas; but many a mound that was once the site of a village is now deserted, and not a trace of the dwellings remains. Yet, from a distance, dependent on light and shade, indistinct foot-paths can be traced, while on the top the want of even a few scattered plants is an indication to the educated eye that a village once stood there. Then, again, there are little creeks near by, in which stepping-stones have been placed, and on one mound have been seen a number of stones arranged as an oval, which could only have been placed there by man.

Although these faint traces may be discovered when carefully looked for, the general result is a virtual obliteration of man's handiwork. No important buildings of stone have ever been erected in British Guiana, but two brick forts show what would happen if even great buildings were abandoned. One of these was deserted about the year 1740, and the other since 1812. Both have been long since hidden among the trees, and even their ruined walls are overgrown, so that it would only be possible to see them at a great expense of time and labor. Burying-grounds in different parts of the colony are in the same condition, and one in Georgetown, abandoned as late as 1840, and nominally cared for, is covered with vegetation, and its tombs almost hidden. When brought to light, as they are sometimes in the dry season by the withering of the tall grasses and weeds, what a picture of Nature's handiwork is there! Every tomb has been taken over by one or more wild figs, and their aërial roots have insinuated themselves between each brick and slab until the sides are cracked and bulged, and the tops lifted off, broken to pieces, and removed. Man's battle was continuous as long as he lived; after his death Nature triumphed.

In a paper read to the Anthropological Section of the American Association, Dr. Brinton called attention to a number of peculiarities in the human skeleton which had attracted the notice of anatomists, and which had frequently been interpreted as signs of reversion to an apelike ancestry. Most of these, however, can be explained by mechanical function, or excess or deficiency of nutrition; and when they can be so explained, this is the only interpretation they should receive. They can no longer be offered as evidence of the theory of evolution, nor considered as criteria or marks of the human races. The doctor gave a long list of such peculiarities and showed the evidence that they are the results of functional working and pathological causes.

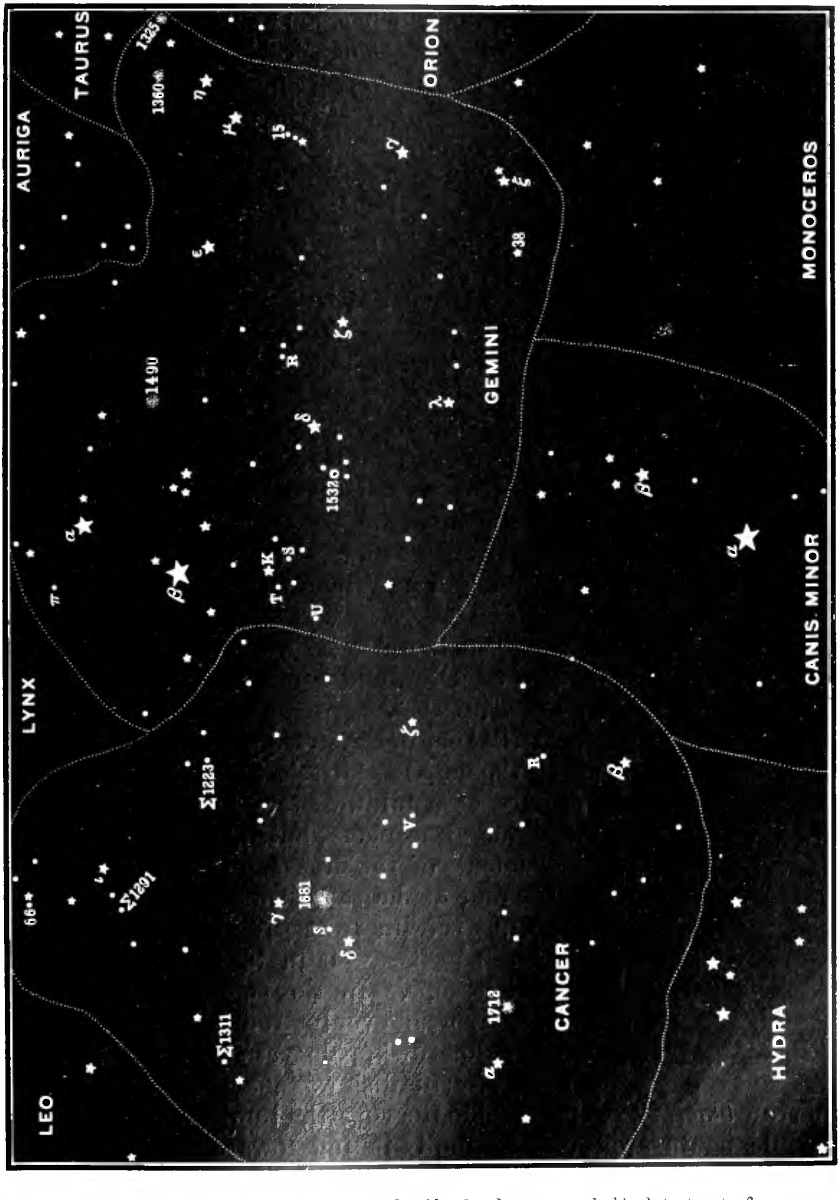
PLEASURES OF THE TELESCOPE.

By GARRETT P. SERVISS.

III.—THE STARRY HEAVENS (*continued*).

THE zodiacal constellations of Gemini, Cancer, and Leo, together with their neighbors Auriga, the Lynx, Hydra, Sextans, and Coma Berenices, will furnish an abundance of occupation for our second night at the telescope. We shall begin, using our three-inch glass, with α, the chief star of Gemini (map No. 4). This is ordinarily known as Castor. Even an inexperienced eye perceives at once that it is not as bright as its neighbor Pollux, β. Whether this fact is to be regarded as indicating that Castor was brighter than Pollux in 1603, when Bayer attached their Greek letters is still an unsettled question. Castor may or may not be a variable, but it is, at any rate, one of the most beautiful double stars in the heavens. A power of one hundred is amply sufficient to separate its components, whose magnitudes are about two and three, the distance between them being 5·8″, p. 230°. A slight yet distinct tinge of green, recalling that of the Orion nebula, gives a peculiar appearance to this couple. Green is one of the rarest colors among the stars. Castor belongs to the same general spectroscopic type in which Sirius is found, but its lines of hydrogen are broader than those seen in the spectrum of the Dog Star. There is reason for thinking that it may be surrounded with a more extensive atmosphere of that gaseous metal called hydrogen than any other bright star possesses. There seems to be no doubt that the components of Castor are in revolution around their common center of gravity, although the period is uncertain, varying in different estimates all the way from two hundred and fifty to one thousand years; the longer estimate is probably not far from the truth. There is a tenth-magnitude star, distance 73″, p. 164°, which may belong to the same system.

From Castor let us turn to Pollux, at the same time exchanging our three-inch telescope for the four-inch, or, still better, the five-inch. Pollux has five faint companions, of which we may expect to see three, as follows: Tenth magnitude, distance 175″, p. 70°; nine and a half magnitude, distance 206″, p. 90°, and ninth magnitude, distance 229″, p. 75°. Burnham has seen a star of thirteen and a half magnitude, distance 43″, p. 275°, and has divided the tenth-magnitude star into two components, only 1·4″ apart, the smaller being of the thirteenth magnitude, and situated at the angle 128°. A calculation based on Dr. Elkin's parallax of 0·068″ for Pollux shows that that star may be a hundredfold more luminous than the sun, while its nearest companion may be a body smaller than our planet Jupiter, but shining, of course, by its own light. Its distance from Pollux, however, exceeds that of Jupiter from the sun in the ratio of about one hundred and thirty to one.



Map No. 4.

In the double star π we shall find a good light test for our three-inch aperture, the magnitudes being six and eleven, distance 22″, p. 212°. The four-inch will show that κ is a double, magnitudes four and ten, distance 6″, p. 232°. The smaller star is of a delicate blue color, and it has been suspected of variability. That it may be variable is rendered the more probable by the fact that in the immediate neighborhood of κ there are three undoubted variables, S, T, and U, and there appears to be some mysterious law of association which causes such stars to group themselves in certain regions. None of the variables just named ever become visible to the naked eye, although they all undergo great changes of brightness, sinking from the eighth or ninth magnitude down to the thirteenth or even lower. The variable R, which lies considerably farther west, is well worth attention because of the remarkable change of color which it sometimes exhibits. It has been seen blue, red, and yellow in succession. It varies from between the sixth and seventh magnitudes to less than the thirteenth in a period of about two hundred and forty-two days.

Not far away we find a still more curious variable ζ; this is also an interesting triple star, its principal component being a little under the third magnitude, while one of the companions is of the seventh magnitude, distance 90″, p. 355°, and the other is of the eleventh magnitude or less, distance 65″, p. 85°. We should hardly expect to see the fainter companion with the three-inch. The principal star varies from magnitude three and seven tenths down to magnitude four and a half in a period of a little more than ten days.

With the four or five inch we get a very pretty sight in δ, which appears split into a yellow and a purple star, magnitudes three and eight, distance 7″, p. 206°.

Near δ, toward the east, lies one of the strangest of all the nebulæ. (See the figures 1532 on the map.) Our telescopes will show it to us only as a minute star surrounded with a nebulous atmosphere, but its appearance with instruments of the first magnitude is so astonishing and at the same time so beautiful that I can not refrain from giving a brief description of it as I saw it in 1893 with the great Lick telescope. In the center glittered the star, and spread evenly around it was a circular nebulous disk, pale yet sparkling and conspicuous. This disk was sharply bordered by a narrow *black* ring, and outside the ring the luminous haze of the nebula again appeared, gradually fading toward the edge to invisibility. The accompanying cut gives but a faint idea of this most singular nebula. If its peculiarities were within the reach of ordinary telescopes, there are few objects in the heavens that would be deemed equally admirable.

Wonderful Nebula in Gemini (1532).

In the star η we have another long-period variable, which is also a double star; unfortunately the companion, being of only the tenth magnitude and distant less than 1″ from its third-magnitude primary, is beyond the reach of our telescopes. But η points the way to one of the finest star clusters in the sky, marked 1360 on the map. The naked eye perceives that there is something remarkable in that spot, the opera glass faintly reveals its distant splendors, but the telescope fairly carries us into its presence. Its stars are innumerable, varying from the ninth magnitude downward to the last limit of visibility, and presenting a wonderful array of curves which are highly interesting from the point of view of the nebular origin of such clusters. Looking backward in time, with that theory to guide us, we can see spiral lines of nebulous mist occupying the space that now glitters with interlacing rows of stars. It is certainly difficult to understand how such lines of nebula could become knotted with the nuclei of future stars, and then gradually be absorbed into those stars; and yet, if such a process does not occur, what is the meaning of that narrow nebulous streak in the Pleiades along which five or six stars are strung like beads on a string? The surroundings of this cluster, 1360, as one sweeps over them with the telescope gradually drawing toward the nucleus, have often reminded me of the approaches to such a city as London. Thicker and closer the twinkling points become, until at last, as the observer's eye follows the gorgeous lines of stars trending inward, he seems to be entering the streets of a brilliantly lighted metropolis.

Other objects in Gemini that we can ill miss are: μ, double, magnitudes three and eleven, distance 73″, p. 76°, colors yellow and blue; 15, double, magnitudes six and eight, distance 33″, p. 205°; γ, remarkable for array of small stars near it; 38, double, magnitudes six and eight, distance 6·5″, p. 162°, colors yellow and blue (very pretty); λ, double, magnitudes four and eleven, distance 10″, p. 30°, color of larger star blue—try with the five-inch; ϵ, double, magnitudes three and nine, distance 110″, p. 94°.

From Gemini we pass to Cancer. This constellation has no large stars, but its great cluster Præsepe (1681 on map No. 4) is easily seen as a starry cloud with the naked eye. With the telescope it presents the most brilliant appearance with a very low power. It was one of the first objects that Galileo turned to when he had completed his telescope, and he wonderingly counted its stars, of which he enumerated thirty-six, and made a diagram showing their positions.

The most interesting star in Cancer is ζ, a celebrated triple. The magnitudes of its components are six, seven, and seven and a half; distances 1″, p. 35°, and 5·5″, p. 122°. We must use our five-inch glass in order satisfactorily to separate the two nearest stars. The gravitational relationship of the three stars is very peculiar.

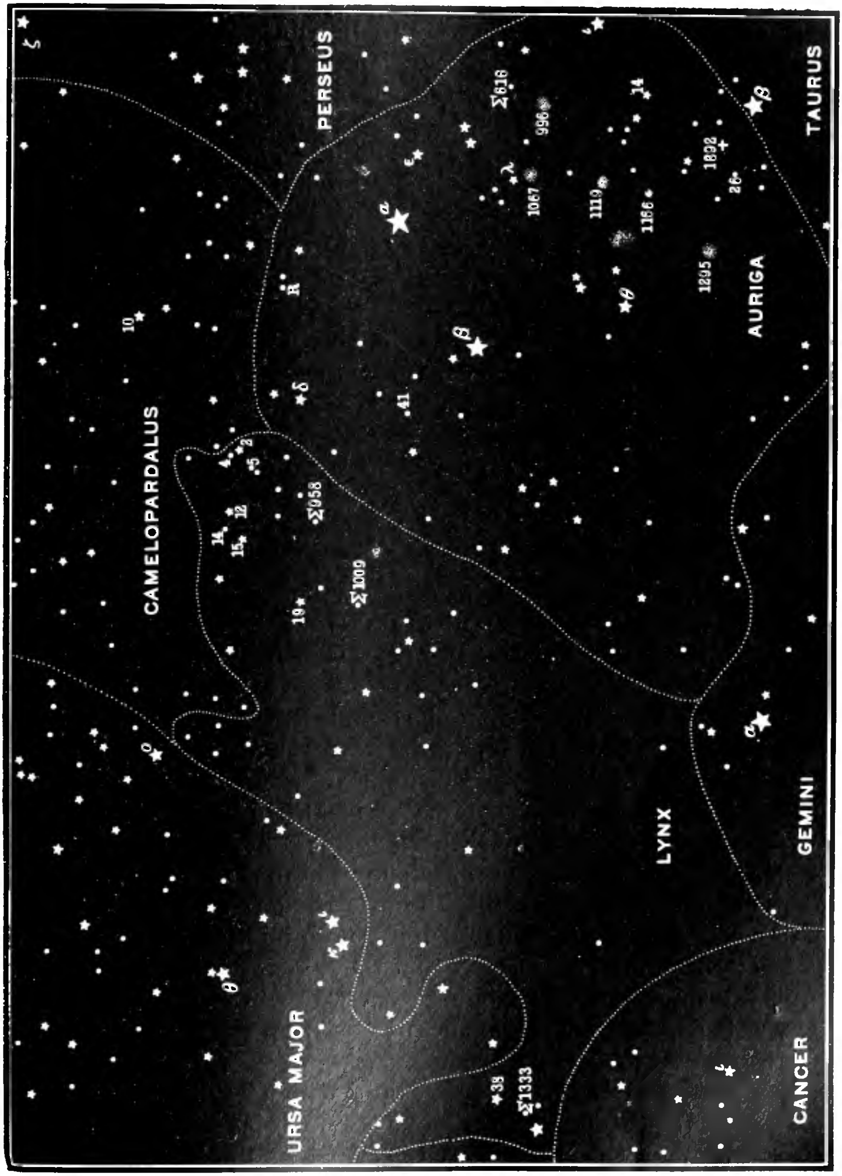
The nearest pair revolve around their common center in about fifty-eight years, while the third star revolves with the other two, around a center common to all three, in a period of six or seven hundred years. But the movements of the third star are erratic, and inexplicable except upon the hypothesis advanced by Seeliger, that there is an invisible, or dark, star near it by whose attraction its motion is perturbed.

In endeavoring to picture the condition of things in ζ Cancri we might imagine our sun to have a companion sun, a half or a third as large as itself, and situated within what may be called planetary distance, circling with it around their center of gravity; while a third sun, smaller than the second and several times as far away, and accompanied by a *black* or non-luminous orb, swung with the first two around another center of motion. There you would have an entertaining complication for the inhabitants of a system of planets!

Other objects in Cancer are: Σ 1223, double star, magnitudes six and six and a half, distance 5″, p. 214°; Σ 1291, double, magnitudes both six, distance 1·3″, p. 328°—four-inch should split it; ι, double, magnitudes four and a half and six and a half, distance 30″, p. 308°; 66, double, magnitudes six and nine, distance 4·8″, p. 136°; Σ 1311, double, magnitudes both about the seventh, distance 7″, p. 200°; 1712, star cluster, very beautiful with the five-inch glass.

The constellation of Auriga may next command our attention (map No. 5). The calm beauty of its leading star Capella awakens an admiration that is not diminished by the rivalry of Orion's brilliants glittering to the south of it. Although Capella must be an enormously greater sun than ours, its spectrum bears so much resemblance to the solar spectrum that a further likeness of condition is suggested. No close companion to Capella has been discovered, and it is not probable that any exists except, possibly, in the form of planets which no telescope can reveal. A ninth-magnitude companion, distant 159″, p. 146°, and two others, one of twelfth magnitude at 78″, p. 317°, and the other of thirteenth magnitude at 126″, p. 183°, may be distant satellites of the great star, but not planets in the ordinary sense, since it is evident that they are self-luminous. It is as ignificant fact that most of the first-magnitude stars have faint companions which are not so distant as altogether to preclude the idea of physical relationship.

While we are in Auriga we must look at the star β (Menkalina), which belongs to a peculiar order of double stars discovered within the past few years. But neither our telescopes, nor any telescope in existence, can directly reveal the duplicity of β Aurigæ to the eye—i. e., we can not see the two stars composing it, because they are so close that their light remains inextricably mingled after the highest practicable magnifying power has been applied in the effort to separate them. But the spectroscope



Map No. 5.

shows that the star is double and that its components are in rapid revolution around one another, completing their orbital swing in the astonishingly short period of *four days!* The combined mass of the two stars is estimated to be two and a half times the mass of the sun, and the distance between them, from center to center, is about eight million miles.

The manner in which the spectroscope revealed the existence of two stars in β Aurigæ is a beautiful illustration of the unexpected and, so to speak, automatic application of an old principle in the discovery of new facts not looked for. It was noticed at the Harvard Observatory that the lines in the photographed spectrum of β Aurigæ (and of a few other stars to be mentioned later) appeared single in some of the photographs and double in others. Investigation proved that the lines were doubled at regular intervals of about two days, and that they appeared single in the interim. The explanation was not far to seek. It is known that all stars which are approaching us have their spectral lines shifted, by virtue of their motion of approach, toward the violet end of the spectrum, and that, for a similar reason, all stars which are receding have their lines shifted toward the red end of the spectrum. Now, suppose two stars to be revolving around one another in a plane horizontal, or nearly so, to the line of sight. When they are at their greatest angular distance apart as seen from the earth one of them will evidently be approaching at the same moment that the other is receding. The spectral lines of the first will therefore be shifted toward the violet, and those of the second will be shifted toward the red. Then if the stars, when at their greatest distance apart, are still so close that the telescope can not separate them, their light will be combined in the spectrum; but the spectral lines, being simultaneously shifted in opposite directions, will necessarily appear to be doubled. As the revolution of the stars continues, however, it is clear that their motion will soon cease to be performed in the line of sight, and will become more and more athwart that line, and as this occurs the spectral lines will gradually assume their normal position and appear single. This is the sequence of phenomena in β Aurigæ.

Such facts, like those connecting rows and groups of stars with masses and spiral lines of nebula, present a terrible temptation to speculation; but who shall say that they do not also, like obscure signboards, indicate the opening of a way which, starting in an unexpected direction, nevertheless leads deep into the mysteries of the universe?

Southward from β we find the star θ, which is a beautiful quadruple. We shall do best with our five-inch here, although in a fine condition of the atmosphere the four-inch might suffice. The primary is of the third magnitude; the first companion is of magnitude seven and a half, distance 2″, p. 5°; the second, of the tenth magnitude, distance 45″, p. 292°; and the third, of the tenth magnitude, distance 125″, p. 350°.

We should look at the double Σ 616 with one of our larger apertures in order to determine for ourselves what the colors of the components are. There is considerable diversity of opinion on this point. Some say the larger star is pale red and the smaller light blue; others consider the color of the larger star to be greenish, and some have even called it white. The magnitudes are five and nine, distance 6″, p. 350°.

Auriga contains several noteworthy clusters which will be found on the map. The most beautiful of these is 1295, in which about five hundred stars have been counted.

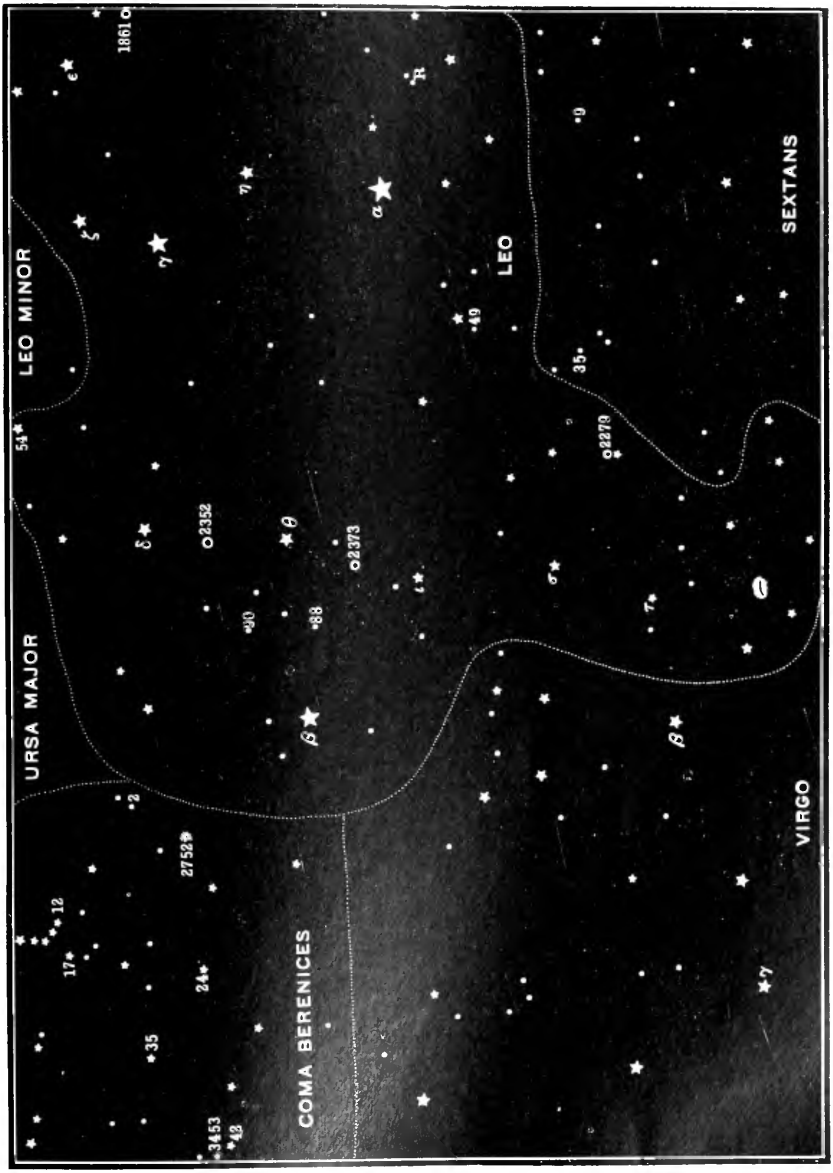
The position of the new star of 1892, known as Nova Aurigæ, is also indicated on the map. While this never made a brilliant appearance, it has given rise to a greater variety of speculative theories than any previous phenomenon of the kind. Although not recognized until January 24, 1892, this star, as photographic records prove, made its appearance about December 9, 1891. At its brightest it barely exceeded magnitude four and a half, and its maximum occurred within ten days after its first appearance. When discovered it was of the fifth magnitude. It was last seen in its original form with the Lick telescope on April 26th, when it had sunk to the lowest limit of visibility. To everybody's astonishment it reappeared in the following August, and on the 17th of that month was seen shining with the light of a tenth-magnitude star, *but presenting the spectrum of a nebula!* Its visual appearance in the great telescope was now also that of a planetary nebula. Its spectrum during the first period of its visibility had been carefully studied, so that the means existed for making a spectroscopic comparison of the phenomenon in its two phases. During the first period, when only a stellar spectrum was noticed, remarkable shiftings of the spectral lines occurred, indicating that two and perhaps three bodies were concerned in the production of the light of the new star, one of which was approaching the earth, while the other or the others receded, with velocities of several hundred miles per second! On the revival in the form of a planetary nebula, while the character of the spectrum had entirely changed, evidences of rapid motion in the line of sight remained. The nebulous speck which represents all that is left of Nova Aurigæ has not yet (February, 1895) faded from sight.

But what was the meaning of all this? Evidently a catastrophe of some kind had occurred out there in space. The idea of a collision involving the transformation of the energy of motion into that of light and heat suggests itself at once. But what were the circumstances of the collision? Did an extinguished sun, flying blindly through space, plunge into a vast cloud of meteoritic particles, and, under the lashing impact of so many myriads of missiles, break into superficial incandescence, while the cosmical wrack through which it had driven remained glowing with nebulous luminosity? Such an explanation has been offered by Seeliger. Or was Vogel right when he suggested that Nova Aurigæ could be accounted for by supposing that a wandering dark body had run into collision with a system of planets surrounding a decrepit sun (and therefore it is to be hoped uninhabited), and that those planets had been reduced to vapor and sent spinning by the encounter, the second outburst of light being caused by an outlying planet of the system falling a prey to the vagabond destroyer? Or some may prefer the explanation, based on a theory of Wilsing's, that *two* great bodies, partially or wholly opaque and nonluminous at their surfaces, but liquid hot within, approached one another so closely that the tremendous strain of their tidal attraction burst their shells asunder so that their bowels of fire gushed briefly visible, amid a blaze of spouting vapors. And yet Lockyer thinks that there was no solid or semi-solid mass concerned in the phenomenon at all, but that what occurred was simply the clash of two immense swarms of meteors that had crossed one another's track.

Well, where nobody positively knows, everybody has free choice. In the meantime, look at the spot in the sky where that little star made its appearance and underwent its marvelous transformation, for, even if you can see no remains of it there, you will feel your interest in the problem it has presented, and in the whole subject of astronomy, greatly heightened and vivified, as the visitor to the field of Waterloo becomes a lover of history on the spot.

The remaining objects of special interest in Auriga may be briefly mentioned: 26, triple star, magnitudes five, eight, and eleven, distances 12″, p. 268°, and 26″, p. 113°; 14, triple star, magnitudes five, seven and a half, and eleven, distances 14″, p. 224°, and 12·6″, p. 342°, the last difficult for moderate apertures; λ, double, magnitudes five and nine, distance 121″, p. 13°; ε, variable, generally of third magnitude, but has been seen of only four and a half magnitude; 41, double, magnitudes five and six, distance 8″, p. 354°; 996, 1067, 1119, and 1166, clusters all well worth inspection, 1119 being especially beautiful.

The inconspicuous Lynx furnishes some fine telescopic objects, all grouped near the northwestern corner of the constellation. Without a six-inch telescope it would be a waste of time to attack the double star 4, whose components are of sixth and eighth magnitudes, distance 0·8″, p. 103°; but its neighbor, 5, a fine triple, is within our reach, the magnitudes being six, ten, and eight, distances 30″, p. 139°, and 96″, p. 272°. In 12 Lyncis we find one of the most attractive of triple stars, which in good seeing weather is not beyond the powers of a three-inch glass, although we shall have a far more satisfactory view of it with the four-inch. The components are of the sixth, seventh, and eighth magnitudes, distances 1·5″, p. 122°, and 8·7″, p. 304°. A magnifying power which



Map No. 6.

just suffices clearly to separate the disks of the two nearer stars makes this a fine sight. A beautiful contrast of colors belongs to the double star 14, but unfortunately the star is at present very close, the distance between its sixth and seventh magnitude components not exceeding 0·8″, position angle 64°. Σ 958 is a pretty double, both stars being of the sixth magnitude, distance 5″, p. 257°. Still finer is Σ 1009, a double, whose stars are both a little above the seventh magnitude and nearly equal, distance 3″, p. 156°. A low power suffices to show the three stars in 19, their magnitudes being six and a half, seven and a half, and eight, distances 15″, p. 312°, and 215″, p. 358°. Webb describes the two smaller stars as plum-colored. Plum-colored suns?

At the opposite end of the constellation are two fine doubles, Σ 1333, magnitudes six and a half and seven, distance 1·4″, p. 39°; and 38, magnitudes four and seven, distance 2·9″, p. 235°.

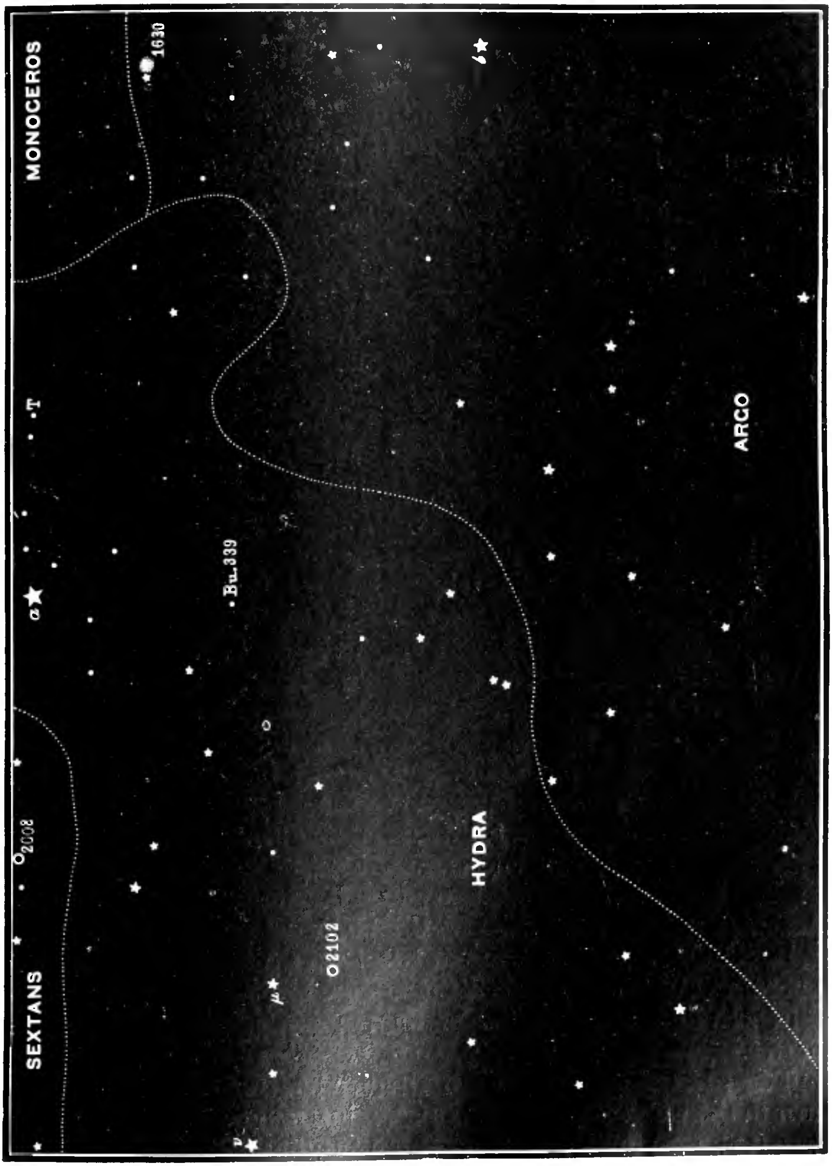
Under the guidance of map No. 6 we turn to Leo, which contains one of the leading gems among the double stars, γ, whose components, of third and fourth magnitudes, are respectively yellow and green, the green star, according to some observers, having a peculiar tinge of red. Their distance apart is 3·5″, p. 114°, and they are undoubtedly in revolution about a common center, the probable period being about four hundred years. The three-inch glass should separate them easily when the air is steady, and a pleasing sight they are.

The star ι is a closer double, and also very pretty, magnitudes four and eight, colors lemon and light blue, distance 2·7″, p. 65°. Other doubles are τ, magnitudes five and seven, distance 95″, p. 170°; 88, magnitudes seven and nine, distance 15″, p. 320°; 90, triple, magnitudes six, seven and a half, and ten, distance 3·5″, p. 209°, and 59″, p. 234°; 54, magnitudes four and a half and seven, distance 6·2″, p. 102°; and 49, magnitudes six and nine, distance 2·4″, p. 158°.

Leo contains a remarkable variable star, R, deep red in color, and varying in a space of a hundred and forty-four days from the fifth to the tenth magnitude. It has also several nebulæ, of which only one needs special mention, No. 1861. This is spindle-shaped, and large telescopes show that it consists of three nebulæ. The observer with ordinary instruments finds little to see and little to interest him in these small, faint nebulæ.

We may just glance at two double stars in the small constellation of Sextans, situated under Leo. These are: 9, magnitudes seven and eight, distance 53″, p. 292°; and 35, magnitudes six and seven, distance 6·9″, p. 240°.

Coma Berenices (map No. 6) contains several interesting objects. Let us begin with the star 2, a double, of magnitudes six and seven and a half, distance 3·6″, p. 240°. The color of the smaller star is lilac. This hue, although not extremely uncommon among double stars elsewhere, recurs again and again, with singular persistence, in this little constellation. For instance, in the very next star that we look at, 12, we find a double whose smaller component is *lilac*. The magnitudes in 12 are five and eight, distance 66″, p. 168°. So also the wide double 17, magnitudes five and a half and six, distance 145″, exhibits a tinge of *lilac* in the



Map No. 7.

smaller component; the triple 35, magnitudes five, eight, and nine, distances 1·3″, p. 61°, and 28·7″, p. 124°, has for colors yellow, *lilac*, and blue, and the double 24, magnitudes five and six, distance 20″, p. 270°, combines an orange with a *lilac* star, a very striking and beautiful contrast. We should make a sad mistake if we regarded this wonderful distribution of color among the double stars as accidental. It is manifestly expressive of their physical condition, although we can not yet decipher its exact meaning.

The binary 42 Comæ Berenicis is too close for ordinary telescopes, but it is highly interesting as an intermediate between those pairs which the telescope is able to separate and those—like β Aurigæ—which no magnifying power can divide, but which reveal the fact that they are double by the periodical splitting of their spectral lines. The orbit in 42 Comæ Berenicis is a very small one, so that even when the components are at their greatest distance apart they can not be separated by a five or six inch glass. Burnham, using the Lick telescope, in 1890 made the distance 0·7″; Hall, using the Washington telescope, in 1891 made it a trifle more than 0·5″. He had measured it in 1886 as only 0·27″. The period of revolution is believed to be about twenty-five years.

In Coma Berenices there is an outlying field of the wonderful nebulous region of Virgo, which we may explore on some future evening. But the nebulæ in Coma are very faint, and, for an amateur, hardly worth the trouble required to pick them up. The two clusters included in the map, 2752 and 3453, are bright enough to repay inspection with our largest aperture.

Although Hydra is the largest constellation in the heavens, extending about seven hours, or 105°, in right ascension, it contains comparatively few objects of interest, and most of these are in the head or western end of the constellation, which we examined during our first night at the telescope. In the central portion of Hydra, represented on map No. 7, we find its leading star α, sometimes called Alphard, or Cor Hydræ, a bright second-magnitude star that has been suspected of variability. It has a decided orange tint, and is accompanied, at a distance of 281″, p. 153°, by a greenish tenth-magnitude star. Bu. 339 is a fine double, magnitudes eight and nine and a half, distance 1·3″, p. 216°. The planetary nebula 2102 is about 1′ in diameter, pale blue in color, and worth looking at, because it is brighter than most objects of its class. Tempel and Secchi have given wonderful descriptions of it, both finding multitudes of stars intermingled with nebulous matter.

For a last glimpse at celestial splendors for the night, let us turn to the rich cluster 1630, in Argo, just above the place where the stream of the Milky Way—here bright in mid-channel and shallowing toward the shores—separates into two or three currents before disappearing behind the horizon. It is by no means as brilliant as some of the star clusters we have seen, but it gains in beauty and impressiveness from the presence of one bright star that seems to captain a host of inferior luminaries.

THE UNITED STATES GEOLOGICAL SURVEY.*

By CHARLES D. WALCOTT,
DIRECTOR OF THE SURVEY.

GEOLOGY in America has advanced by steady evolution from a small beginning eighty years ago to its present proportions, where it stands as one of the great sciences of the present and of the future. The geologists of Europe founded the science of geology in the earlier years of this century, and as the tide of emigration passed across to this continent it brought with it a knowledge of science and a spirit of scientific investigation. In geology this first took systematic form in the State of New York. State after State then took up the work, and finally the Federal Government, in its western Territories. Among the men who have led in the States were William Maclure, Amos Eaton, James Hall, Ebenezer Emmons, Timothy Conrad, and their associates on the New York Survey; the brothers Rogers, and Richard Dale Owen. Jules Marcou, J. S. Newberry, and others began work in the west under the Federal Government, and following them the organizers of the first Government surveys—Clarence King, F. V. Hayden, J. W. Powell, and George M. Wheeler.

The organization of the present Geological Survey went into effect July 1, 1879, the independent surveys that had previously existed having been discontinued. It is a bureau of the Department of the Interior, and is under the immediate control of a director, who is appointed by the President and confirmed by the Senate. The members of the regular and permanent corps of the survey are nominated by the director and appointed by the Secretary of the Interior, the director making only such temporary appointments as are authorized by the secretary. A plan of operations and an estimate of the expenses of the survey are submitted annually to the secretary, to whom the director also makes report of the operations of the survey at the close of each fiscal year.

The survey occupies a rented building which has 46,480 square feet of floor space. In addition, the engraving and printing division occupies an annex building, with 8,253 square feet of floor space, and in the National Museum there are four laboratories for the preparation and study of paleontologic and paleobotanic material. Within the main building there is a chemical laboratory, in which analyses of rocks, oils, minerals, etc., are made for the geologists of the survey, as well as certain special investigations

* Presidential Address before the Geological Society of Washington, delivered December 18, 1894.

relating to problems directly affecting the study of rocks or minerals, a knowledge of which is necessary for the field geologist; a photographic laboratory, in which all negatives taken in the field are developed and prints made therefrom, and where the field topographic maps are reduced to the scale required before engraving for publication; a petrographic laboratory, which includes the necessary machinery for cutting thin sections of rocks and minerals, and for the cutting and polishing of sections of limestones, fossils, etc.

The topographic division occupies the fourth and fifth floors of the main building. This division is fully equipped with the necessary instruments for triangulation and topographic surveying. The second and third floors are occupied by the geologists of the survey, and the first floor by the administrative offices, the editorial rooms, and the library. The library at the present time contains thirty-five thousand books, fifty thousand pamphlets, and twenty-six thousand maps, all of which are intended for study and reference by the members of the survey. The administrative branch of the survey includes the chief clerk's office, the financial division, and the miscellaneous or correspondence division. In the printing division there is a full equipment for engraving, lithographing, and printing the topographic maps and folios of the survey.

The organic law of the survey, enacted in 1879, provides that "the director of the Geological Survey shall have the direction of the Geological Survey and the classification of the public lands and examination of the geological structure and mineral resources and products of the national domain." In 1882 the doubt as to the territory to be embraced by the operations of the survey was removed by the addition of the words "and to continue the preparation of a geological map of the United States." Under the directorship of Mr. Clarence King prominence was given to investigations of the mineral resources of the Rocky Mountain region in Colorado, Utah, and Nevada. A general division of mining geology was also organized, but, owing to the uncertainty of the area to be included under the term "national domain," its operations were limited to the States and Territories of the west. With the change of directorship in 1881 and the granting of authority in 1882 to complete a geological map of the United States, the policy of the survey was modified and its work was directed, under a very comprehensive plan, to the preparation of the required geologic map. This included the making of a topographic map of the entire United States as a base for the mapping of the areal geology. As adequate maps were not in existence, and areal geology without a good topographic base would be of little value, the topographic work was pushed forward; and in geology special attention was given to the consideration and solution of certain broad geologic problems presented by the wide domain of the United States. These problems embraced those of the geologic growth and development of a great continent, many of which had to be solved before the areal geographic mapping could be carried forward intelligently and with due consideration for scientific accuracy and economy. With the completion of topographic sheets, areal geology was gradually taken up, and in 1894 more than three fourths of the available geologic force was employed in areal work.

The scope of the work of the Geological Survey has thus come to include the preparation of a topographic base map of the entire United States; the study and mapping of the areal geology upon this base; the examination of the geologic structure and mineral resources of the national domain; the gathering of the statistics of mineral production; the study of the artesian and surface water supply of the United States; and, indirectly, the mineral and agricultural classification of the public lands under survey.

There is one fact that should be borne in mind when considering the scope of the work, and that is that the Geological Survey is a bureau of research. Its work is to a large extent the discovery of unknown facts and principles, and the scientific co-ordination of these and all known facts and inductions, within the scope of its work, in such a form that they shall subserve the use of both the Government and the people; the latter to include not only the farmer, prospector, miner, owner of lands, investor, and mining and civil engineer, but also the most highly trained students, teachers, and specialists.

Topographic Base Map.—Captain George M. Wheeler said of topographic surveys: "The topographic is the indispensable, all-important survey, being general and not special in its character, which underlies every other, including also the graphic basis of the economic and scientific examinations of the country. . . . This has been the main or principal general survey in all civilized countries, and all other so-called surveys (as geodetic, trigonometric, etc.) are but accessories or addenda thereto. . . . The results of such a survey become the mother source whence all other physical examinations may draw their graphic sustenance." *

A recent European writer † (1892) on the general topographic maps of the present time says that all European states have undertaken uniform and continuous topographic surveys of their

* Facts regarding the Origin, Organization, etc., of Government Land and Marine Surveys of the United States. 1885. 4to pamphlet. Washington, D. C.: War Department.

† C. Lowinsin Ymer. Tidskrift utgiven af Svenska Sallskapet for Antropologi och Geografi. 1891. Elfte argangen, 3e och 4e haft (slut). Stockholm: Samson & Wallin, 1892.

whole domains, and that outside of Europe the United States claim first attention by their grand topographic works.

Similar surveys are also in progress in the principal colonies of the European powers, such as India, Canada, Algeria, Tunis, etc. The scale of the maps varies from 1 : 2,000 to 1 : 420,000.

According to Lowinsin, seventy per cent of the area of Europe has had a fairly satisfactory topographic survey ; and of the land area of the world, about twenty-seven per cent has been surveyed more or less accurately. Bartholomew estimates that only one seventh of the whole land surface of the globe has been exactly surveyed. He publishes an instructive map exhibiting the area of topographic surveys, both exact and general, and of geographic surveys, both fairly reliable and approximate or hypothetical.*

Most European topographic maps were made, primarily, for military purposes, under the supervision of military officers, and secondarily for the scientist and statesman only. In the United States the necessities of the geologist developed the first interior surveys, and they are now being carried forward under the direction of the Geological Survey, and, along the ocean borders, by the Coast and Goedetic Survey.

The methods employed are the same in all topographic surveys, in respect to the two essential divisions of work, viz., location of points of control and sketching in of contours, streams, culture, etc. The minor methods of procedure differ in details within these two divisions; but geometrically located points of control are in all cases obtained, and the contours, roads, streams, and all features shown on the map are sketched in, whether the located points of control are ten inches or a thousand feet apart. Usually it is only the features sketched that appear on the map, as the geometrically located points that control the sketch are mathematical points. If desired they can be represented by conventional signs.

The first contoured topographic maps of the United States for geologic purposes were on the scale of 1 : 250,000 (four miles to the inch), with contour intervals of two hundred to two hundred and fifty feet; but the necessities of science and the demands of the public called for a more detailed map, and the scale of 1 : 125,000 (two miles to the inch) was adopted. This was again enlarged in certain regions to 1 : 62,500 (one mile to the inch). The topographic maps of the Geological Survey are now being made, in the rougher mountain region and thinly populated areas, on the 1 : 125,000 scale, with contour intervals of from ten to one hundred feet, and in the more valuable, economic, and thickly populated areas, on the 1 : 62,500 scale, with contour intervals of from five to one hundred

* John George Bartholomew. Scottish Geographical Magazine, vol. vi, 1890, pp. 294, 295, and map.

feet. Special maps, for the detailed survey of areas of unusual mining or scientific interest, are made on still larger scales, up to 1 : 10,000. With the increase in scale there has been an increase in cost; but the latter has been in a considerably smaller ratio than the increase in the value of the maps produced. Since the beginning of topographic surveys by the Geological Survey there has been a steady improvement of methods, and the survey has been making better maps during the past two years than ever before.

Primarily the topographic maps are for the use of the geologist, and their scale has been determined largely by this fact. With the progress of the survey from year to year, the public became more and more acquainted with the maps, and a strong demand arose for the topographic maps as such. Massachusetts, Rhode Island, Connecticut, and New York asked to have the work pushed more rapidly within their respective boundaries; this was done on the condition that the State pay one half of the cost of the work. Of the States mentioned, all have a completed topographic map with the exception of New York. In the great semi-arid region of the interior the maps were requested as an aid in the development of their resources in artesian water and in the application of drainage waters to irrigation. Severe criticism of the survey has been made on account of the extent of the topographic surveys in the semi-arid region; but when it is considered that the Geological Survey is a national institution, it is evident that the great interior has as just a claim for consideration as the mining regions of the mountain areas of the eastern and western sides of the continent. If water is the principal mineral resource, it should receive due attention in making the topographic map. The uses of the topographic maps are many, and it is the policy of the survey to give them as high a standard of accuracy as the limit of scale will permit. A map may cost one dollar or one thousand dollars, or more, a square mile, according to its scale and its contents. For general purposes an excellent map can be made for ten dollars a square mile, one that will subserve the uses of the geologist and the people. This will answer for nine tenths or more of the area of the country; and when more detailed, expensive maps are required for the remaining tenth, they can and will be made. In the meantime the development of the country will be assisted in many ways by the maps constructed on the scales now adopted.

The following table exhibits the area of topographic work completed up to December 1, 1894. Of this, a considerable portion of the 1 : 250,000 scale (four miles to the inch) will be revised as detailed geologic work is carried forward. A thorough revision will also need to be made of certain areas in the Appalachian Mountains and west of the Mississippi River, to the Pacific.

This arises mainly from defective work in the earlier years of the survey, when men and methods were more or less on trial, and from the demand for more detailed and accurate maps on which to plat the geology of the coal and iron regions of the Appalachians, and the gold, silver, iron, coal, and artesian areas of other sections of the country:

	Area surveyed, sq. miles.	SCALES.			Per cent of total area surveyed.
		1/62,500	1/125,000	1/250,000	
Alabama	15,870	......	15,870	......	30
Arizona	41,000	......	......	41,000	36
Arkansas	15,000	......	15,000	......	28
California	35,100	4,000	16,700	14,400	22
Colorado	36,000	1,500	34,500	......	35
Connecticut	4,990	4,990	......	......	100
Delaware	15	15	......	......	1
District of Columbia	70	70	......	......	100
Florida	1,900	1,900	......	......	3
Georgia	15,275	......	15,275	......	26
Idaho	12,000	......	12,000	......	14
Illinois	3,875	3,875	......	......	7
Indiana	20	20	......	......	..
Indian Territory	250	......	250	......	1
Iowa	4,450	4,450	......	......	8
Kentucky	12,800	......	12,800	......	32
Kansas	67,385	......	67,385	......	82
Louisiana	7,000	7,000	......	......	14
Maine	4,200	4,200	......	......	13
Maryland	6,930	3,000	3,930	......	57
Massachusetts	8,315	8,315	......	......	100
Michigan	231	231	......	......	..
Minnesota	850	850	......	......	1
Missouri	26,000	300	25,700	......	37
Montana	14,400	......	6,000	8,400	10
Nebraska	14,300	......	14,300	......	18
Nevada	19,980	......	5,580	14,400	18
New Hampshire	1,990	1,990	......	......	21
New Jersey	7,815	7,815	......	......	100
New Mexico	27,800	......	10,000	17,800	23
New York	10,000	10,000	......	......	20
North Carolina	11,110	......	11,110	......	21
North Dakota	4,960	......	4,960	......	7
Ohio	50	......	50	......	..
Oklahoma Territory	3,423	......	......	......	9
Oregon	13,180	......	980	12,200	14
Pennsylvania	6,537	6,537	......	......	14
Rhode Island	1,250	1,250	......	......	100
South Carolina	4,350	......	4,350	......	14
South Dakota	9,800	......	9,800	......	13
Tennessee	19,000	......	19,000	......	45
Texas	57,000	......	57,000	......	21
Utah	6,000	......	......	6,000	7
Vermont	2,175	2,175	......	......	23
Virginia	32,120	1,120	31,000	......	84
Washington	450	450	......	......	1
West Virginia	22,500	......	22,500	......	90
Wisconsin	6,540	6,540	......	......	12
Wyoming	7,700	......	7,700	......	8
	624,016	94,793	427,163	102,060	
Per cent of all	......	15	68	17	

In addition to the above, areas amounting to about one hundred and six thousand square miles have been adopted from the Powell, Wheeler, Hayden, and King surveys, and published on the scale of 1:250,000. From this table it appears that during the past twelve years the Geological Survey has mapped six hundred and twenty-four thousand square miles, being more than one fifth the area of the country, excluding Alaska. Of this, more than two thirds is on the scale of 1 : 125,000, and nearly one sixth on the scale of 1 : 62,500.

GEOLOGIC WORK.—The geologic work is readily classified as *special investigations* and *areal mapping*.

The first branch of the geologic work, special investigations, is illustrated by the study and report on The Tertiary History of the Grand Cañon District, by Captain C. E. Dutton; Lake Bonneville, by Mr. G. K. Gilbert; Geology and Mining Industry of Leadville, Colorado, by Prof. S. F. Emmons; The Palæozoic Fishes of North America, by Prof. J. S. Newberry; and the thorough investigation of the geologic phenomena of the Yellowstone National Park, by Mr. Arnold Hague. Twenty-four monographs and one hundred and sixteen bulletins have been published by the survey as the results of such investigations. They are frequently the basis of generalizations that must be obtained before the areal geologic work can be successfully prosecuted; and the areal geologist is constantly making use of the data furnished him by the specialist. Immense collections have been accumulated in the laboratories of the survey and in the National Museum, which are the basis of correlations used almost constantly in areal mapping and frequently in the solution of problems arising in connection with the study of economic questions of a high order. The interrelation of the various branches of geology are such that all must be kept up to a high standard, or all will sooner or later deteriorate and thus affect the quality of the output of results by the survey.

Under the direction given, in 1882, to complete the geological map of the United States, a comprehensive scheme of work was outlined. A large corps of geologists soon began work on various problems that arose in planning a system of mapping that would serve for all phases of geology to be met with in the three million square miles of the area of the United States. A large amount of valuable detailed local work had been done by various State surveys; several of the Government surveys had made more or less complete reconnaissances of large areas west of the Mississippi River, and a few fairly accurate geologic maps were published by them; but the State and Government surveys had been conducted each in its own way and with little regard to co-ordination with the work of the others. It was necessary to bind together the scattered results of all these in a comprehensive whole, before a beginning could be made on the publication of the geologic map. This work was carried forward for ten years before the first folio of the final geologic map was published. Most of the larger questions affecting the classification and nomenclature of the sedimentary and volcanic rocks were brought to a satisfactory conclusion. Great progress was made in the study of the altered (metamorphic) rocks and of the complex of crystalline rocks grouped under the term "Archean." A satisfactory solution of the lower Mesozoic (Juratrias) series is yet to be reached; and there is a great field in the pre-Paleozoic sedimentary and crystalline formations, in which further study will bring out important data for classification and geologic mapping; but the areas affected are relatively small within the United States, and the areal geologic mapping can go on without serious injury on this account. Director Powell and members of the survey gave much time and thought as to the best method of representing the geology on maps. The result is a color scheme that, under the skillful application of the editor of geologic maps, has thus far met the demands made upon it.

The areal geologic map in its final form, as presented in the geologic folios, is intended to place before the geologist, mining engineer, student, and all persons interested the topography and geology of the area included within each atlas sheet. The topographic map has already been mentioned. In each folio a brief explanation is printed of the topographic and geologic maps and of the uses to which they can be applied. It is a simple, short lesson for the layman, to enable him to make use of the folios intelligently.

The areal geologic map represents all that the geologist preparing it knows of the areal distribution of the rocks occurring within its area, so far as he can delineate such knowledge within the scale of the map. Taken in connection with the topographic base, it presents the geologic distribution of the various rocks in a form for the use of geologists and students, but it does not appeal directly to persons interested in the mineral resources of the region. To meet this important demand a second map is prepared, upon which the rocks carrying minerals of economic value are clearly indicated by distinct colors, the import of which is shown by the colored legend on the margin of the map. Thus the distribution of the coal- and iron-bearing rocks of the Appalachians in Tennessee and other States, and of the gold-bearing rocks of California and elsewhere, is clearly presented. These maps refer only to the areal distribution of the rocks. What is known of the underground geology is graphically illustrated on a structure section sheet and a sheet of columnar sections. With the four sheets before him the geologist, mining engineer, landowner, or other inquirer has in view in graphic form all that the geologist can tell him of the area. A general text accompanies the folio; and, when considered necessary, a full, detailed description will be published in the form of a bulletin. This is as far as the director of the survey considers that he is legally authorized to go in the preparation of a geologic map. On the scale now used this map will require many years for its completion. Its value depends upon its thoroughness, and it is thought that quality, up to the scale adopted, is to be considered before the question of area. The standard adopted is to do the field work up to and beyond the scale of the map, and to represent on the map all that the scale will permit. The result thus far is shown in the folios published, and the folios of the future will prove the quality of the work now being done. Cost and practical working methods limit the ideal perfection of field work and of the resulting maps; but in all cases the ideal standard will be aimed at, and the attempt made to present the best results obtainable under the conditions surrounding the work.

ECONOMIC WORK.—Some one has said that utility is the bane of science, and a greater man has written that Philosophy is never more exalted than when she stoops to minister to humanity. Geology is essentially practical in many of its branches, and thus commends itself to those interested in the material welfare of individuals, communities, and nations; and, at the same time, its great problems concerning the history of the evolution of the earth and of life, including man, command the attention of intelligent mankind. In its economic aspect the Geological Survey touches the interests of the people in many and varied ways. Human endeavor is limited to the surface of the earth and its immediate underground resources, and whatever is of assistance here is an aid in the development of the higher material civilization.

In the first place, good topographic maps are essential. They are needed in the construction of roads of all kinds, and in problems of water supply and drainage. In all future military operations such maps will be of service. As a basis for representing the distribution of mineral resources they can not be dispensed with, and in all investigations relating to the surface of the earth they are of great value.

Mineral Resources. The organic law of the survey provides that the director shall have charge of the examination of the mineral resources and products of the national domain. This has been interpreted to mean a *statistical* examination of the products from the mineral resources, and a *geologic* examination of their occurrence and character. The former has led to the compilation of statistics and the publication of an annual volume under the title of Mineral Resources. It is proposed to continue this work, and to make it as complete and accurate as the means available will permit. It seems particularly appropriate that the Government should collect statistics of mineral production, and give the volume prompt publication and wide circulation. The first ten annual volumes have appeared as a distinct publication by the survey, but in the future it is proposed to issue the statistics as the second part of the annual report of the director.

Geologic Economic Work. The geologic examination of the mineral resources is one that commended itself very strongly to Mr. King. He regarded it as the primary work of the survey, and gave it great impetus by establishing surveys of the Leadville district of Colorado and of the Eureka and Virginia silver districts of Nevada. These were carried forward under Major Powell, and new economic work was entered upon. Dr. Becker surveyed and completed a report on the quicksilver deposits of California, and began a thorough survey of the gold belt of California. Profs. Irving and Van Hise surveyed and reported on the copper district of Lake Superior, and pushed forward researches on the iron-ore districts of Wisconsin and Michigan. The phosphate deposits of Florida were studied, and the mapping of the coal fields of the Appalachians was begun. With the development of areal geologic work, 1886 to 1891, many minor economic problems were met with and studied. Previous to 1892, when the appropriation for geology was reduced more than one half, a large percentage of it was employed in distinctly economic work. With the revival of geologic work the present year, the geologic examination of the mineral resources has received attention. A statement of what has been and is being done the present year will explain the present policy of the survey.

Four field parties were engaged in the areal survey of the coal fields of Tennessee, Virginia, West Virginia, and Maryland; one party on the iron-ore deposits of western North Carolina; one party on the marbles, etc., of northwestern Georgia; one party in making a preliminary study and reconnaissance of the gold belt of Georgia, South and North Carolina, and Virginia; one party on the southern limit of the roofing-slate belt of eastern New York; one large party on the iron ores of northern Wisconsin; one party on the mining districts of the Helena atlas sheet of Montana; one party on the Cripple Creek gold field, and in making a reconnaissance of the Rico district of Colorado; one party in completing the survey of the Leadville (Col.) district; one party in surveying the coal field of the Trinidad, El Moro, and Walsenburg sheets, Colorado; one party in studying the artesian water problem of the valley of the Arkansas, in Colorado and Kansas;

three parties in the study of the water supply of the United States, especially in the arid and semi-arid central region; one party in examining the clays, etc., in connection with the areal geology of central Texas; one party in making a reconnaissance of the mineral belt of central Idaho; and two parties in the areal mapping and a study of the gold belt of California. Thus twenty-one parties were engaged in work relating to important resources. It is also planned to continue the study of the phosphate deposits of Florida during the winter, and to begin the mapping of the coal deposits of southwest Oregon and western Washington in the spring of 1895. In addition, work on the geology of highways has been started, and the economic chemical work of the survey has been continued. To provide topographic maps for the geologic work thirty-two topographic field parties were engaged in the various sections of the country.

A typical illustration of geologic economic work is that on the iron-ore deposits of the Lake Superior region. The results include the determination of the geologic position and geographic distribution of the iron-bearing formations, and of the laws which control the occurrence of ore bodies within the iron-bearing formations.

First.—The investigations thus far made show the presence of an iron-bearing formation at the summit of the lower Huronian series, another near its base, and a third at the base of the upper Huronian series which was derived largely from the detritus of the iron-bearing formation of the lower Huronian. Their geographic distribution has been carefully mapped in the old districts and also in new districts, where prospecting had not yet shown them to exist.

Second.—The discovery of the laws which control the occurrence of the ore bodies is of equal if not of greater economic importance than the mapping of the iron-bearing formations. They are as follows: 1. The iron ores always rest upon a relatively impervious basement. 2. Large ore bodies are found only when the impervious basements are in the form of pitching troughs. 3. The pitching troughs are particularly likely to bear unusually large ore bodies when the iron-bearing formation has been much shattered by folding.

By the aid of the areal and structural maps which have been and will be prepared, and the application of the above laws, the mining engineer may avoid unnecessary expenditure of money in exploration, and be guided in the development of the mineral resources of the region.

Hydrography. The scope of the work of the hydrographic division of the survey is expressed in the statute authorizing it, which reads: "For gauging the streams and determining the water supply of the United States, including the investigation of underground currents and artesian wells in arid and semi-arid regions. . . ." (Passed August 18, 1894.)

The demand on the survey from time to time for information concerning the water resources of the country has increased from year to year, especially from the arid and semi-arid regions of the west. Inquiries come from farmers seeking to provide water for domestic use and for irrigation, from individuals and from municipal organizations seeking artesian water supply and water power, and from members of Congress having in view legislation concerning the regulation of streams flowing across State or national boundaries. Response to the inquiries made requires not only broad knowledge of the topography, geologic structure, and meteorologic conditions of the regions involved, but also more or less familiarity with local conditions. In the past the hydrographic work of the survey has been limited because of the small sum available for the purpose. Such results as have been secured were largely an incidental product of the brief irrigation survey, which was practically suspended in 1891. Under the law above quoted, the work was taken up systematically during the present year, and will now be prosecuted as thoroughly and extensively as the money appropriated for the purpose will permit. A large amount of volunteer assistance has been given by local observers who realize the value of the work, and by railroad companies which are sufficiently interested to have their bridge-tenders read the river gauges. By this co-operation much more extensive results are possible than with the limited resources thus far at the command of the survey.

The water which has been utilized for irrigation by the farmers of the west is that which is most readily available, but both the great supply of storm water and the underground yield are scarcely touched. The utilization of this unappropriated water is the first condition for the further development of the arid and semi-arid lands in both public and private ownership. In order that the water may be intelligently utilized it is necessary that a thorough investigation should be made to obtain information as to the quantity and its fluctuations, before dams and reservoirs for storing it can be economically constructed.

The range of the requests for information on this point and concerning water powers shows the popular appreciation of the best work in this direction. From this standpoint the inquiries are encouraging; at the same time they are embarrassing, in that it is assumed that the survey has extended its investigation over the whole field. The data, however, are far from sufficient, and for their completion there is demand for a field survey which should be prosecuted at once and in the most thorough and systematic manner possible. The work is essentially economic, and, owing to its intimate relations to geology, is considered to be directly germane to the work of the survey.

Highways. The geology of highways embraces the study of the materials entering into their construction. It is distinct from the engineering problem of the mechanical construction of highways—a subject that is not intended to be taken up by the survey. The main questions have to do with the choice and manipulation of materials. Experience has shown that many kinds of rocks, which are not suitable for road-building when used alone, may be combined with other materials in such wise as to give good results. It is well known that in many districts great expense has been incurred in building roads on the best known engineering principles of road construction, with the result of producing dusty roads in summer and muddy roads in winter. This outcome is the result of ignorance in regard to the character of the rock necessary for the production of good roads. Inferior materials have sometimes been used when there were other materials in the immediate vicinity which alone or in combination would have produced a solid roadbed. A large part of the country, including the greater portion of the southern States and some portions of the Mississippi basin, has been thought to be essentially destitute of materials suitable for the construction of good roads. The inquiries that have been made by geologists have shown that in many places within these regions there are hidden deposits of gravel and other sorts of rocks which, when properly used, might give excellent highways; and that around the margin of this great area, often within the limits of convenient railway distribution, there are abundant supplies of rock well fitted for such use. It only remains to discover the supply of such rocks as are cheapest and best for each region. This information can be obtained in practical form for each district as the work of the survey advances.

The movement for the betterment of roads and the obtainment of information relating to the materials available for the purpose has not yet taken a national character; but it is believed that, by establishing a laboratory in connection with the Federal survey, a great impulse may be given to the improvement of highways. Such a laboratory should be arranged to obtain information as to the character of the material best adapted to road construction, tests being made of specimens sent to the survey by the various road commissioners immediately interested, by geologists surveying areal geology, and by public-spirited citizens interested in the making of good roads. During the present year the survey is temporarily using a laboratory, under the direction of Prof. N. S. Shaler, at the Harvard Scientific School, Cambridge, Mass. Attention has been called to the use of bricks for highways, such as have been used for centuries in Holland and the lowlands of Europe. It now seems not only likely that this kind of pavement may become of great value in the south and the lower Mississippi Valley, but also important that the investigation of the clays of the country, with reference both to distribution and burning qualities, should be undertaken. Much information is at hand concerning the clays of many portions of the country, but little attention has been paid to their availability for making paving bricks.

Limitations of Economic Work. There have been and will continue to be differences of opinion as to the line to be drawn in economic work between that belonging to the States and individuals and that coming fairly within the field of the Federal survey. Broad interstate problems are clearly of the latter class, also those that by full study and elucidation will aid development in other areas. A test of the value of a high order of areal and economic work is brought out by a comparison of old and new conditions in the Rocky Mountain region. When the country was new, prospectors made many discoveries, and often accumulated fortunes with pick, shovel, and pan. These conditions have begun to pass away; and the mining industry now demands the highest skill and every assistance that can be given to it by geology and its collateral branches. The mining expert who is equipped with a full knowledge of the geology of the district in which he is working will succeed where the untrained man would fail. The new conditions will dominate even more in the future, rendering necessary a full knowledge of the geologic conditions surrounding mining problems. The work of the survey is not that of the prospector, nor that of the mining engineer who develops the property—that is the work of the individual, company, or community. The Geological Survey will give them the maps and the geologic data, and, if it will, the State can also aid by having analyses made for the prospectors, as well as detailed examinations and reports of special properties and of special methods of mining, treatment of ores, types of mining machinery, etc. Cases will arise when the study of a general problem will require the geologist of the Federal survey to make minute and detailed study of a mining district; but, as a whole, the work of the Federal survey is preparatory to the more detailed economic work of the State survey. The former will deal with broad interstate problems, and, when the States request it, co-operate in making a topographic map, and in the working out of such geologic problems as are germane to the work of the Federal survey.

Theoretic Work.—One of the criticisms often made of Government scientific work is that it is too theoretic in character and not sufficiently practical. In the case of the Geological Survey it has been said that the people needed practical results to assist them in their material development, and that abstract studies should be left to the universities and technical schools. The critics fail to recognize the fact that scientific or technical knowledge is necessary to the solution of any geologic problem, and that, if it is not already in existence, investigations must be made in order to obtain it for the purpose. Geology is essentially a science of exploitation; and the geologist must have at his command the best instruments and most reliable information that can be obtained to aid him in observing, in recording the results of observation, in classifying and assimilating such results, and in correctly interpreting them. He must also have a knowledge of the principles and laws that govern the phenomena under investigation, and if it is only by experimentation and special research that he can obtain such knowledge, then the time and energy must be expended to secure it. In view of these facts there is no necessity for apology for the existence of chemical, lithological, physical, and paleontological laboratories in connection with the Geological Survey, nor for special studies in the glacial formations, the physics of the earth's crust, etc. They are all essential to its scientific and practical work, and to the securing of results that will command the confidence of all who may have occasion to use or refer to them. The survey will keep in view the fact that it receives its support from the people, and endeavor to give in return practical results, and at the same time to furnish information that will advance the higher education, and especially the science of geology, in America.

CO-OPERATION.—The recommendation of the National Academy of Science, that "all mensuration surveys be consolidated under one organization," was not adopted; nor could it have been fully successful as outlined in the plan submitted to Congress. If the topographic surveys were governed by any other condition than that of being made principally for the geologist, in the territory where his work demands the maps, they would be more likely to prove a hindrance than an assistance to him. An illustration may explain this. During the past field season it became desirable to make a geologic survey of the western Maryland coal field. The old topographic map of that area being found inadequate to supply the data required, a topographic party was sent with the geologists; but as the season advanced it became apparent that the one topographic party could not keep pace with the geologists, and a second and third topographic party were sent to their assistance. Jointly they completed both the topography and geology of that area before the close of the season; and the maps will be published within a year of the survey. Similar cases occurred in Colorado and the southern Appalachians. It is evident that if the topographic work had been in charge of another bureau such quick adjustment could not have been made, and the economic geologic work would have been delayed a year or more. Prompt publication of economic work must be made, as its value as an aid to development decreases with every year and almost every month of delay. Thus it is that co-ordination with any other bureau in mensuration survey becomes impracticable, unless the Geological Survey controls it. The work must be carried forward in accordance with the needs of the bureau.

To promote its own work and to avoid duplication the Geological Survey uses the points established by the Coast and Geodetic Survey, the Lake Survey, and the Mississippi River Commission whenever they are available. It also furnishes data to the several bureaus and departments of the Government as they are requested from time to time.

The attitude of the Federal survey toward State surveys has been in the past to co-operate fully and freely, though commonly in an informal way; and it has uniformly encouraged the institution of State surveys. It has been disposed to encourage a division of labor whereby economic problems of a local character would be dealt with chiefly by the State survey, while the more general and usually interstate problems, which State surveys have difficulty in dealing with, would receive the special attention of the Federal survey; the latter, including triangulation, topography, paleontology, and special researches, requiring time, labor, and specialists. The Federal survey discusses the relations of the various mineral resources, such as iron, copper, phosphates, etc., to particular geologic formations; then the State surveys come in with their independent organizations and fix the values, methods of development, and other questions relating to the local geology and mineral resources. Partial co-operation between the Federal survey and several State surveys has been thus effected, the States making use of the results of the national work, and, in return, furnishing the Federal survey with data resulting from their more restricted and detailed economic work.

Co-operation in topographic mapping has been effected in Massachusetts, Connecticut, Rhode Island, and New York, under an arrangement by which each State pays one half the cost of the work, scale and other details being agreed upon by a commission, or an officer representing the State, and the director of the Federal survey. It is essential that uniformity of methods and results should obtain throughout the topographic maps, and to secure this the execution of the field work and the drafting and engraving of the maps have been entirely in charge of the Federal survey. If agreeable to the States, co-operation will be continued on essentially the same conditions in the future as in the past.

Relations to Agriculture.—The work of the Geological Survey touches the interests of the agriculturist by furnishing data in relation to the distribution and supply of mineral manures, marls, phosphates, etc., and the distribution of soils. The soils are the direct result of the decay of rocks, and in the non-glaciated areas of the United States the geological maps, showing the distribution of the rocks, are practically soil maps, as the clay, lime, sand, and other constituents of the rocks are the chief ingredients of the soils. The maps of the superficial deposits within the glaciated region will show the distribution of the different types of soils produced during the drift period, and those of the deposits without the glaciated region, the drift materials deposited in the river valleys.

In the arid and semi-arid region all questions of the occurrence and distribution of artesian water and water supply for irrigation are of great importance to the farmer, and a knowledge of the underlying geology will be of service in determining extended systems of drainage in areas provided with abundant water supply by precipitation. The study of the materials entering into the construction of highways is also of moment to the farmer, as good roads mean so much to his industrial and social development.

It is not practicable adequately to summarize in a few paragraphs the results of the work of the survey for the period 1879–1894. A somewhat full statement has been made in the fourteenth and fifteenth annual reports of the director of the survey. But, in brief, it may be said that there are completed of topographic surveys, six hundred and eight thousand six hundred and fifty square miles, of which five hundred thousand are available for areal geologic mapping; of geologic mapping, one hundred thousand square miles, of which sixty thousand are ready for the engraver; of special geologic and miscellaneous investigations, fifteen large annual reports, one hundred and sixteen bulletins, and twenty-four monographs. Many thousand topographic and special geologic maps have been printed and distributed, and, what is most important, a material and intellectual equipment has been assembled that will have a marked influence in all future work.

Under the statutes the function of the Geological Survey is to make a topographic and geologic map of the United States, and to continue the examination of its geologic structure and mineral resources and products. To accomplish this successfully, unity of thought and purpose is essential among those engaged in the work; and the survey should be carried on as a strictly scientific investigation, with the view of aiding in every possible manner the development of such material industries as are affected by its operations. These industries include mining, hydrographic and engineering work, and any practical object that can be advanced by a knowledge of the surface and interior of the earth and its resources.

The immensity of the work which is now before the Geological Survey would be sufficient to discourage the attempt to complete it, if the review of the past and the importance of the results to be attained, both to science and to the people of the country, were not kept constantly in view. The results of the past, however, are not a true index of the character and progress of work for the future, as a great amount of energy and time has been spent in preliminary studies and experimentation as to the best methods to be pursued and in obtaining a large amount of data necessary to the satisfactory prosecution of areal geologic work. These will not have to be repeated in the future.

The plan for the immediate future is to continue topographic work in areas of primary geologic importance, and to do such other topographic work as will be of service to the people and aid in the development of the areas mapped. In areal geology it is proposed to continue work in the following provinces: 1. The coal and iron region of the Appalachians from Alabama to the Pennsylvania line, which is considered especially important, as there is a large area of the Mississippi Valley and Atlantic coast which draws its coal and iron supplies from this region. 2. The crystalline areas of the eastern Appalachian region, in which gold, corundum, mica, etc., occur. 3. The phosphate deposits of Florida, extending the inquiry northward into Georgia and South Carolina and possibly into the areas of southwest Tennessee. 4. The marls, etc., of New Jersey, Delaware, and Virginia, working southward as rapidly as topographic maps are completed and the areal geology can be surveyed. 5. The northeastern section, where the mapping and study of the roofing-slate region of New York and Vermont, and the mapping of the areal geology of Massachusetts, Connecticut, and Rhode Island, are to be completed; and surveys will be extended to such areas of Vermont, New Hampshire, and Maine as the available means will permit. 6. The Lake Superior iron region, where areal and structural work will be carried forward systematically for the purpose of mapping the extent of the known mineral deposits and of determining the existence of other deposits not now known. 7. The Rocky Mountain area, where it is proposed to continue the investigation and mapping of the gold, silver, and coal-bearing rocks of Colorado, Utah, Wyoming, Idaho, and Montana, and, if feasible, to begin work in Arizona and New Mexico. In this connection detailed studies will be made of such typical mining districts as will throw light upon and aid in the development of similar districts elsewhere. 8. The Pacific slope: The mapping and study of the gold belt of California has been greatly advanced, but a number of years will be required to complete it, and this will be one of the essential features of the work in this region. Areal work will also be continued in southeastern Oregon; and it is planned to begin the mapping of the coal areas of Washington, and the study of the coal resources of the Pacific slope. 9. The interior southwest and the region of the Great Plains, from the Rio Grande to the British boundary. In this broad area special attention will be given to areal mapping, and also to the mineral resources in coal, iron, lignite, cement clay, building stones, the occurrence of artesian water, etc.

The resources of the interior Mississippi basin are more generally known, and the work there will be of a special character, or in co-operation with State surveys.

The investigation of the water resources of the arid and semiarid regions and of the country at large will be systematically carried forward until the available water supply from every artesian source and from every stream in the United States is accurately known, both for irrigation and power. This project, if carried out, will cover a number of years, and it will doubtless repay the outlay in the assistance it will give to the development and prosperity of all sections of the country.

If the proposed amendment relating to the geology of highways is adopted by Congress, material entering into road construction will be obtained by field parties of the survey and also through State surveys, road commissioners, and individuals; and tests will be made to enable all who are engaged or interested in the construction of highways to make an intelligent selection of materials to be used. It has been said that the status of a nation's civilization may be estimated by its facilities of communication within its own borders. Believing this to be true, the policy of the Geological Survey will be to assist in perfecting all roads by addressing itself to the purely geologic question of choice of materials entering into their construction.

The investigation of the phenomena of the great ice invasion of the north will be continued until all of its important features have been studied and interpreted, and the formations resulting from its influence, direct and indirect, have been determined and mapped.

It is also proposed to co-operate with individuals and State surveys, wherever such co-operation will advance the work of the survey in accordance with its general scope and plans and will assist the local surveys.

The division of engraving and printing has been very successful in its work on the geologic folios; and it is hoped that arrangements can be perfected and authority secured for engraving and printing under its immediate direction all the maps of the survey.

Such special studies will be made in the chemical, paleontological, petrographical, and physical laboratories as may be needful to solve the problems that arise in connection with the areal geology or in the investigation of important scientific and economic problems.

The legislative branch of the Government has been very liberal in the past, and it is anticipated that the work will be fully sustained in the future. On the part of the survey it is proposed to retain the services of the most capable men that can be secured; to maintain the work at the highest standard of efficiency possible; and to advance it as rapidly as the means provided will permit.

THE THORNS OF PLANTS.

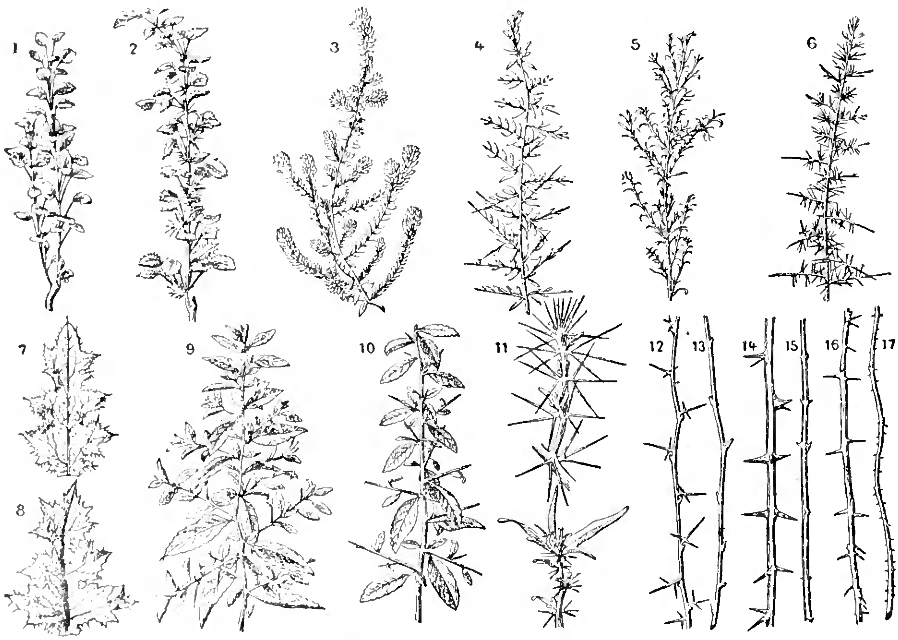
By M. HENRI COUPIN.

THE seeming absence of means of defense in plants, putting them in contrast—to the eye—with animals, which are bountifully and variously armed, is only apparent. A not very close examination of the behavior of plants toward animals, their great enemies, will soon satisfy one that they have many protective organs, some of them very efficacious. The spines, thorns, and prickles with which the stems and the leaves of some plants bristle are known to all, and we can hardly fail to perceive a protecting function in the aggressive defense of plants against animals and against the hand of man put forth to pluck them. In the spring, for instance, when vegetation is very little forward, the plum trees would soon disappear completely under the attacks of cattle, sheep, horses, and other foliage-loving animals, if Nature had not provided them with those long, sharp spines that make browsing of them very difficult if not impossible. The shapes of thorns are various, but may always be brought back to a protuberance broad at the base and pointed at its free end, and of an extremely hard consistence. Usually simple, they are sometimes bifid or trifid. Their positions are various. All the organs of plants may be said to bear them: the stem, as in the rose; the base of the leaves, as in the barberry; the leaves, as in the thistle;

the floral parts, as in the thistle; the fruit, as in *Datura*; and even the roots, as in *Acanthus rhiza aculeata*.

The body of plants is, we all know, composed of three members—the root, the stem, and the leaf. In determining with which part to class the thorns, an important distinction should be made, which, unfortunately, can be perceived only by the aid of the microscope. Some thorns, like the stem, leaves, and roots, contain vessels that bring up the sap, while others are destitute of them. The unvesseled thorns, simple risings of the superficial tissues, are scattered without visible order over the body of the plants. The vesseled thorns, on the other hand, are disposed in a fixed and regular manner, easy to be comprehended, for they are modified members, as the vessels running through them prove. Many thorns originate in transformations of branches; a form very evident in the plum tree, on which the thorns frequently bear flowers. Sometimes, too, they proceed from leaves, as in the barberries, or from parts of leaves, as in the agaves, or from stipules, as in acacia. Often both leaves and branches are sharpened, as in the rush and the broom. In this case, if in any, we can say that Nature employs various means to reach its ends.

Thorns are interesting, not only on account of their functions and their morphology, but also on account of the modifications they exhibit in different situations. A plant, for example, richly armed with thorns in one region, will have fewer in another place, and none in a third. It is observed that the influence of the medium in these different regions makes itself felt in the same way on all the thorned plants that inhabit them. The flora of the steppes, which extends over vast arid plains, and the flora of deserts comprise more thorny species than the flora of forests. So it is in Senegal, a country remarkable for prolonged dryness of the atmosphere and the intensity of the solar light. M. Antoine Martin has remarked that similar conditions are observable in France, where in dry, bare places, as at the Grand Camp, near Lyons, the vegetable carpeting is constituted of plants with reduced leaves or thorns, such as *Genista*, *Ononis spinosa*, and *Eryngium campestre*; by which it is given an appearance comparable with that of desert regions. Thorny plants are especially prominent in deserts, where vegetation is subject to the triple stunting action of dryness of the air, aridity of the soil, and intense light. On the question as to which of these causes is the one that influences the production of thorns, an interesting memoir has been published by M. Lothelier, of the Sorbonne. He employed in his investigation the scientific and fruitful method adopted at the laboratory of Prof. Gaston Bonnier, which consists in subjecting many individuals of the same species of plant to identical conditions of light, moisture, and temperature, and then introducing variations of one at a time. Then, whatever differences are observed in the results obtained at the end of a certain time, are evidently due to the factor which has been changed. In studying the modifications caused by the hygrometric conditions of the air, M. Lothelier capped two specimens of barberry with a long cylinder of glass, along which he placed broad-mouthed flasks of sulphuric acid to absorb the moisture of the air; and two other plants with a similar tube along which were flasks filled with water. These two lots of plants, growing side by side under



Plants with Thorns.—1 and 2, *Berberis* (barberry grown under moist and under dry conditions); 3 and 4, *Genista*, or broom, moist and dry; 5 and 6, *Ulex*, or furze, moist and dry; 7 and 8, *Cirsium*, moist and dry; 9 and 10, *Pyracantha*, moist and dry; 11, *Xanthium*, upper sprig moist, lower sprig dry; 12 and 13, *Gleditschia*, or honey locust, grown in the sun and in the shade; 14 and 15, *Robinia*, or locust, grown in the sun and in the shade; 16 and 17, *Rosa*, grown in the sun and in the shade.

the same conditions of light, temperature, and watering, were then experimented upon for about six weeks, at the end of which it was found that the new leaves of the plants in dry air were spiny, while the leaves of the two in moist air were well developed, and had acquired long petioles. Like experiments were instituted on other plants, with always the same results; the differences of appearance presented by these plants as they grew in dry or moist air were really remarkable, and so great as almost to suggest that they were of different species.

An interesting observation was made that the disappearance of the thorns in moist air was effected in two different ways. The thorns, when they possess the morphological significance of a limb of the plant, whether of a leaf, as in *Berberis*, or a bough, as in *Ulex*, have a tendency in the saturated air to return to the normal type. When they proceed from organs that are not indispensable to the life of the plant, whether from a stipule as in *Robinia*, or from a stipule peduncle as in *Xanthium*, they tend constantly to disappear by retrogression.

The influence of light on the production of thorns was studied by M. Lothelier in a similar manner. His results were for the most part parallel. Shade tends to suppress the thorny parts of plants. The tendency is exhibited sometimes in a return to the normal form of the organ; but more frequently the thorns suffer a greater or less atrophy in the shade.

It is evident, then, that the conditions that most influence the production of thorns are especially dryness of the air and intensity of light. There are also, doubtless, other conditions of life that act in the same direction. I recollect having seen a cultivated and a wild olive tree growing side by side in the south. Only the latter had thorns. This even seems to me to be a general law which M. Lothelier has unfortunately not touched upon—that wild plants lose their thorns when they have been cultivated for several generations. It seems as if the plant, when brought under the protection of man, gradually gives up its defensive arms, which are thenceforward not needed, since its enemies are kept away by the care of its master.

The office of thorns is not limited to defending plants against herbivorous animals. With a number of plants, particularly those which form long shoots and live in thickets, thorns, usually curved downward, help hold up the stems. When thorns are localized on flowers, fruits, and seeds there seems generally to be a purpose of aiding in the dissemination of the seeds by enabling them to hook themselves in the fleeces of animals that come to graze among them. The thorns then serve for the defense of the species rather than of the individuals. The seeds which are aided by this mode of dissemination are called zoöphiles, while those which are adapted to dissemination by the wind are called anemophiles.—*Translated for The Popular Science Monthly from La Nature.*

Dean Buckland's interest in hyenas, whose remains and the remains of their feasts he found in the Kirkdale Cavern, caused some amusement to Lyell, who is quoted in Mrs. Gordon's Life of Buckland as writing to Mantell in 1826: "Buckland has got a letter from India about modern hyenas, whose manners, habitations, diet, etc., are everything he could wish, and as much as could be expected had they attended regularly this course of his lectures."

SOME MATERIAL FORCES OF THE SOCIAL ORGANISM.*

By Prof. JOHN W. LANGLEY.

AT the outset of this paper I wish to define one or two terms, and my own position in using them. The expression "the social organism" is generally taken in a merely figurative sense, but to me it has more significance than that. I will employ it with nearly its full literal meaning.

Society, denoting by that the people collectively of any one nation or government, is an organism distinctly endowed with the attributes of a living structure. Its individual units, men and women, are alive; its various political parties, charities, industrial groups, and its government all have an organic character; and, finally, the whole society shows the fundamental attributes of vitality in the specialization of parts, the partial co-ordination of these for a common end, and particularly by the constant phenomena of mutation and change.

The social organism is, then, a vitalized structure, not only in its separate parts but in its entirety. Now, if this is so, then many of the conditions which modify the more familiar forms of life may be expected to, indeed necessarily will, influence and modify the progress of social development and growth.

Foremost and most obvious of these conditions will be the character of the raw material of society—I mean matter, substance, material things. For, just as a brick house differs from a wooden one, even if the general plan is the same, because one is made of mineral matter while the other is vegetable; or, as a porcelain vase will differ from a bronze one of exactly the same shape by all the fundamental properties belonging to clay and metal, so equally must the possibilities of social conditions be fundamentally controlled and limited by the properties of matter.

There is a very different view from the above, illustrated by this quotation from Bishop Berkeley: "Some truths there are so near and obvious to the mind that a man need only open his eyes to see them. Such I take this important one to be, namely, that all the choir of heaven and furniture of the earth—in a word, all those bodies which compose the mighty frame of the world—have not any substance without a mind."

But the question I raise here is not one between the Berkeleian or the anti-Berkeleian philosophy, or between idealism and materialism, because for the practical purposes of this paper it makes no difference in which camp we stand; and while the language

* Delivered before the Cleveland Council of Sociology, June 25, 1894.

will necessarily be somewhat materialistic in terminology, because we are dealing with material things and material forces, the writer does not wish his words to seem to be conditioned by any metaphysical system.

Practically speaking, we are dealing with concrete things—stones, bricks, men and women, society. The materialist says they evolved themselves; the idealist says they were made by an outside agent; but for the purposes of this paper it is all one and the same, because any structure, whether self-created or manufactured by intelligence, is largely conditioned by the substance out of which it is made.

Now, how is society conditioned by that out of which it is made? How do the general properties of matter enter into the natural history of its development? That, I think, is a very interesting and a vitally important question if it could be answered in its entirety, but no one can do this for us yet. All we can do is to pick out a few characteristics so obvious that perhaps they will seem only trite. But granting they are so, still, it sometimes happens that the familiar and the commonplace take on new features when looked at from fresh standpoints.

The first thing, then, to be noted in regard to circumscribing conditions is that the inherent strength of materials puts a limit to the possible size of any structure, whether artificial or natural. As an example, consider a cannon: The actual size of a big gun is not limited by its weight, for much heavier ordnance than any now made could be handled by modern machinery; what stands in the way is the tensile strength of the metal employed. As soon as the pressure of the exploded powder upon a square inch of the internal surface of the gun is greater than the elastic limit of the steel, the metal will give way by stretching. This will enlarge the surface of the chamber, which will thus offer fresh portions for the action of the pressure, and so the operation will go on until rupture takes place. There is thus a certain powder pressure beyond which no thickness of metal, however great, can prevent bursting; this limiting size is already nearly reached in recently built cannon, and nothing but the discovery of some new metal or alloy stronger than steel will enable us to build guns materially larger than those now made.

Another instance is found in bridge work. As the spans grow longer, the proportionate load they can carry grows smaller. It is easy to calculate from the known properties of iron just how long a span must be to barely sustain itself. Nothing longer than this could stand, because, when the weight of the bridge puts a stress on its members greater per square inch than the breaking stress per inch, the bridge must fall, even without any extraneous load. In living creatures the same condition is found. No land animal is as large and heavy as a whale, because the bone and muscle of which they are made would be incapable of supporting so great a weight. In the water, however, it is different; the huge mass is evenly supported by the water in which it almost floats, thus relieving the anatomy of the whole from nearly all stresses due to gravity.

The same cause has operated to make all inhabitants of the air small. No very large bird, say as large as a horse, is known, and not even the extraordinary creations of past geologic ages show us any examples of very large flying creatures. The necessary relations between velocity of wing movement, weight, and size might be found for a flying elephant, but the intrinsic strength of living tissues would prove too weak to sustain so large a mass in the air by muscular exertion. So it is apparent that it is the intrinsic strength of living tissue, and not weight alone, which limits the size of aërial creatures.

The second general relation between substance and structure may be stated thus: "The nature of matter puts a limit to the intensity of action."

This proposition is nearly self-evident, and needs only one or two illustrations. All living structures consist largely of water. In the actively growing portions of vegetables upward of sixty per cent of the weight is water, while in animals more than seventy-five per cent of the weight of the whole body is represented by the same liquid. Physically and chemically speaking, life is chiefly an aqueous phenomenon. Now, as water forms steam of a quite sensible pressure at temperatures a little over 100° F., while it becomes a solid at 32°, we see that this property of water would alone be sufficient to account for the fact that living creatures can not grow and propagate outside of these temperature limits, while if they are somewhat exceeded, even the smallest and most resisting forms of life, the so-called germs, are permanently killed.

Again, the rate of nerve transmission in warm-blooded animals is about one hundred and fifty feet per second. A peripheral sensation takes a sensible time to reach the brain, another interval for the brain to act, and a third for the order to be executed. Herein lies the explanation why we are burned by unintentional contact with fire. All the time during which the message to and from the nerve center is being transmitted, the finger is passively lying in the flame and chemical destruction of tissue is going on, so that by the time the finger gets the order to move it has become badly injured.

If the nerves could take up and transmit a stress with the intensity and velocity of a copper wire carrying electricity; if the brain could act with the promptitude of a Leyden jar, and the muscles move like the snap of a steel trap, no one would ever be burned in those cases where freedom of bodily motion was possible. Thus the slowness of these processes resulting in injury to the body is, from the physicist's standpoint, a defect, but it exists because the nature of the matter out of which the man is built puts an undesirable limit to the intensity of action.

If we leave now the consideration of the static properties of matter, and view it in its dynamic aspect, we encounter a generalization of the widest significance. The most notable thing about the universe is that it is the scene of incessant change. Absolute stability is unknown; no single thing living or nonliving is exactly the same for two consecutive hours. Even those phenomena which stand as types of the permanent, the revolution of the earth and the position of the stars, are now known to be undergoing changes which, though exceedingly slow, are nevertheless constant and ever progressing toward some future condition whose character we know not, but which we are certain will be as fleeting and transitory as the present.

If "all our yesterdays have lit the way to dusty death," then is it not also equally true that all our to-morrows will usher in new and unknown forms of resurrection ?—for, I take it, the material universe of stars and planets, the great globe of the earth, the movements of matter and the sequences of life, all tell one impressive story, which is, that to undergo change, endless change, is the sentence pronounced on everything built of matter and having its share of the universal motion around us.

But while there seems no escape from the above conclusion, there is another generalization equally great, which is its supplement; this is, that the changes are not chaotic: everywhere there are method, rule, law; and these laws, as we interpret them, are the unchangeable elements of the universe. The method by which a given result is produced is not exhausted by that result. The rule that all living things must die will still remain unimpaired when the last man shall have sunk into his grave. The law that all things shall change is itself enforced and executed by that change, so that *it* remains permanent while the forms and agglomerations of matter are fleeting.

Now, the purpose of this paper, to which the above is a peroration rather than an argument, is to show that social changes, like other mutations, are governed by law. The discovery of these laws will constitute the *science* of sociology, just as in nonliving things the same kind of study is called physics or chemistry. The application of these laws will give us an *art* of sociology, very much as pure science finally culminates in engineering or medicine.

Religion excepted, the study of sociology as a pure science seems to me to be the highest field for the exercise of our intellectual faculties, for it includes ethics on the one hand and psychology on the other, both together constituting the phenomena of mind, while the visible results are conditioned by the attributes of matter. But to-night I propose to begin on a much lower plane, and to attempt only the suggestion of one or two simple laws which are common to nonliving structures, to living beings, and to an organized society.

Since the metamorphoses of matter are endless in number and infinite in succession, let us limit the word "change" to some fixed and definite alteration, such as the burning of an ounce of gunpowder, the falling of the water of Lake Erie over the cliff at Niagara, or the duration of a human life from infancy to old age. In this restricted sense physicists and chemists have recognized two kinds of changes: first, those which tend to go on indefinitely until all the matter present has suffered the alteration in question; second, those which give rise to products which are unfavorable to the original forces at work—such changes are self-limited and may cease, therefore, long before all the material has been used. As an example of the first type—that of unlimited change—I may again cite Niagara, for here the falling water sets up no reaction against itself. This is the popular idea of a change, because we seem to be surrounded only by such cases.

The falling snow or rain, the uprooting of trees by a whirlwind, the constant streaming away of light from a lamp or heat from a stove, with the concomitant burning of fuel, all are familiar experiences and they are unlimited in character. But while these and others like them have served to stamp the word "change" with a definite meaning in the mind of the public, it is because they seem the only types to a superficial observation. In reality, however, the other kind, the self-limited changes, are vastly more numerous. Take as an example the freezing of water: the moment ice is formed it acts as a partial nonconductor, or blanket, to keep heat from escaping, and so the rate of freezing is diminished, and here in our climate is wholly stopped when a thickness of two feet of ice is reached. Or, again, consider the case of an elastic body on which a weight is placed. If it is a spring, it will bend, and finally, if the weight is not too great, will reach a position where the latter is just supported. This equilibrium is brought about by the internal stress of resilience of the spring acting against the force of gravity, and thus the change in position of the weight has called forth a power which is the result of that change, and at the same time limits it in amount.

While this illustration is an elementary one, it is for all that exceedingly important, because it is so common; it covers every case of mechanical stability, whether of a house, a tree, a mountain, or a man walking.

There is another term to be considered in this connection which is used by physicists frequently in a special sense, and that is the word *system*. An open system is one in which the products of a change do not return into themselves, as, to repeat illustrations already given, a waterfall, a fire, or a whirlwind. A closed system, on the other hand, is one in which these products are retained, or at least the internal changes of shape or stress do not travel away; a pendulum might be spoken of as a closed system, because, while gravity causes it to move down to the lowest portion of its arc, the motion thus acquired carries it beyond this point and up the other side, thus converting actual into potential energy, and this alternate conversion and reconversion will go on forever in the absence of friction. Some machines may also be considered under this head, as a stationary steam engine. The apparatus is indeed receiving steam at one end and dispensing mechanical power at the other, but on the average these balance, leaving the machine as the seat of many complicated stresses playing back and forth against each other. In this respect the engine is a closed system.

Now, it may be laid down as a general proposition that self-limited changes occur only in closed systems. Also that any organized structure, and more especially a living animal, may be considered as a closed system; for, though it is true the animal is dependent on food, and is constantly giving out heat and other forms of energy, still, for any moderate period of time these balance each other, while the organism as a whole is dependent for its integrity upon a constant regulation of its internal states through incessant changes, which, moreover, must be self-regulating in character. Life is but a sequence of these delicately adjusted actions and reactions. Physiology is full of instances of this fact. One illustration may suffice. When a muscle is exercised, a portion of it is oxidized or burned. Some of the products of this oxidation are acids, but the vitality of a muscle is diminished by the presence of an acid. The sense of fatigue is the language by which the nerves inform the brain of this muscular state, and the mandate, Let the organ have repose, is only another way of telling the scavengers of the body to go and take that acid away. Here, then, the law is illustrated; the voluntary change in the muscle, represented by its work, sets up a chemical force which limits and finally stops the change by which it was produced.

One machine, more than any other I know of, represents the play of self-limited forces admirably. It is the alternating dynamo for the production of currents of electricity. It has also many of the attributes of an organic being, and I almost feel like saying it is alive. If we can not strictly and literally call it so, yet there are such broad features in common that I think we may study it as one of the nearest approximations by mechanism to some of the simplest forms of actually living creatures.

The general arrangement of the apparatus is as follows: A number of magnets, with their ends, or poles, alternately north and south, are arranged around a circle with the magnet legs pointing inward toward the center, but not reaching it. Within the smaller circle thus formed a few loops of copper wire wound on an iron drum revolve, but without touching the magnets or outer frame. So long as the inwardly projecting legs are not magnetized the armature, as the coils of wire are called, revolves freely, and no effort on the part of the engine or other source of power is required to turn it except sufficient to overcome the slight mechanical friction of the shaft. Also, if the magnets are excited and the copper wire of the armature does not have its ends joined so as to form a complete return path, there is no opposition to the rotation. But when both of these conditions are supplied—viz., the magnets, also called the "field," are excited and the armature wire joined to itself—then a mysterious and extraordinary resistance to motion at once occurs. If we are turning the armature by hand, it feels as though we were forcing it through thick jelly. If more force, such as that of a steam engine, is applied, it may take many horse power to revolve the armature rapidly, and yet there is no scraping or contact between the surfaces of the armature and field, nothing giving rise to ordinary mechanical friction, and nothing directly corresponding to the ordinary losses of power in other machines.

This wonderful result has been analyzed into three fundamental conditions, often called causes. They are mysterious, like the original phenomenon; but, then, every appearance in Nature is a mystery to the last analysis. These three are, first, a peculiar force emanating from the ends of the field magnets and extending from pole to pole by curved paths, called "lines of force," going through space, whether filled with substance or entirely empty. They are probably lines of stress in the ether, and we know that any metallic body placed in the path of these lines is submitted to the influence of the lines of force. Whatever this influence is, it does not give rise to anything perceptible to our senses in non-magnetic matter, like copper or India rubber.

Second. As soon as the wire moves so as cut through these invisible lines of force, a new stress, called electro-motive force, is produced in it, and now the free ends of the copper wire have suddenly acquired the property of attracting each other, but the magnitude of this attraction is exceedingly small. This electro-motive force is caused in some way by motion in a magnetic field.

So soon as the motion ceases the force is gone. But it is most important to notice that no power need be exerted by the engine to call forth a manifestation of electro-motive force, because there is not as yet any appreciable opposition to the rotation of the armature.

Third. The instant the free ends of the armature wires are joined, the attraction, or potential as it is called, diminishes, a current of electricity rushes through the wire, and the mysterious opposition to rotation at once springs into existence, the belt grows taut on the driving side, the engine takes more steam and labors harder and harder, while a constant stream of mechanical power must be supplied by it to the dynamo to maintain that motion which a minute before went on so easily and freely.

The electrical current passing out from the dynamo is constantly carrying energy away from it. This loss must be incessantly supplied by the steam engine, and this demand is brought about by the opposition to rotation set up within the machine through reaction of the electro-motive force on the material of the conductor and on the magnetic lines. Thus we have here the constant characteristic of a closed system where invariably the product of a reaction opposes the primitive cause of the change.

Thus far the phenomena just quoted exemplify the rule. It would not have been worth while to take so much time to describe the dynamo if nothing more was to be learned from it, but there is. This semi-living machine, whose elements are so simple compared with those of a really living structure, enables us, because of its mechanical simplicity, to go one step further in our analysis and to inquire how the result of the change reacts on the exciting cause. It is known beyond doubt that in a working dynamo the action of the current is twofold. It not only tends to stop the armature, but it actually diminishes the magnetism of the fields, and so lessens the electro-motive force by attacking it at the very place of its origin. Let me repeat: the magnetism and the rotation create the electro-motive force; this latter creates the current; then the current in turn reacts both to oppose the rotation and to cut down its own initial cause; and, further, this reaction on the cause is found always to require an appreciable time.

Here, I think, we have struck a new principle. In electrical matters it has been known only a few years, and has had no applications in other sciences, but I venture to think it is somewhat general, and that illustrations of it may be found elsewhere, one or two of which I will endeavor to submit.

A spiral spring supporting a weight does not manifest this principle, for the cause—that is, the weight—is not lessened by the pressure it produces. The same is true of all static states; but when motion occurs, then this new principle may often be observed.

Now, there are no more perfect examples of closed systems which are the seat of constant motion than living beings, because life is a type of never-ceasing co-ordinate changes. Can instances be found in living beings? What we have to look for is a reactionary force, which not only opposes the generating stress by setting up one like it and opposite in direction, but, furthermore, as the change progresses it must tend to reduce the initial impulses which created the change, this being what I have ventured to call the new principle.

Let us once more consider the case of muscular fatigue in the light of this idea. The initial cause of muscular contraction is the nervous stimulus sent to the organ. As soon as the muscle contracts, the motion within it generates free acid. This acid, which is therefore of the nature of a reactionary product, reduces the irritability of the fibrillæ, but, *in addition,* it reduces the power of a nerve to transmit and to generate nerve force, so that not only is the mandate traveling along the nerve resisted by the greater sluggishness of the muscle, *but also* the nerve force itself, which is the material form taken by the will, is attacked and lessened in the very place of its origin.

Is this not closely analogous to the cutting down of the electromotive force of the dynamo by the current which that same force creates?

Another example, dealing with the chemical rather than the mechanical force of the body, is found in digestion. Hunger is a sensation which is probably the collective cry sent up from all parts of the organism; but the stomach and certain nerves seem to be its principal seat. The irritability of a hungry man is a well-known phenomenon. The exacerbation of many nervous symptoms due to exhaustion is familiar to physicians. Hunger, then, is an active, not a passive, state, and denotes that certain changes of a positive kind are going on which tend to proceed to the ultimate destruction of the animal if not checked. When food enters the stomach and commences to be digested that organ works harder, but the production of this labor taxes the forces of the body by calling blood away from other organs; in addition to this, the nutriment given to the nerves stops the wasteful action going on in them. So here, as in the previous cases, the reaction set up cuts down the initial cause, and hunger vanishes.

Many other instances might be drawn from physiology, but, leaving them on one side, I desire to make a few suggestions concerning that larger aggregate of life—the social state.

The warlike temperament of man has been one of his most prominent characteristics from the earliest times. To live to fight has been the chief aim of most primitive peoples, and has been a leading occupation of all civilized ones. Armies have grown in size, weapons have multiplied in number and destructiveness, battles have grown more and more deadly in action, while also becoming more merciful in their accompaniments; but still it is everywhere apparent that, in spite of these aids to carnage, the military spirit is on the decline. May we not look for the cause of this in the enormously increased cost of warfare and its interference with the pursuit of prosperity and wealth? When the internal losses to a people become greater than those they can gain through conquest and annexation, they will be very loath to enter into a great conflict. I am very far from saying that many other causes, such as ethics and a growing spirit of mercy, may not have contributed to this pacification of the nations, but is it not true that the cost of war is the chief preventive of war? If so, does it not illustrate the rule that the reactions set up by the vast technical improvement of methods of destruction have reacted on the primitive cause of the destruction—viz., the human will—and have lessened the cause by modifying the heart and brain of man?

It is not a difficult task to point out analogies more or less vague. It is generally a safe exercise to move about in the region of diffused generalization. It is prudent to keep one's balloon in the clouds so long as the country below is full of sharp and jagged rocks; but, then, one must come down some time, and anchor the craft to some tangible thing.

Now, I must bring this paper to an end, and relate it, if possible, to some present fact, and the fact I want to tie to is the existing socialistic movement. That is rugged enough to gore anybody, and so I will approach cautiously with two or three suggestions.

A closed system, possessed of incessant internal motion and alive, is conditioned by many things, but three only of these have been touched on in this paper: First, by its size; second, by possible intensities of action; and, third, by the reactionary forces set up by changes now going on. That the size of a community tends to disrupt it no one will deny. That the intensity of effort of the whole community is dependent on the average vigor and intelligence of its members is also a truism; while the operation of the third law seems to me to lead to these conclusions: 1. The dynamic value of any social movement depends more on its past history than the immediate present. Any forecasts which ignore the past, and predict future states only by observing the momentary conditions of to-day, will be surely in error. Indeed, I would go further, and say that a visible movement is already but the autumn crop of something sown long before. 2. Any movement of a portion of the community thereby sets up a counter force, whose tendency is to lessen or abolish the initial desire which started the movement. Socialism, as the craving of the human mind, has appeared through all history, but it has hitherto been a desire mainly, not a force. Now it has become a power, and resulted in a movement throughout the civilized world; it will grow like the current in the dynamo, but, like it too, as the leveling downward of social inequalities goes on, it will raise up such a repulsion against a dead uniformity, and especially against the loss of those things which make life most worth living—art, music, architecture, education, and religion—that crass communism and anarchy will be extinguished by that which they are now evolving, and the doctrine of personal freedom will once more arise to work in a new but greatly modified field.

THE SERUM TREATMENT OF DIPHTHERIA.

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IT is almost seventy-four years since Bretonneau submitted to the Paris Academy of Medicine a report on croup and malignant sore throat, in which he maintained that a number of differently named diseases that were characterized by a membranous inflammation of the fauces and upper part of the air passages constituted but one specific disease, for which he proposed the name diphtheria. But the confusion he hoped to dissipate by the use of a generic term was maintained until recent years, notwithstanding the familiar employment of that term in medical nomenclature. There are few to whom its sound is unassociated with dread, for old and young, rich and poor, are alike susceptible to its infection.

In 1883 Prof. Edwin Klebs discovered, and in 1884 Prof. F. Loeffler succeeded in isolating and cultivating, the micro-organism now known as the Klebs-Loeffler bacillus, that is generally accepted as the productive agent of diphtheria. These bacilli, inoculated upon an abraded mucous membrane of animals susceptible to diphtheria, produce false membranes, systemic disturbances, and even death; they are found in the nasal and throat secretions and in the diphtheria membrane; microscopically they occur in the form of straight or curved rods that stain, with aniline dyes, most intensely at the ends, and thus present a dumb-bell appearance. Imbedded in organic matter and protected from the light, the bacilli may keep alive for many months outside of the animal organism. Uncleanliness, accumulations of dirt, and particularly dark, damp rooms favor the preservation of the bacilli and the propagation of the disease. This bacillus has never been found as the morbid agent in any other similar affection, or in a spontaneous disease among lower animals; nor is there any existing evidence to support the idea that true diphtheria may be conveyed from sick animals to human beings.

The diphtheria bacillus may be found in the air passages, especially the nose, of healthy persons, in whom it has produced no disturbance whatever, nor does it cause any indication of sickness until it has settled down for good. Lesions of the mucous membrane of the nose or throat, small eruptions in the air passages, chronically enlarged tonsils, and especially catarrhal changes consequent upon cold, damp weather, favor the development of the bacillus. If these membranes are normal, the bacillus finds insufficient material in which to multiply, and the poisonous products that it forms are thrown out with the mucus ordinarily produced; but if there is any lesion or disorder of the membranes, then these poisonous products act at first locally and cause such disturbances of the usual processes of the affected region that the bacilli multiply vigorously and form such quantities of their poison that it is absorbed into the system and the disease follows.

From the moment the bacilli are found on the membranes the person should be regarded as infected, and the term diphtheria should be reserved exclusively for those affections in which this particular bacillus is found. Not infrequently cases are met with that present the physical features of diphtheria, but a bacteriological examination will show that the condition is due to other organisms, such as pneumococci, streptococci, and staphylococci. Indeed, in 1887 Loeffler announced that, in addition to the organism identified with his name and Klebs's, there occurred in diphtheritic membranes another organism resembling it in many essential respects, but differing from it in its disease-producing power, and to this organism he gave the name of pseudo-diphtheria bacillus; these bacilli are shorter and more uniform in size than the typical Klebs-Loeffler bacillus.

The importance of distinguishing between these forms of throat inflammations is apparent when it is recalled that the specific character of the disease not only determines the necessity of isolating the affected person but also the method of treatment that should be followed. New York was the first city in which a municipality endeavored to make that distinction, and what is now known as the "New York plan" was inaugurated by Prof. Hermann M. Biggs, and his associate, Dr. William Hallock Park, of the Board of Health. In New York, as in most cities, physicians are required to report the cases of diphtheria they are called upon to treat; if the environment of the affected person renders it desirable to transfer the individual to a hospital for contagious diseases, it is a matter of importance to decide that the disease is diphtheria. Some of the material from the suspected person's throat is obtained by rubbing the latter with a rod having a piece of sterilized cotton wound around its end, and then the cotton is rubbed over a sterilized mixture of blood-serum contained in a closed test-tube, so as to transfer any micro-organisms from the cotton to the serum. The test-tube is placed in an incubating oven and within twenty-four hours the character of the growth of micro-organisms may be decided. In one year Dr. Park and his assistant, Mr. A. Beebe, made bacteriological examinations of 5,611 cases of suspected diphtheria, and the bacilli of true diphtheria were only found in 3,255 cases, or fifty-eight per cent, twenty-seven per cent of the cases being pseudo-diphtheria, and fifteen per cent being of a doubtful character. This seems to prove conclusively that every case suspected of being diphtheria must be examined bacteriologically by an expert.

The affected person should be regarded as infectious from the moment the diphtheria bacilli are found to be present upon the mucous membranes, and, while the bacilli usually disappear with or soon after the disappearance of the local signs, yet in some cases they may remain in an active and virulent state for weeks and even months after the patient has apparently recovered. Therefore no patient should be discharged as recovered until at least two or three bacteriological examinations, made at different times, have failed to reveal the presence of the Klebs-Loeffler bacillus in the secretions of the air passages.

Diphtheria is most rapidly communicated by direct contact between the sick and healthy persons. Coughing, sneezing, spitting, kissing, holding the patient's hands, the use of utensils in contact with the patient, drink or food in the sick-room, and clothing, books, and toys may be the media for carrying the bacilli. From this it may be appreciated that the diphtheria patient must be isolated either in a separate room in the house or in an isolation ward, and that there must be thorough disinfection of all articles in contact with the patient, as well as a local antibacillary treatment of the nose and throat to remove the bacilli and thus limit the possibility of their dissemination.

When diphtheria is prevalent the best prophylactic measures are cleanliness, dryness, ventilation, and proper light in dwelling rooms; cleanliness of the nose and mouth that may be secured by thorough daily irrigation with a one-per-cent solution of common salt or a two-and-half-per-cent solution of common baking soda, used as hot as can be borne, with careful brushing of the teeth and medical care of the tonsils if enlarged or diseased; and, finally, cold ablutions of the neck.

The difficulty heretofore referred to of distinguishing, by the naked-eye appearances, the diphtheritic from the pseudo-diphtheritic inflammation, as well as the formerly existing confusion regarding the identity of all such inflammations, at first inspired doubt in the minds of many investigators that the Klebs-Loeffler bacillus caused diphtheria, especially as it could be injected into animals without producing diphtheritic paralysis. But in 1888 Roux and Yersin found that such injections would kill animals if the bacilli were introduced in sufficient number and sufficient degree of virulence; and, further, that the growth of the bacilli in culture fluids produced poisonous substances, called toxines, so that if the cultures were passed through a porcelain filter in order to remove all the living germs, the filtered liquid would produce exactly the same symptoms, and consequently the microbe only acted through its toxines.

The toxine is produced by the cultivation of the virulent diphtheritic bacillus in broth, in contact with the air. Flat-bottomed flasks that have lateral tubes, and that contain a thin layer of a two-per-cent peptonized alkaline broth, are sterilized in an incubating oven, and then a fresh culture of very virulent diphtheritic bacillus is added to the broth. The flasks are kept in the oven at a temperature of 98° F., and by means of the lateral tubes moist air that has been passed through a wash-bottle is constantly kept passing over the broth; within from three to four weeks a culture that is rich in toxines is obtained, a thick layer of bacilli covering the bottom of the flask. All diphtheritic bacilli do not furnish the same quantity of toxine in cultures, nor is the power of the toxine the same in cultures that are apparently made under the same conditions. When the cultures are completed they are filtered by a Chamberland filter, and the clear liquid is kept at the ordinary temperature in well-filled, stoppered bottles, that are protected from the light. A dose of one tenth of a cubic centimetre, about a drop and a half, of this toxine usually kills a guinea pig weighing five hundred grammes, or one pound, within from forty-eight to sixty hours.

Pasteur's success in producing immunity to chicken cholera, anthrax, and rabies by the inoculation of toxines produced by those diseases has stimulated other investigators to seek out methods for producing immunity to the infectious diseases affecting man. Prof. Carl Fraenkel first immunized guinea pigs against diphtheria by injecting them, with great care, with diphtheria toxine modified by heating it at a temperature of 70° C. (158° F.). Subsequently Behring commenced his experiments regarding the production of immunity, and injected animals with a mixture of the toxines and iodine trichloride, though to-day he injects very small doses of pure toxine at sufficient intervals for the animals to rest comfortably. Brieger and Wassermann produced immunity by injecting a culture of diphtheria bacilli in a broth of thymus gland, after having heated it at 65° to 70° C. (149° to 158° F.) for a quarter of an hour, they having assumed that the thymus extract exercised an antitoxic influence on the specific diphtheria toxine. Roux and Vaillard immunized animals by a mixture of three parts of toxine and one part of Gram's solution of iodine, the substances being mixed a few moments before they were injected beneath the animal's skin. Roux found that a rabbit of medium weight easily supported an injection of half a cubic centimetre of that liquid, and after a few days the injection could be renewed and so continued during a few weeks, when the injection would be increased in quantity or the pure toxine might be administered. He also found that it was necessary to frequently weigh the animals and to interrupt the injections when they lost weight, otherwise a depraved condition of the animal's system developed, that might terminate fatally. Animals thus immunized may be injected with a dose of toxine, or a quantity of culture of virulent bacillus that would ordinarily be fatal with but little if any unpleasant effect.

In 1890 Behring demonstrated the fact that blood-serum taken from an immunized animal was capable not only of producing immunity from the same infectious principle in another animal, but, further, that it possessed the power of curing an infection already in progress. This latter remedial employment of serum containing some antitoxine is called serum therapy. The serum is called an antitoxine serum because it contains some agent that antagonizes the toxine.

Besides the serum, Ehrlich, Roux, and others found that the milk of goats and cows that had been immunized was a source of antitoxine, though such milk was much less active than the serum.

The investigators found that of all the animals capable of furnishing large quantities of antidiphtheritic serum the horse was most easily immunized. Roux frequently found horses in which the injection of from two to five cubic centimetres of strong toxine beneath the skin provoked only a transient fever and a local swelling that quickly disappeared. The cow and the ass were found to be much more susceptible to the action of the toxine. Behring held that the antitoxic properties of the serum furnished by an immunized animal were greater in proportion to that animal's sensitiveness to the action of the toxine. But Roux did not consider this an established fact, and since 1892 had employed horses for immunization against diphtheria, because horse serum was not harmful when injected into lower animals or man, and from the jugular vein of a horse large quantities of blood might be obtained from which a perfectly clear serum could be separated.

The horses selected for the purpose of supplying serum should, Roux states, be ordinary coach horses from six to nine years old, well nourished but incapacitated for work on account of some injury of the limbs. Such horses must be carefully examined to determine the absence of lesions of the internal organs, especially of the kidneys, while the absence of tuberculosis or glanders must invariably be determined by a failure of the animal to react to an injection of tuberculin or mallein.* Roux reported the details of the process in a horse seven years old, weighing four hundred kilogrammes, that was injected beneath the skin of the neck or behind the shoulder with toxine, one tenth of a cubic centimetre of which sufficed to kill a guinea pig weighing five hundred grammes in forty-eight hours.

Day.	Injected.
1st	$\frac{1}{4}$ c. c. of toxine with ten per cent iodine. No local or general reaction.
2d, 4th, 6th, 8th	$\frac{1}{2}$ c. c. Do. Do.
13th, 14th	1 c. c. Do. Do.
17th	$\frac{1}{4}$ c. c. of pure toxine. Slight reaction.
22d	1 c. c. " " " "
23d	2 c. c. " " " "
25th	3 c. c. " "
28th, 30th, 32d, 36th	5 c. c. " "
39th, 41st	10 c. c. " "
43d, 46th, 48th, 50th	30 c. c. of pure toxine. Œdema that disappeared in twenty-four hours.
53d, 57th, 63d, 65th, 67th	60 c. c. of pure toxine.
72d	90 c. c. " "
80th	250 c. c. " "

In two months and twenty days this horse received more than eight hundred cubic centimetres, or twenty-five ounces, of toxine with no worse symptoms than transient local swelling and temporary rise of temperature about one degree centigrade. Serum was obtained from this horse by bleeding it on the eighty-seventh day, and immediately thereafter two hundred cubic centimetres of toxine were injected into the vein with but moderate subsequent fever. The latter procedure is less efficacious than injecting smaller doses of toxine from time to time and allowing the animal to rest for twenty days before being bled again. Roux has horses from which blood has been taken more than twenty times with a large trocar, yet the vein is as supple as in the beginning.

The serum obtained from the horse above referred to had a preventive power above fifty thousand—that is to say, a guinea

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* Tuberculin is a sterilized and filtered solution, in glycerin, of a culture of the tubercle bacillus, and mallein a similar preparation of the glanders bacillus.

pig was unharmed by an inoculation of half a cubic centimetre (fifteen drops) of a recent virulent culture of diphtheria bacillus if it was injected one hour before with a quantity of serum equal to one fifty-thousandth part of its weight. If this antidiphtheritic serum is mixed with diphtheritic toxine, either in a test-tube or before injection into the organism, the toxine is rendered harmless.

The serum is obtained by abstracting blood from the jugular vein of the horse by means of a small hollow needle. All the instruments employed are carefully sterilized and kept in a five-per-cent solution of carbolic acid until they are used. The blood is received in wide-mouthed bottles, holding about two quarts, that have paper tied over the mouths, and that have been carefully sterilized. The horse is blindfolded, its extremities fastened to prevent struggling, a noose is passed around its upper lip, the neck is then made tense, the hair clipped from the skin where the hollow needle is to be introduced, and the entire locality thoroughly scrubbed with a five-per-cent carbolic-acid solution. A small incision is then made through the skin of the neck, and the needle, with the point directed downward, is passed into the jugular vein; a tube connected with the needle is pushed through the paper covering the bottle, and from one and a half to two gallons of blood are withdrawn. The blood is allowed to coagulate and the bottles are placed in an ice chest, where they remain until the serum, amounting to from five to six pints, has separated from the other constituents of the blood. In twenty-four hours, as a rule, the serum is withdrawn from the bottles by means of peculiarly shaped tubes devised by Pasteur, and it is transferred to a flask containing a small piece of camphor that is intended to preserve it.

The serum may be filtered through a porcelain filter if there is reason to believe it was contaminated during its withdrawal, or if it is desired to keep it for some time. As at present prepared the serum has a tendency to lose its remedial influence after it has been kept for a time, and especially if it has been exposed to variations in temperature or to light.

Numerous experiments on animals inoculated with virulent cultures of diphtheria bacilli showed that the quantity of serum necessary to save life varied according to weight, to dose of toxine, to quality of toxine, and to the time of intervention. The serum is preservative and therapeutic, not only when opposed to the toxine but also against the living virus. Roux has frankly acknowledged that these properties of antidiphtheritic serum were discovered by Behring, and upon them depends the serum treatment of diphtheria. The specific action of the serum depends upon a complex substance known as "antitoxine."

An animal injected with the antidiphtheritic serum becomes refractory to diphtheria almost immediately; but the immunity does not last, as it diminishes from time to time, disappearing in some days or weeks according to the strength and the quantity of the serum administered.

To give an idea of the strength of the serum used in his experiments on children and animals, Roux stated that one tenth of a cubic centimetre, about a drop and a half, of the toxine he employed would kill a guinea pig weighing five hundred grammes, or one pound, in forty-eight hours; but a mixture of one tenth of a cubic centimetre of this serum with nine tenths of a cubic centimetre of those toxines did not even cause a local effect in the guinea pig that received it. In other words, a dose of toxine that would suffice to kill nine average guinea pigs was rendered inert by one ninth of its quantity of serum. Experiments on animals have shown that where the toxine is introduced first it is necessary to give more of the serum, and after a certain delay the serum exercises no antagonistic effect on the toxine that was administered.

The preceding facts have served to bring us to the consideration of the use of the serum in the treatment of diphtheria. The prevalence of the latter disease may be judged from the reports of the United States census of 1880 and of 1890, the statistics of the former year showing that diphtheria and croup caused 77·96 deaths per thousand deaths, and those of the latter year showing that they caused 49·54 deaths per thousand deaths. This experience of a lessening of the mortality from diphtheria has not been confirmed by the statistics of New York city, in which there was a rise and fall from 1883 to 1892 inclusive:

Mortality per Thousand of Deaths.

1883	48·60	1888	63·54
1884	52·46	1889	59·55
1885	61·09	1890	44·46
1886	72·15	1891	45·12
1887	78·49	1892	47·55

In fact, it may be noticed that the year the census statistics were obtained the mortality in the city of New York was less than in any other year of the series. This oscillation has occurred in other countries. Thus, in England, during the decade 1861 to 1870 the diphtheria mortality was one hundred and eighty-seven per million living; during the decade 1871 to 1880 it fell to one hundred and twenty-one per million living; while from 1881 to 1890 it increased to one hundred and fifty-nine per million; and this increase was the more conspicuous because both the general death-rate and the death-rate from infectious diseases had been constantly diminishing during the three decades mentioned. With this evident increase in diphtheria mortality—an increase that is the more noticeable when the general activity in sanitation during recent years is recalled—the necessity for some remedial agent is apparent. Like epidemics of other infectious diseases, diphtheria epidemics show various characters; sometimes being very mild, sometimes very severe, with a high death-rate. This variation seems to be due to differences in the number and virulence of the bacilli, the result of unknown causes, to the association of other bacteria with the Klebs-Loeffler bacillus, and to unrecognized individual tendencies.

The serum treatment of diphtheria is being generally tried throughout Europe and America, and the evidence seems conclusive that it is of benefit. In a series of almost fifteen hundred cases of diphtheria that has been collated from the reports of a number of observers, treated by antitoxine serum, the mortality averaged 22·99 per cent, the maximum being 44·9, the minimum 5·5 per cent. This in itself is striking, for the usual diphtheria mortality is over 50 per cent. Roux, Martin, and Chaillon reported four hundrsd and forty-eight cases treated in the Paris Hospital for Children's Diseases, from February 1 to July 24, 1894, with a mortality of 24·33, while during the same time five hundred cases of diphtheria were treated in the usual manner at the Trousseau Hospital in the same city, and the mortality was 63·2 per cent. W. Koerte reported one hundred and twenty-one cases treated in the Berlin Urban Hospital between January 20 and October 27, 1894, with the serum, in which there was a mortality of 33·1 per cent, while of one hundred and six cases treated during a period of that time without the serum—none being obtainable—53·8 per cent died.

The injection, which is administered slowly in quantities of twenty cubic centimetres (a little more than five drachms) beneath the skin of the flank, is not painful; and if it is made antiseptically, no ill effect follows, and the dose is absorbed within an hour. In twenty-four hours a second injection of from ten to twenty cubic centimetres may be given, and the two injections ordinarily suffice to cure. The temperature usually falls after the injection, although in grave cases the fever may persist. The pulse becomes normal more promptly than the temperature.

The general condition remains good, as a rule; and the false membranes usually cease growing after the first injection, becoming detached within seventy-two hours. Roux gave a child a thousandth part of its weight in serum, though in severe cases he increased the quantity to a hundredth part of the weight. The treatment should be instituted as soon as possible after the infection, as those children treated with serum on the first or second day of infection have all recovered. While the experiments on animals showed that injections of the serum did not exercise a permanent influence in immunizing the animal, there can be no doubt that such injections would exercise a prophylactic effect if administered to those that have been exposed to diphtheria.

One of the great obstacles to the general employment of the serum is the cost of its manufacture. In this country from five to ten dollars is asked for a small quantity that sells on the continent of Europe for not more than one fourth of those sums. The British Institute for Preventive Medicine finds that the serum for a single case costs, to be manufactured, from fifteen to twenty-five cents. Public subscriptions have been started in various large cities in the world for the purpose of securing funds to establish and maintain laboratories for the manufacture of the serum. Roux estimated that for a population such as Paris has (two millions and a half) a serum laboratory would require twenty horses, three grooms, two bacteriologists, and two laboratory assistants, bringing the expenses of maintenance to eight thousand dollars a year, a sum that would be insufficient in this country, where the salaries, etc., would have to be so much higher.

From what has been said it may be deduced that the production of antitoxine serum is a matter of time, that it must be made with the greatest care, and that each lot must be tested to determine the degree of its antitoxic power. Only by such tests can its efficiency be determined, for there is nothing in the gross appearance of the yellowish fluid to indicate whether it will or will not exercise therapeutic influence. As no other remedy should be employed in conjunction with it, the dire results to the patient of administering a worthless serum may be appreciated. The Board of Health of New York has found specimens of serum, alleged to be antitoxic, exposed for sale, bacteriological tests of which demonstrated its worthlessness. This can only be prevented by the enactment of State laws that punish by heavy fine the sale of, or allow the recovery of heavy penalties for the administration of, any antitoxic serum that is not approved by the State Board of Health. The importance of exercising such control is appreciated abroad, where, in France, a bill is in preparation for introduction in the Chambers providing that no antidiphtheritic serum but that prepared under Roux's observation, or tested in his laboratory and found equal in curative influence to that prepared by him, shall be sold or administered. In Italy no antidiphtheritic serum but that prepared by Roux, Behring, or Aronson is admitted into the country. A good antidiphtheritic serum is not only harmless but is a remedial agent; a poor or spurious serum may be poisonous in itself as well as being worthless for controlling the disease.

Our present knowledge of diphtheria depends upon the discovery of its specific microbe by Klebs and Loeffler, on the proof that this micro-organism causes diptheria, on the isolation of the diphtheria toxine by Roux and Yersin, and on the discovery of the antitoxine by Behring. An immense field of research spreads out before us; for example, all but the last-mentioned fact is as true of typhoid fever as of diphtheria, and it is probably a matter of but a few months when physicians will be at work determining the scope of usefulness of a typhoid antitoxine.

WINDMILLS AND METEOROLOGY.

By P. J. DE RIDDER.

THE credit that has been given in all ages to the spirit of observation of sailors is only justice. There are other observers, however, no less sagacious and no less assiduous than sailors, whose powers have not been so conspicuously published. These are the millers of windmills. The number of these observers is necessarily diminishing rapidly in our days in consequence of the progressive disappearance of windmills before the advance of steam mills. Yet there are still in the lands of Holland and Flanders a considerable number of these old-fashioned millers, and it has occurred to me to give a few lines to the consideration of the way in which they observe the phenomena of the atmosphere.

They are real observers, as we shall show. The most intelligent of them observe, according to their own rules, all the changes of the weather. Those of a lesser degree of intelligence are satisfied with noticing the movements of the mills situated farthest in the direction whence the wind comes, and thus regulating the management of their own mills after the example set them by their fellows. These prepossessions of millers concerning the weather should not surprise us, for it is in the line of their direct interest to prognosticate atmospheric changes, and especially to be able to foresee how strong the wind will be, as much for the safety of their mills, which are exposed to all the storms, as in view of keeping on good terms with their customers by properly executing their orders.

So, after a considerable duration of calm weather, the miller, seeing the cirrus and the cirro-stratus appearing in the southwestern horizon, joyfully exclaims:

"To-morrow the wind will blow
And the mill will turn."

Modern meteorology was still in an embryological stage when the millers had attributed their true signification to the cirro-stratus clouds which stretched out in long, narrow bands, sometimes from the horizon to the zenith. They called them "wind trees." They were as well acquainted with the cirro-cumulus, the alto-stratus, and the cumulus. Proof of this is found in the enigmatical and obscure language of an old miller who declared he had seen in the sky "a shepherd under the shadow of a tree while the sheep were pasturing in the field."

Besides looking into the nature and meaning of the cirrus and the cirro-cumulus, the miller tried to calculate the force of the wind in distant storms; he observed the direction and velocity of the lower clouds; he estimated at sight the volume and density of the storm clouds; and if the wind fell off before the rain came, he recollected the old saying, "A calm comes before a storm."

He especially displays extraordinary vigilance in times of heavy showers. He observes, among other things, if the mills farthest away in the direction of the rain have kept their sails unfolded; if they have, it is a good sign. He scrutinizes the sky at every moment, from the zenith to the horizon; he measures the curvature of the forward part of the precipitation or of the storm. The lines of rain or hail that escape from it show him by their length and their approach to the perpendicular how intense the precipitations are. If the lines run obliquely, he is shown the direction of the dominant wind in the squall—in short, no sign indicating the force and direction of the wind passes unperceived by him. He knows likewise that these showers are often accompanied by tempestuous, plunging gusts which seem to come out of the clouds; and frequently, before the most advanced flecks of the storm cloud have reached the zenith, the sails of the mill are rolled up around the arms so as to give the squall free passage.

Except by meteorologists, it is still not generally known that the air is urged on more violently on the right of the squall than on the left; but the old miller knew it long ago by experience. The storms that passed by on his left, from west-by-southwest to south, never gave him any fear, and he confidently left his sails all unfurled in the wind; but whenever he was directly threatened with a storm which would pass over his zenith, or which was coming from the right—that is, from north-by-northeast to east, at a distance of less than five kilometres—he foresaw the possibility of a strong blow, and took his measures accordingly. I never knew of a miller who could account for the squalls from his left being less formidable than those from his right. The explanation of the phenomenon was reserved for modern meteorology, which has taught us that squalls and thundershowers constitute depressions in miniature, or at least weak secondary depressions dependent upon a principal depression and formed under its immediate influence.

The old miller, an observer by virtue of his profession and then an observer by the force of circumstances, was obliged to study the wind in all its manifestations of direction and force; he was thus aware that its maximum velocity corresponded with the maximum temperature of the day. Although this rule is not without exceptions, the miller was rarely mistaken. Proof of this is given in the habitual and reassuring response to the farmers who came to the mill in the afternoon, when the wind had fallen so low that no grinding could be done:

"Come to-morrow noon again,
And then I will grind your grain."

Everyday observation has taught us that things really go thus when the wind originates under anticyclonic conditions; in the opposite case, if the wind rises in the evening and gains force during the night, the meteorologist concludes that its origin is cyclonic, and a change of weather is probable.—*Translated for The Popular Science Monthly from Ciel et Terre.*

In a paper on the Inheritance of Acquired Characters, Prof. A. S. Packard assumes that "all progress in humanity appears to be due, not only to our maintaining the present intellectual environment, with the manifold and many-sided stimuli of our present social structure, but also to the unceasing efforts of the leaders in advanced thought in many different departments of training and effort to open up new fields of research in natural, physical, and mental science and their applications, to gain new and higher points of view in sociology and morals as well as in statecraft, and, in short, to perfect and hasten the development of the ideal man. Unless this progress, which is a historical fact, has been due, not only at the outset, but all through human history thus far, to this principle of the inheritance of mental traits, causing the intellectual efforts of one generation to pass down and thus to have finally a cumulative effect, how could there be any progress in human society? On the one hand, let us imagine a cessation of the operation of this principle. Suppose all the forces and stimuli of modern society to be removed, and the human organism to live like blind beetles in a cave, or a savage tribe isolated in the midst of an otherwise uninhabited continent, with a total uniformity of conditions, physical, social, and moral, the effects of disuse would at once set in. Heredity without this vivifying principle of cumulative transmission, as it might be called, would be retrogressive in its action, and the race would by reversion return to the status of prehistoric times. Or, on the other hand, if the present intellectual environment were maintained without the cumulative action of the principle of inheritance of acquired characters, the social organism would become stagnant, and the race would be semi-fossilized, or in a state of arrested development, like the Chinese."

BRAIN DEVELOPMENT AS RELATED TO EVOLUTION.*

BY HON. G. HILTON SCRIBNER.

I.

NO subject in recent times has received so much attention, or been so carefully investigated, as the question of the origin and age of man. Even that large class of scholars who long since came to regard the development of man from lower forms as a closed question have persistently held that it would be extremely desirable to ascertain the full extent to which visible and indisputable evidences could be discovered and authenticated, bearing upon this particular issue of the antiquity of man in the developed form we now call a human being. And it is safe to add that no investigations have ever been carried forward with more circumspection on the one side, or under the fire of a more searching and severe criticism on the other. For this question, involving the origin, and age of man as such, constitutes the very pith and animus of the captious contention still going on as to the soundness of what is commonly called, in a broader sense, the doctrine of evolution.

If the theory of the gradual unfolding of all other organic life could possibly have been accepted without disturbing the belief in the recent and exceptional origin of man, it doubtless would have long since received the approval of all intelligent minds.

It is because man, the head and consummation of all animate existence on the globe, is drawn into the restless current of all common and lower life, although in the van yet as part and parcel, kith and kin of it, that the whole theory of evolution is at first thought and to many minds fearful and shocking. Therefore the arguments and the objections constantly hurled against the broad conception of evolutionary descent involving man are legion, and this theory could never have held its ground against such an assault but for the one controlling fact that, fortunately or unfortunately, it is true. It is so true that, like a principle in morals, or the philosophy and spirit of Christianity, or a logical sequence, or a theorem in mathematics, when once understood, it compels belief.

Its critics, therefore, from whose ranks nearly all converts to the theory have been made, regarding the antiquity and origin of man as its most objectionable feature, have very naturally and from the first attempted to discredit all evidences of his prehistoric existence.

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* Read before the Fortnightly Club for the Study of Anthropology, of Yonkers, N. Y., February 16, 1893, by G. Hilton Scribner, president.

For instance, the reality and authenticity of the "human remains and works found in the Danish shell mounds and peat mosses, in the lake dwellings, in the coral reefs of Florida, in the cromlechs, barrows, and kistvaens, and in the rock shelters," were at first disputed, and when fully established by repeated discoveries it was then claimed that they all fell within the historic period. This contention was, however, quickly overshadowed and swept away by the more recent and numerous discoveries of stone implements, carvings, and human remains found in England, France, Belgium, Sicily, and America.

"Many of these discoveries were made in the valley of the Somme, the caves of the Dordogne, the valley of the Ouse, the basin of the Seine, the valley of the Thames; in the clay of the Hoxne, in the gravel of Icklingham, in the caves of Engis, Engihoul, and Neanderthal; in the cavern of Wells, in the caves of Gower in Glamorganshire, in the Grotto di Maccaquone in Sicily"; in the aqua-glacial deposits of the Delaware, of southern Ohio, of Mississippi, in Minnesota, and also in the old river bed under Table Mountain in California, and in many other localities, carrying back, in some instances, the age of man as a human being probably to the first or great Glacial period, and certainly to the beginning of the Quaternary, "for many of these remains are found intermingled with the bones of that large class of extinct animals which passed away with the telluric conditions to which these animals were organically related."

Now, since the almost immeasurable antiquity of man, as such, has been thus shown and placed beyond reasonable doubt, a new and popular objection has come to the front which brings us face to face with the subject in hand.

It is claimed by an immense number of people who are but slightly acquainted with the subject in its broadest significance, that the cranial capacity of these early men is found to be nearly equal to that of modern savages; that the cranial capacity of the modern savage is nearly equal to that of the average routine laborer among the civilized of to-day; and that these facts are inconsistent with the alleged progressive and developing character of man structurally and organically. And it is also urged that these discoveries really show affirmatively that man, as a human being, has always been mentally, structurally, and organically just what he is now, at least as far back as we have been able, with all our research, to trace him.

Now, these objections merged in one are, as we have stated, based upon an alleged comparative uniformity, or nearly equal cranial capacity, at present and during all the past ages, whenever and wherever man has been revealed.

This objection is what it appears to be, a random shot, or a convenient expedient, resorted to by that large class of persons who have made no exhaustive examination of the subject; but, baseless as it is in fact, it has about it a certain degree of plausibility not common with its predecessors. Moreover, as it is probably the last objection possible in the premises, it is better to deal with it patiently and set it aside carefully and becomingly.

It is not quite true that the cranial capacity of these ancient and primitive men has been shown to be nearly equal to that of modern savages, but, not to split hairs, let it pass that it is so, for a comparison of the cranial capacity of the savage and civilized races now existing, and an explanation of their relations in this respect, can be more accurately made, and it may be assumed that no one will be found to deny that a great change of some sort has taken place which is synonymous with what is commonly called the rise from savage to civilized life, even though the cranial capacity of the two classes should be held to be nearly equal—which, however, is not, as a rule, the case; at any rate, the two questions thus presented are as exactly alike as are two equilateral triangles, and so the former is fully answered by making a satisfactory disposition of the latter.

If we first consider, then, the difference in cranial capacity between the lowest savages and the highest civilized men, we shall at least know that all other cases will fall within the limits of this comparison. For this purpose perhaps no better or more reliable information can be found than that furnished by the exhaustive and well-known investigation made by John R. Marshall, F. R. S., Surgeon to University College, London, and reported in the Transactions of the Royal Society as early as 1864, and thus before the question we are examining became important. The entire report is very lengthy, extending to the minutest details.

The subject was an average Bushwoman, selected and sent him on request from southern Africa. She was about fifty years of age and five feet in height. Her brain weighed thirty-one ounces, while that of an average European woman of the same age and height would weigh forty ounces. The ratio of the Bushwoman's brain weight to her entire weight was as one to forty-five, while that of an average Europeon woman of the same age and height would be as one to thirty-seven. Let us now look at the extremes. The cranial capacity of the Bushwoman was sixty-one cubic inches, while the largest cranial capacity known in America is that reported by Morton, of Philadelphia, as being one hundred and fourteen cubic inches, and the largest in Europe is that reported by Wagner, of Germany, as one hundred and fifteen cubic inches. Still, this Bushwoman had a generous cranial capacity considering her race, for the average negro has but from sixty-one to sixty-nine cubic inches—the former being her exact capacity. The Malay, although much higher in intelligence, has a still less cranial capacity, being only from fifty-seven to sixty-two, thus showing at the largest but one cubic inch in excess of that of the Bushwoman, and at the lowest, four cubic inches below hers. The Hottentots, but a shade if any higher in intelligence, have the large comparative average of seventy-five, or fourteen cubic inches more than the Bushwoman; while the Hindu, with all his arts and sciences, his literature, castes, complex government, and great book religions dating back to the very dawn of the historic period, has a less cranial capacity than the Malay, the negro, or the Hottentot, and it has been found in some normal instances as low as forty-six cubic inches. Is it not clear, then, that cranial capacity alone is not an infallible index of mental capacity or intelligence?

But Mr. Marshall found other and more important conditions in which the Bushwoman was exceedingly low down, notwithstanding her comparatively ample cranial capacity.

Let us quote his own words: "The convolutions are remarkably simple. The extreme curved convolution forming the outer border of the frontal lobe consists of three short, simple, curved branches, very like those found in the ape, instead of the tortuous sulci seen in the European brain. The forms of the surrounding orbital convolutions themselves, including the supra-orbital, are so broad and simple that the subordinate divisions which are so complex in the European brain can hardly be said to exist. All four of the primary convolutions are present, but all are characteristically short, narrow, and simple, instead of being complex and occupying a large space, but the arrangement is normal. They are evidences of structural inferiority, and show an infantile or even fœtal leaning." Having regard to the sum of its convolutional characters, judged by their presence or absence, their individual and relative size and position, their comparative simplicity or complexity, and the symmetry or asymmetry of particular fissures and convolutions, there is after all, Mr. Marshall concludes, a greater difference between the Bushwoman's brain and that of the highest apes yet described than between it and the European brain, but not so great a difference as exists between the brain of the orang and that of the chimpanzee, or between the brains of many other species of quadrumana.

Here we have two very interesting and important facts disclosed, which have been substantiated by many other similar investigations, of which this recital is but an example. First, that cranial capacity is not the main factor in determining intellectual and emotional development, but that increased brain surface, or the extent, number, variety, and depth of convolutions by which the brain surface is increased, do furnish a better index. Second, that this physical co-ordination with increased mental and emotional activity, this physical manifestation of developing mind, has already taken place in the brains of apes, and is foreshadowed in the lower species of quadrumana.* Furthermore, from an intelligent standpoint this is precisely what might have been expected.

Let us bear in mind that out of all the innumerable, almost infinite number of variations, eccentricities, and oddities, however slight, found by examining each individual microscopically (if such a thing were possible), those minute changes and peculiarities, and those only, will be preserved in the long run, and after many generations, which are of such a character as to secure for their possessors more vigor and longevity than those without them can possibly have, simply because vigor and longevity vastly increase the opportunities of heredity.

Now the size and weight of the brain in proportion to the size and weight of the body is just one of those important proportions of parts which would make for or against the vigor and long life of the individual in a marked degree. One other concurrent condition, however, would perhaps be of even greater importance, and it is this: that the height, size, form, and weight of the whole body should have the fittest adaptation to its circumstances and to the work required of it, in order to secure the greatest vigor and longest life, and so at last to become the characteristic of every member of the species. So it is plain that the brain as to size and weight must stand two tests. It must not only bear the best possible proportion to the body, but that body must be of the fittest size and weight to meet successfully, and for the longest period, all that it is compelled to encounter, and thus to succeed above all other less fortunate individuals in finally making this double due proportion the property and the universal characteristic of the species. Within these limitations and conditions, but not otherwise, the size and weight of the brain and consequent cranial capacity are doubtless subject to the amount of mental instinctive, receptive and emotional activity demanded of it, and carried on within it. In shorter phrase,

* Functions of the Brain, by David Ferrier, M. D., F. R. S., Professor of Forensic Medicine, King's College, London, published by Smith, Elder & Co., 51 Waterloo Place, London, p. 297: "The brain of man is constructed on the same type as that of the monkey, and essentially the same primary fissures and convolutions are recognizable in both, the chief differences consisting in the greater complexity of the convolutional arrangement of the human brain, caused by the development of the numerous secondary and tertiary gyri, which tend to obscure the simple type of the simian brain. These differences are more marked in the adult and highly developed brain, but are less pronounced in the fœtal human brain." See, also, Ecker on the Convolutions of the Human Brain, translated by Galton, etc.

the brain may grow with increased exercise and larger and more frequent demands upon it like any other organ up to the point of becoming out of due proportion to the body, but still, the individuals possessing brains which exceed this limit would necessarily labor under such a disadvantage, as entire organisms, that they would in time be eliminated from the species. Now these are not simple deductive conclusions, as we shall soon see.

We have now cleared the ground for a statement of the actual sequential physical development accompanying increased mental activity after the head has attained such size that the cranial capacity can not be further enlarged without serious disadvantage to the individual. It is well known tha' the exterior surfaces of the brains of the lower vertebrates have, as a rule, comparatively smoother surfaces where they come in contact with the cranium, showing that the capacity of such heads as are in best proportion to their bodies is quite sufficient (without any such convolutional development as we find in the case of man) for all the mental and emotional activity and brain work demanded in the lives they lead.

But there are other animals that have thumbs opposed to four fingers like our own, and they can use these hands as we use ours, they can pick up stones and sticks, fruits, seeds, and nuts, catch insects, break branches and throw them down; they can pick and pull things in pieces, examine, inspect, and experiment with them, and reach conclusions (such as they are) about almost everything with which they come in contact. They can also unite their strength and their ingenuity, and can thus render services to each other. All this naturally multiplies their needs, and much more their desires, renders the exigencies of their daily experience more frequent and important, and their lives more diversified and complex. Thus the mental and emotional activities of all the quadrumana are so much increased by the use of a thumb and fingers that a head which is in due proportion to a body such as would be best adapted to springing, climbing, jumping, swinging, and other arboreal habits requiring great activity and expertness, has not sufficient cranial capacity for a brain with so much mental and emotional work to do. Here, then, we find for the first time a variation which characterizes more or less the whole family of quadrumana according to the degrees of intelligence of the several species. It consists of slight corrugations on the exterior of the brain, thus increasing the superficial area for the gray matter, without enlarging the head, the brain weight, or the cranial capacity to their disadvantage in other respects.

In the case of anthropoid apes, and proportioned to their greater intelligence, these corrugations or convolutions are increased in number. In the case of the lowest savage there is still another increase in number, variety, and depth, as we have seen in the case of the Bushwoman. And thus these convolutions go on *pari passu* with increasing manual dexterity and intelligence, multiplying, assuming more varied and complex forms and greater depth, until we reach the most thoughtful and learned members of the highest civilized communities, where the brain surface if smoothed out would measure, on an average, about four square feet.

What immediately concerns us, however, in this connection, is the fact that not only the savage and the primitive man, but the ape and even certain quadrumana, have already found more contriving, thinking, remembering, and other kinds of brain work to do than a head and cranial capacity in due proportion to their bodies will admit of. And thus each and all are preserving and perpetuating by natural selection and heredity all the variations of increased cerebral surface resulting from more numerous, varied, and deeper convolutions.

Is it inconsistent, then, with the theory of evolutionary descent for the savage to have the largest possible cranial capacity and head not out of due and advantageous proportion to his body and the demands of his mode of life? This question is completely answered by the fact, which has now been fully set forth, that the further growth of head and consequent cranial capacity in his case has been already arrested, as in the case of the ape and the quadrumana, at the point of becoming too large for his body and mode of life, while his still increasing and developing mental and emotional powers and activities have already found a substitute for further cranial capacity, or head growth, in more numerous, complex, and deeper convolutions, thus increasing the brain surface.

It is surprising that this objection has not been earlier demurred to on the specific ground of inadequacy. It now appears that as well might the cranial capacity of an ape as that of a savage or a primitive man be made the basis of this objection, since in all three cases further head growth has been checked at the point of undue proportion to the body, and thereafter increasing mental activity has found a physical substitute for further head or brain growth in the preservation, as a fitter adaptation, of every fortuitous variation in the direction of these increased convolutions, first foreshadowed in the quadrumana, reaching the highest complexity in civilized man, and co-ordinated to advancing intelligence at every intermediate step.

Thus we see that this popular objection crumbles at the first touch of a few simple and well-known facts.

II.

We have now reached a position where we may compare with more interest than before the mental activities of the savage with those of the routine laborer in civilized life, and thus show inductively that the conclusions adopted are sustained by an applied and practical test.

We are all equally well qualified probably to form an estimate of the degree of emotional intensity and mental strain exercised in making again and again for a lifetime the same one single thing—for instance, a pair of shoes or trousers or a coat; in doing mason, painting, or plumbing work; in constructing furniture, shoeing horses, or setting type; in putting bobbins into and taking them from a machine in a factory, or in running the machine itself by switching on and off the belt; or in running the engine which propels the machine, or even in running a lathe which carves out over and over again the same part of some machine or implement; or in planting, harvesting, mowing, or chopping, or any other kind of routine work which is learned by imitation and thereafter performed automatically. Of course, the case was different when the same man, as formerly, had to perform nearly all the above kinds of labor for himself.

It is safe to say, however, since the recent extreme division of labor, that a month of any one kind of such work would not give rise to as many exciting incidents or unexpected exigencies stirring the emotions and requiring sagacity, mental alertness, quick perceptions, rapid decisions, and skillful execution, as would be encountered in a successful attempt to catch a squirrel, kill a deer, or fight a wild cat with savage appliances.

Flippant and superficial as such a comparison may seem, at first blush, in a serious paper, it is, however, quite necessary to illuminate, as no other method of presentation would do, the almost immeasurable difference between all the vocations of the savage and those of the routine laborer in our civilized life. To get a living, the hunting savage of the stone age is obliged to go through these wildly exciting experiences and vicissitudes, no two of which are exactly alike, nearly every day of his life, and frequently several times a day. It is, moreover, the exciting nature of primitive pursuits which makes this everyday labor of the savage a lively and interesting recreation for the most cultured and intellectually advanced classes among the civilized.

Now this wide and extreme dissimilarity arising from the very nature of savage pursuits, when compared with those of the routine laborer, uncovers to our view a far-reaching cause in development of which careful note should be taken.

The savage, as we might even now imagine, and a little later on shall more fully see, has a brain which is insufficient for his mode of life, and it is therefore constantly overtaxed by the amount of mental and emotional activity required of it. This, too, is the one antecedent condition and primal cause underlying, lifting, and advancing not only his but all human brain development, and probably all brain development.

Here we must leave for a time the savage and consider the present condition of the routine laborer.

He, on the other hand, has more cranial capacity, and convolutional development than he needs or knows what to do with. Two great changes have recently come over the whole civilized world, and among many other far-reaching effects these two changes have left him in this unfortunate condition. In the first place, machinery has taken the place of implements, and the latent energy of lifeless matter has been transformed into kinetic force and has taken the place of muscular power. The greater and constantly increasing part of his food is sown by machinery, cultivated by machinery, harvested, thrashed, transported, ground, cooked, and brought to his door by machinery. He is clothed, sheltered, and shod by machinery. His house, except the putting of it together, is made by machinery. The water of a distant lake or stream is brought through pipes to his very lips by machinery. His furniture, utensils, and tools are all made by machinery. His distant communications are conveyed by machinery. He himself is transported about from place to place by machinery. His cradle and his coffin are made by machinery, and from the time he leaves the one till he enters the other he is lucky if he finds any more soul-stirring or intellectual employment than feeding, watering, shining up, waiting upon, and serving a machine.

The second great change is of a social character, but it has been greatly hastened and extended as a result of the first. At any rate, the two, each supplementing the other, have left his inherited cerebral outfit almost wholly unemployed, as compared with its busy activity at a time not very remote, even in the age of our grandfathers, when, like the savage, the worker cared for himself and his family and did nearly everything for himself, instead of doing possibly, as at present, some one thing for himself, and having all else done for him.

His children now receive a rudimentary education in public institutions, their moral and religious instruction is received in the free Sunday school; hospitals, dispensaries, and doctors take care of him when ill, and charitable societies take charge of him when he comes to want; savings banks receive his money and manage his investments; insurance companies relieve him from the calamities of fire and flood, accidents, illness, and death; public health officers sniff through his dwelling and order its sanitary conditions; public overseers of buildings supervise its construction, and are required to serve notice on him when it is likely to tumble down and hurt him; the police protect his person and his property, and the courts settle his disputes; he is examined, vaccinated, and protected from contagious diseases at public expense; the overseers of the poor help him in unexpected exigencies; public baths are provided for his use, and public soup houses are opened for him in time of general depression; temperance societies try to help him control his appetite; salvation armies endeavor to restrain his vices and improve his habits; trades unions tell him when he may and may not work, what work he may do and who he may work with, how much he may do in one day when he does work, within how many hours of that day he will be permitted to do it, and who he may or may not work for, and the least price he will be permitted to receive for his labor; the churches all assist him in his spiritual and religious life, and the largest and oldest of them all will engage, for a small weekly pittance and a few formal observances on his part, to safely deliver in paradise at last what little soul a man may have left after such a life as this. Thus all the complex cerebral and convolutional development in his case, which it has taken perhaps some hundreds of centuries to build up, is rendered comparatively superfluous and, to the same extent like all unexercised and useless organs or parts of organs positively detrimental and so to be modified or got rid of, and all brought about by these two great changes, we brag of (and with good reason from other points of view), both of which changes have taken place within the last two centuries, chiefly within the last hundred years, and the most important features of each within our own lifetime.

It is possible, of course, that some unforeseen change may occur, and it may bring with it some new and unexpected field for the exercise of his former mental activity, but at present it is neither apparent nor probable. Thus the routine laborers, constituting a large proportion of the inhabitants in many civilized countries, most of whom have, or recently had, sufficient cerebral capacity for great mental activity, are left with little more need of, or exercise for a complex organ of thought in the performance of their actual work than a caged squirrel has in rotating his wheel, and outside of their actual work society in one form or another has taken almost complete charge of them and of all which formerly interested them. It is certain that with this continuing condition—despite all social and educational efforts to the contrary—the routine laborer must fall back through atrophy and degeneration to some plane where the equilibrium between his inherited cerebral capacity and the actual demand for mental activity shall be restored.

We have now only time left us to review briefly two or three of the many peculiarities of savage life which stimulate increasing mental activity and its physical manifestation in convolutional development, and which peculiarities do not to the same extent, if at all, affect civilized men, and especially the routine laborers among them. To do this exhaustively would require a volume, and we can therefore only glance at the matter in the most cursory manner.

It is an open question as to the extent that the use to which learning is to be put constitutes a factor in determining the value of the mental development received in acquiring such learning. To whichever school of thought one may incline, it can hardly be denied by either side that in the acquisition of the same knowledge by two persons, the one for one purpose and the other for an entirely different but equally important object, the strengthening and developing effect, other things being equal, would be the same. Now the common hunting savage of the neolithic age takes up one branch of the study of natural history and pursues it until he is able to teach an Agassiz, an Audubon, or a Darwin. Not one of these learned men knew, after a life of study and observation, as much about this one thing, the habits of the wild beasts, birds, and fishes, as does the average savage hunter. To him such knowledge means food and life, and the lack of it hunger and starvation. He must know their color, size, and movements; when, where, and how they get their food and water; where and how they make their nests or lairs or homes; when they rest and when they go forth, and where; all their cries and sounds, and the meaning of them; and he must be able to imitate them so exactly that they shall think these sounds made by one of their own kind; he must know when and where they are moved about by winter and summer, by drought and flood; when and where they breed their young, and in each case whether the young are protected by hiding, defense, or flight. He must know what animals have leaders or sentinels, and how to distinguish them, and how to interpret their sounds of alarm, and distinguish them from the sounds of safety, and he must be able to perfectly produce both; he must know their strength, alertness, and acuteness of sense, speed, and endurance as related to the species and to the age and sex of the individual; he must be familiar with their dispositions, their courage, cunning, intelligence, and timidity, and be able to determine in advance what they would probably do under all conceivable conditions. Then it is not less necessary that he should know all the relations of each species to each and all of the others. To acquire this knowledge he must roam far and wide, and to do this with safety he must learn the physical geography and topography of the country; he must know the trend of the coast, the course of the rivers, the valleys, and the mountains, and the extent of the different water-sheds; he must discover the location and character of all the varieties of vegetation upon which animals feed; he must learn all their methods of capture and escape in all cases where they feed upon each other; he must become an expert in the study of all their tracks and the traces of their movements. The broken twig, the cropped grass, the grazed log, the pressed or upturned leaf must each reveal to him a whole series of facts in which a determination of the lapse of time is always most difficult; he must study the movements of the sun and moon and planets, and the position of the stars; he must learn to determine direction by the growth of mosses, the leaning of trees and the appearance of the foliage, and many other things equally important.

It is true that some part of this vast amount and variety of information may be communicated and so handed down from one generation to another, but the larger part must be acquired in the field and by each individual for himself. Much of it to be of practical use must be accompanied by the most wonderful skill and adroitness in its application. A practiced eye, an acute sense of hearing, deftness in movement, promptness in decision, coolness in execution are indispensable, and can not be taught orally or communicated. No civilized man could equal a savage hunter in this whole department of knowledge.

But comparisons of this sort are unsatisfactory to the last degree, because the probability of deriving a reasonable and fair conclusion from them depends more upon the ability of the mind to grasp and value details, to weigh justly many considerations, and to deal fairly and wisely with the facts, than it does upon the facts themselves. One thing is certain, however, that the savage would exercise the same amount of mental activity in obtaining all this knowledge for the purpose of getting a living by it, that a student of natural history would exercise in obtaining it for the purposes of a scientific classification. Moreover, the strength of motive, depth of desire, and intensity of emotion of the savage in his work would be as much greater than that of the student as it is more important to sustain life than it is to make a scientific classification; for the student, admitting that he works for bread or for fame or for gratification, may find many other ways if he fails in this to obtain either, while the savage must succeed in this one way or die in the attempt. Lastly, the savage obtains and applies his knowledge by the Baconian method of experience and experiment, while the student obtains his largely from books, and the balance by observation, but the routine laborer does not rise to either method, relying on oral instruction and imitation for the little he needs or learns.

Let us now glance at another peculiarity of savage life. In all civilized communities, and under every form of government, the protection of the person, of life, and of property devolves upon a few members of society who from time to time are appointed or elected for that especial purpose. This, except in rare exigencies, relieves the individual from taking any direct measures for the defense of his rights. Indeed, he is forbidden as a rule to do so, but is required in case of assault or trespass to call to his aid those officers who have been selected to defend him. Neither may he make reclamation, obtain redress, or inflict punishment directly in his own behalf. The savage, on the other hand, contrives and maintains all of his own safeguards. All these things he invariably does for himself in obedience to the quickest and strongest of his instincts—that of self-preservation. Thus the civilized man is guarded, policed, and protected by others, while the savage is his own patrolman, judge, jury, and executioner. All the protective devices he needs, at any rate all he can have, he must contrive and enforce for himself. He is his own defender, detective, and avenger. This whole broad field of activity, therefore, which we call domestic police regulation, including also many other departments of the general government, the savage concentrates in himself and brings within the scope of his own mental, emotional, and physical activity.

It would be a mistake to conclude, however, from what has been said, that the savage enjoys a wider freedom by reason thereof than the man who lives on the avenue and pays taxes, or strolls in the park and reads the notice, "Keep off the grass." The savage has a government and laws in abundance, all founded on traditions, maxims, customs, signs, omens, religious superstitions, quasi canon law, and crude ecclesiastical usages, and the notions and whims of a despotic chief, which reach to every detail of life, but they are all mandatory and restrictive rather than protective in their purpose and character.

When we couple all this with the amount they must learn, the ingenuity they must exercise, and the exigencies they must encounter in wrenching even the most precarious livelihood from unreclaimed Nature, is it at all strange that their immature brains are overtaxed, and that every variation in convolutional development is preserved and perpetuated, especially after head growth and cranial capacity have been checked at the point of undue and disadvantageous proportion to the body?

Thus it appears, in view of all the facts which modern investigation has disclosed, the merest outlines of which have been here given, that the comparatively equal head growth of all known men is no evidence whatever against the theory of their evolutionary descent, while the closely related fact that man shares with certain lower species of animals built like himself a brain development peculiar to him and them, and which has succeeded to an arrested head growth in his and their case alike, is more than an indication, it is very good proof so far as it goes that he and they had a similar if not the same origin and are members of the same family. And it is also evident, in the case of man at least, that this convolutional brain development is continuous from the lowest savages up to the age of machinery and the extreme division of labor, the accompanying institution of voluntary benevolent associations, and the modern forms of parental government, when it thus meets for the first time with a threatened reversal in the case of the routine laborer. He finds himself as a result of these changes in this predicament, he is still in possession, by inheritance, of the full brain development of the civilized, but with less use for, or need of it than has the hunting savage of the neolithic period.

In taking leave of this subject, one question not quite pertinent to the issue can not be repressed. Since all civilizations thus far have encountered a brood of incidental evils peculiarly their own, and, if not of their own creation, still consequent upon them, who can say that the one just exposed may not be the primal cause of the world-wide unrest of the present laboring classes, finding expression in all sorts of disorder from strikes to anarchy—the first fruits of atrophy—the vain attempt to employ an otherwise idle and already degenerating organ of thought, and, like all readjustments to a lower plane, resulting in vicious and reactionary conduct? If this result had been foreseen, could the cause have been suppressed? Is social growth, to any greater extent than individual, modified by desire and volition?

On the temperature of the surface of the huge extents of water of the oceans, Captain W. J. L. Wharton observes, the climates of the different parts of the world largely depend. Areas where great differences of surface temperature prevail are those in which storms are generated. In the region south of Nova Scotia and Newfoundland many of the storms which travel over the Atlantic have their rise. Here the variations are excessive, not only from the juxtaposition of the warm water of the Gulf Stream and the cold water of the arctic current flowing southward inside of it, but in the Gulf Stream itself, which is composed of streaks of warm and colder water, between which differences of as much as 20° Fahr. exist. The same conditions exist south of the Cape of Good Hope, another well-known birthplace of storms. Here the Agulhas current of about 70° Fahr., diverted by the land, pours into the mass of water to the northward, colder by some 25°, and the meeting place is known as being most tempestuous.

SYMBOLS.

By HELEN ZIMMERN.

THE progress made by the experimental school of anthropology in Italy is proved by the works which are appearing in rapid succession by such men as Lombroso, Ferri, Gorofalo, Cogliolo, Sighele, and Bianchi, to mention but a few. The study of criminality and degeneration has in these later years greatly modified the juridical canon, and that which once appeared monstrous heresy is now shown to be truth; nor, owing to the power of science, are the summary judgments any longer possible of which Dante wrote when describing Minos:

"Judges and sends according as he girds him."—(*Longfellow's translation.*)

Guglielmo Ferrero, author of a work entitled Symbols in their Relation to the History and Philosophy of Law and Sociology, also belongs to this school, being one of its youngest members. In order to introduce him to our readers it is enough to mention his collaboration with Cesare Lombroso in his great work, Criminal Woman (La Donna Delinquente), discussed in these pages, which was written as a companion to the Professor's former work, Criminal Man (L'Uomo Delinquente). Symbols is an accurate, minute, conscientious study of a phenomenon innate in humanity, and the volume appears opportunely at the present time, when fiction and dramatic literature are so often inspired by symbolism. On this account besides scientists, novelists, and dramatists are invited to make use of the book, above all in Italy, where, unfortunately, gentlemen of that kidney study but little and talk at random. Guglielmo Ferrero says in his preface: "This book is only an essay, only a rapid transit across an immense unexplored region of the history of mankind"; adding: "The moral miseries of man have been much studied; the many devious ways of the passions, love, hate, vanity, covetousness, have been explored; but his intellectual miseries have been studied but little, those wretched errors into which man falls by reason of the organic weaknesses of his intelligence, owing to which the paths of humanity up to the present day have been bathed so often in blood and tears."

Such the genesis of Ferrero's book; such its *raison d'être*, as I deduce from his own words: "If we reflect that accidental changes of name have generated ferocious rites, that for a question regarding statues or pictures blood ran in floods under the Byzantine Empire; that at this day, at any moment, Europe might blaze up with fires of war, provoked by some unlucky metaphor, or by an ill-expressed phrase exchanged on account of some high political axiom: when we think of all this, who is it that can not see that beyond the ferment of the passions the most fatal enemies of man have been certain weaknesses and imperfections of his intelligence otherwise so highly developed?" A *raison d'être* therefore highly moral, and above all useful.

The volume is divided into two parts. The first deals with the physio-psychology of the symbol, the second with its psycho-sociological application. It is preceded by an introduction which treats of the laws of least resistance and of mental inertia, concerning which Ferrero holds views that are supported by Spencer, Letourneau, Garlanda, and other sociologists. It is beyond doubt a fact that man feels a natural repulsion for mental labor, and if there is one thing on earth that he dislikes it is work, even that of the muscles. In our author's words: "The Hebrew legend of Genesis causes God to give to man labor as a punishment for sin; a precious and ingenuous human document regarding the sentiments of primitive humanity toward activity. The love of savages for rest is for that matter so well known that it would be almost useless to dwell upon it at any length. It is sufficiently proved by the fact that almost universally the most fatiguing labors are reserved for women—that is to say, laid on the sex that were the first slaves, and which can not rebel owing to its weakness. In all savage communities the only male labor has been war and the chase; because war and the chase are associated with the pleasures of success—that is, those which arise from a consciousness of personal power, and the pleasures of vanity, through the esteem which surrounds, in primitive tribes, the strongest warrior or hunter."

Comparative etymology teaches that in Hebrew, in Latin, in Italian, and in French the word labor signifies pain or punishment. Man, by nature, avoids not only physical exertion but also mental, in that form which is known as attention. One constantly sees, "how practice precedes theory, and action is adapted to surrounding circumstances without the intervention of abstract thought."

How man acts under the influence of the law of the least effort Ferrero explains by the following example: "Another proof that man seeks to obtain results by the least possible effort is furnished to us by the growth of sociological evolution. Spencer has justly criticised with severity those scientific systems which see in every human institution, in the exact form in which we find it, the ultimate result of an effort on the part of mankind directed toward its creation. Man does not think as much as that; and no peoples have ever created their own institutions according to a finished plan, previously traced. Every social organism is the result, not of a complex idea, created by the people at a given moment, but of the accumulation of many small inventions and ideas which each generation has brought as its contribution to the entire work. This may be clearly seen by the study of the genesis of social institutions. Ministries are at this day a very complex institution, and therefore were not created at one cast. What was their origin? In Egypt, the king's fan-bearer belonged to the military staff, and in time of war commanded a division of the army. In Assyria, the king's eunuchs acquired great political importance. They became the monarch's counselors in peace and his generals in war. In France, in the Merovingian period, the blacksmith and the chamberlain, who were personal servants of the king, became public functionaries. In England, in the most ancient times, the four great functionaries of state were the master of the robes, the superintendent of horses, the blacksmith, and the house steward. This shows that the position of minister was not deliberately created, but that when the king found, especially in military affairs, that his functions were too numerous, he delegated one to a servant. At first this could certainly have been merely a temporary expedient, which through the continuance of the conditions which led to it became definitive. From this first sketch arose, by successive small modifications, the whole political structure."

With other examples, and by close reasoning, the author closes his introduction by saying that "symbols also must be regarded as the unpremeditated result of a series of small inventions, each intended to satisfy some elementary need."

Ferrero then passes on to the main divisions of his essay. He treats first of symbols of proof, as he names them, dealing at length with the written document, so important to the transactions of modern civilization and yet so tardily produced, and for a long time so incomprehensible to the multitude. Ferrero describes the primitive symbols that existed to guarantee property, or to mark the right of conquest, and of contracts in general, particularly of matrimony, of parental authority, and of adoption. After a minute examination of their origin, he writes: "We see thus from these examples how symbols of this class have nothing mysterious about them. They are only our written documents, our citations, etc., in a less abstract and more simple and primitive form. To us, accustomed to the dry and bare juridical forms of our own time, these symbols make a singular impression, almost as of simple and ingenuous poetry; but we may be assured that those who practiced those acts found no more poetry in them than we find in our formalities. These symbols are characterized by the greater simplicity of the mental effort necessary to understand them, as compared with our own formalities, and are therefore explicable by the law of least effort —the tendency, that is, of man to resolve the difficulties he encounters in the path of civilization by the methods which cost the least mental effort, accepting the most obvious solutions, and contenting himself with these until through the increase of his needs they become entirely inadequate to his requirements."

Ferrero then treats of descriptive symbols, enumerating them separately, and narrating how, from the primitive signs of recognition known to savages, we have arrived at the alphabetic writing, justly called by Ferrero "the most laborious and most complex of all the means of communication of use among men." And he is right, for writing is a most complicated association of optic sensations, acoustic images, and mental images and ideas. To read, we must be able to associate with the sight of a certain number of letters the images of certain sounds, drawing thus from graphic signs the acoustic image of the spoken word. We use these signs as spoken words, associating with them a given idea, a complexity of functions which is demonstrated also by physiology, because a particular nerve center is probably attached to the function of reading, as is shown by those persons who suffer from the malady called verbal blindness—that is, those who lose the sense of sight for graphic signs only, while they can see persons, houses, objects, etc., though they no longer recognize letters, either written or printed.

Symbols of survival, the hinges of the law, form the argument of another chapter. Born from the right of occupation and conquest, the epochs in which the *res nullius* abounded, they have come down to us, growing gradually, and forming in their turn those which regulate all the social movement of nations. Ferrero examines the analogies between these symbols in different nationalities, and concludes: "We have thus a fresh proof that man has never created institutions and customs, etc., according to a preconceived idea, and that his own determination counts for nothing in the ultimate results of his work. It was not the idea of contract or of pacific discussion which led to the substitution of purchase and judgment for rapine and the duel, but purchase and judgment substituted for rapine and the duel generated by slow suggestion the idea of contract and pacific discussion in the brain of man."

The sensations we experience of complex things are reduced sensations. Spencer also affirms this in his First Principles. The eye sees reduced images; the mind, by the theory of least effort, receives reduced sensations; and this phenomenon exerts a great influence upon the formation of symbols. For example, the reduplication which takes place in many languages in the formation of the plural, when it is the custom to repeat the substantive twice, is seen also in the most ancient art of Greece, where on the bas-reliefs a forest was represented by one tree, an army by one soldier, a house by a single column.

Gradually symbols become more abstract and tend to lose their concrete character. "The consignment of a piece of sod taken from the ground in presence of the buyer and of witnesses is a concrete and material formality, almost a consignment of the earth itself; but the consignment of a bundle of straw as a sign of the sale of land or of a house is already a much more abstract symbol, because its visible connection with the thing is less, because the separation between the symbol and the thing is much greater, and man fills up the gap with the rich mental associations which are already formed in his mind. Another step, and the fragile straw too will disappear, and the material symbolism of primitive times be replaced by the more ideal forms of proof which we employ. So, little by little, almost unawares, man is brought by evolution face to face with the most complex abstract ideas."

Emotional symbols is the subject of an interesting division. Ferrero says: "We perceive that an emotion, produced by whatever cause, lasts for a certain time, then grows weaker until it is extinguished. Neither love, nor hatred, nor pleasure, nor pain are, fortunately for mankind, eternal, because, as they are also transformations of force, they cease when they have exhausted the initial quantity of energy which they possessed at their origin. We perceive also that by the law of mental inertia this emotion can not be repeated, even with reduced intensity, unless a sensation antecedently associated with the same emotion in experience excites or recalls it. Now emotional symbols are composed of those sensations which have the power to awaken dormant emotions; by the law of inertia they arise once more and reacquire their immense importance." Hence he proceeds to show how the trophy arose, and also how, from the custom of taking from the vanquished his most brilliant garments, splendid garments came to be the insignia of dominant and privileged classes, kings, princes, chiefs, to be held as tokens of authority. Ferrero makes a minute examination of the importance attached to dress in modern society, and proves how this is an excellent specimen of an emotional symbol. In support of his views he cites the words of Buckle, where he says that dress was of such importance in the sixteenth century that a person's condition was evident from his exterior, no one daring to usurp the habit of a superior class. But during the democratic movement which preceded the French Revolution the innovations of fashion were felt even in the reunions of good society. At dinners, suppers, and balls, as contemporary writers tell, dress had been so much simplified that ranks were confused; ere long both sexes abandoned all distinctive garb, men went into society in "*frac*," women in simple bodies.

We now come to the most important chapter in Ferrero's work, that which treats of mystic symbols. It is a minute analysis of the genesis and development of these symbols, of their primordial and consequential causes, of their importance, and of the evil caused by their false interpretation. The series of mystic symbols is produced by the phenomenon which Ferrero calls ideatic arrest, and which he explains in the following way:

"We here find ourselves confronted by an ideatic arrest—that is to say, the series of mental associations by which we have arrived at a conclusion of causality becomes restricted to those facts which furnish an immediate sensation, and therefore leave in the brain images and ideas that have a tendency to associate themselves, and to exclude such facts as do not produce a special state of consciousness except through reflection; a laborious mental process, which ordinary men, and even thinkers in fields which are not their habitual objects of research, avoid, by the law of least effort." It is thus with writings, thus with books, with formulas mysterious to the vulgar, with commands, with prayers. By the phenomenon of emotional arrest in religion, nearly everywhere and at all times, the adoration which should lift itself up to God stops at the image which represents him. And Christianity, although inaugurated by Christ, the apostle of a spiritual religion, is at this day too often nothing else than a real idolatry, at least in the multitude. We cite Ferrero once more: "God is here confounded with his symbol; and the theory of emotional arrest explains such a confusion. No one has ever seen God, wherefore we can not have an image of him, unless we construct one ourselves by our own intelligence. Now, to construct mentally, without the aid of the senses, a graphic image, necessitates a considerable mental development. For this reason, even to-day, for nearly every person the word God corresponds in the consciousness only to a vague and nebulous image. Hence it comes that when the peasant sees the cross, which awakens in him a complexity of sentiments compounded of respect and terror, the idea or the image of God, through being a most indeterminate state of consciousness, associates itself weakly, or not at all, with his emotions. Wherefore there is at such times present to his consciousness only the sight of the symbol, the cross, and the sentiments relating to it, not the image of God; and therefore such sentiments can be directed only to the symbol, because that alone comes into the field of consciousness, and behind it there is not for the worshiper the image of God which it should represent. Now, as a symbol works only in so far as it has power to recall a group of ideas and sentiments, if these associations do not come the symbol passes into the condition of reality, because the emotion is arrested by it and does not rise to what it represents. This is why idolatry is always repugnant to great intellects, from Moses and Mohammed to Pascal and Matthew Arnold, who protest always, but often in vain, at least from the plebeian point of view, against the worship of images."

Another phenomenon of emotional arrest is the banner, substituted for the fatherland, for whose sake are created honors and feuds. Thus, in politics, parties are designated by colors black, blue, red, according as men hold to one set of ideas or another. Thus also in parliaments there are the Right, the Left, and the Center; so, at the time of the rise of the new Italy, there was a fierce struggle over the emblems of the three colors, to display which every opportunity was seized. So, again, the name of Verdi, at the same epoch, served as a symbol for the patriotic cry "*Viva Vittorio Emmanuele, Re d' Italia!*" The toga, like the flag, is a mystic symbol, and it symbolizes in the tribunals the majesty of justice. Nor does the bureaucracy disdain the use of symbols.

In his chapter on the pathology of the symbol, Ferrero narrates how it had been adopted by criminals, and is the hinge of such secret societies as the "Maffia" and the "Camorra." Our author relates how even madmen adopt symbols, as well as the sick, concluding: "Certainly we are here treating of disease, but the extraordinary intensity of the phenomenon proves how profound is the tendency of the human soul to reduce sensations, images, sentiments; to exchange the whole for a part; to concentrate all its energies upon some particular, which thus becomes more potent in its action. Certainly in those normal processes of reduction whence the symbol proceeds, this absorption of everything into itself of the particular, is not so intense as in these morbid cases, precisely because these are an exaggeration. But in any case the phenomenon of symbolism by reduction, and these phenomena of moral pathology, throw light upon each other."

The second part of Ferrero's essay is entitled Symbolism in Modern Law. This chapter contains precious and useful observations with regard to the manner in which the letter and the spirit of the code are applied. The greater part of the juridic ideas consecrated in our codes, and the manner in which they are applied—almost everything, in short, known as justice—is nothing but one gigantic mystic symbol, the effect of a fatal confusion of the sign with the thing, a spring of infinite evil to society, and above all of that greatest of evils: the possession, that is, of a justice which causes more torment, perhaps, than benefit. In these utterances we recognize the great informing idea of the positive juridical school, the reasoning of Lombroso and of the other modern criminalists and sociologists. Ferrero, in summing up, to support his assertion, cites many practical examples, civil and penal, too long to be quoted here. He says: "From these rapid indications, which I hope to be able, in the future, to develop in a longer and more complete work, we may gather how the future of justice and of juridical institutions lies in the abolition of codes, in the abandonment of juridical principles which are dangerous generalizations and determining causes of ideo-emotional arrest; in the institution of boards of arbitration, composed of honest and intelligent persons, charged with judging *ex æquo et bono*, appealing, not to the authority of our fathers, but to the authority of their consciences: perhaps also it may be in the abolition of the profession of magistrate, and in a varied choice, often renewed, of arbiters, among persons of intelligence, instruction, and integrity, of diverse occupations; because the constitution of a class of magistrates favors professional ideo-emotional arrests. At all events, since the gravest danger to the right administration of justice lies in the production of this arrest, the normal and supreme scope of all reform should be to prevent, in the best manner possible, that for any reason ideo-emotional arrest should be produced in those who administer justice."

When that day dawns, if ever it see daylight, no pessimist will be able any longer to repeat, for the shame and condemnation of modern society, the bitter verses which Goethe has put into the mouth of Mephistopheles:

"Customs and laws in every place,
Like a disease, an heirloom dread,
Still trail their curse from race to race,
And furtively abroad they spread.
To nonsense, reason's self they turn;
Beneficence becomes a pest;
Woe unto thee, that thou'rt a grandson born!
As for the law born with us, unexpressed—
That law, alas! none careth to discern."

Guglielmo Ferrero—who, by the way, is quite a young man, not far advanced in the twenties—has shown in this book not only great promise but great achievement; and proved once more what a wonderful amount of talent is possessed by that Italian nation to which we owe so much of our culture and civilization.

SKETCH OF CHARLES A. LE SUEUR.

By DAVID STARR JORDAN,
PRESIDENT OF THE LELAND STANFORD JUNIOR UNIVERSITY.

SOME years ago I began to collect material for biographical sketches of several of the early naturalists in America. Among these was CHARLES A. LE SUEUR, the artist, traveler, and naturalist, who was "the first to study the ichthyology of the Great American Lakes." Le Sueur traveled widely in Pennsylvania, New York, and New England from 1817 to 1828. He was an artist of high degree, a careful and faithful observer, and according to accounts, a man of most genial and attractive character. He had won a high reputation in Europe as an artist. As a naturalist he had been around the world with Péron and La Pérouse. He was one of the founders of the Academy of Natural Sciences at Philadelphia. When the famous socialistic colony was established by Robert Owen at New Harmony, Ind., Le Sueur was one of its members. He came down from Pittsburg in the famous "boat-load of knowledge" with which the colony was intellectually equipped.

During his stay at New Harmony, Le Sueur made considerable collections and many drawings, some of which are still preserved, and others have been published in the Journals of the Academy at Philadelphia. A most spirited portrait of the old Governor Vigo is still extant. I have received an account of the drop-curtain painted by Le Sueur for the old theater in New Harmony. On this curtain were represented a rattlesnake and the Falls of Niagara, as two natural features most characteristically American.

After the failure of the New Harmony colony, Le Sueur returned to Philadelphia, and probably went from there to Paris, where, according to Swainson, he earned a precarious livelihood as a teacher of painting. For the latter part of his life he was curator of the museum at Havre. His scientific work was done chiefly in America, and it ranked with the best of its kind at the time. Le Sueur's most important memoir was a monograph of the suckers, a group of American fishes constituting his genus *Catostomus*, each species being represented by a clever and accurate figure—drawing and engraving being both by the hand of Le Sueur. In 1878 I had occasion to speak of this paper as "an excellent one, comparing favorably with most that has since been written on the group." Other valuable papers were on certain blennies, rays, and flying fishes, accounts of new species from the West Indies, and descriptions of tortoises and other reptiles.

The Royal Society's Catalogue of Scientific Papers contains the titles of nine papers of which Le Sueur was joint author with

François Péron. These appeared in 1809 and 1810 in French scientific serials and deal with jelly-fishes and some other marine animals. Le Sueur was joint author with Anselme G. Desmarest of two papers on certain mollusks and sea-mosses in 1814 and 1815. The papers of which he was sole author number forty-three. They begin in 1813 with a memoir on several new species of mollusks and radiates, published in the Journal de Physique. The first six were written before he came to America, and he picked up material for the seventh on his way over. It deals with three new slug-like mollusks, and is entitled Characters of a New Genus (*Firoloida*) and Descriptions of Three New Species upon which it is Formed; Discovered in the Atlantic Ocean, in the Months of March and April, 1816, lat. 22° 9′. It appeared in Volume I of the Journal of the Academy of Natural Sciences of Philadelphia, in 1817. Dr. Ruschenberger relates, in his Notice of the Academy, that in the first year of the Journal, "Mr. Ord, anxious to forward the publication, translated or rather prepared the papers of M. Le Sueur from materials furnished by him, as that gentleman, who immigrated from France in 1816, possessed very little knowledge of the English language." The last three of the list appeared in Paris in 1827, 1831, and 1839 respectively. Two are on certain tortoises, the other is an observation on a bite of a viper. Three other papers, written while he was in this country, were published in Paris; the rest appeared in the Journal of the Philadelphia Academy, except one in the Transactions of the American Philosophical Society. He evidently restricted himself quite closely to the fishes and other aquatic animals, though with an occasional excursion among the reptiles.

His descriptions are clear, exact, and honest. His drawings are not accurate only, but spirited. They are works of art rather than mechanical representations. With less range of learning than Rafinesque and some other contemporaries, Le Sueur had, what Rafinesque had not, sound sense and faithfulness in the study of details. In America he was perhaps the first of that school of systematic zoölogy which regards no fact as so unimportant that it need not be correctly ascertained and stated—a method of work with which has been rightly associated the name of Prof. Spencer F. Baird. This attention to accuracy in detail marks the so-called "Bairdian epoch" in vertebrate zoölogy.

The pressure of other duties has led me to abandon the gathering of materials for the study of the lives of the earlier American naturalists. I therefore leave this sketch unfinished,* using it

* In the hope that this sketch may some time be completed, I ask any one having additional information regarding Le Sueur's history or his personality to send it either to the editor of The Popular Science Monthly or to the writer.

only as a reason for printing the most valuable of original documents concerning Le Sueur. This is a personal letter from the late Prof. Richard Owen, whose early life was spent at New Harmony, and who was my predecessor in the chair of Biology in the University of Indiana.

Prof. Owen writes as follows under date of December 14, 1886:

"Charles A. Le Sueur was, when I knew him in 1828, about fifty to fifty-five years of age, tall, rather spare in muscle, but hardy and enduring. He permitted his beard to grow, which at that time was quite unusual; hence he sometimes platted it and tucked it almost out of sight when he went from home. In New Harmony he usually went barenecked, often bareheaded, and in summer occasionally barefooted, or at least without socks. His hair had been dark, but was sprinkled (as well as his beard) with gray. His manner and movements were quick; his fondness for natural history (as it was then called) led him to hunt and fish a good deal.

"In summer he was fond of swimming in the Wabash, and I frequently accompanied him. He instructed me how to feel with my feet for *Unios* and other shells as we waded sometimes up to our necks in the river or ponds, searching to add to our collections. When he went fishing with others he always exchanged his fine common fishes for the smallest and to them most indifferent-looking, when he recognized some new species or even variety. This item I have from Mr. Sampson, who is well acquainted with the fish of the Wabash, but who confesses he could see no difference in many caught until Mr. Le Sueur, who at once detected that difference, had pointed it out.

"He was temperate and active in all his habits, smoking being the only objectionable habit in which he indulged. His temper was quick and used to call out an occasional "God bless my soul!" the only approach to anything like irritation that he evinced; he was very kind-hearted.

"In conversation with Agassiz about Mr. Le Sueur, the great Swiss ichthyologist paid a high compliment to Le Sueur's acquirements in that department, considering him then (as I inferred) the next best to himself at that time in the United States. He was, however, I judge, remarkably conversant with other branches of biology, inasmuch as nearly all the magnificent drawings he had made when left in New Holland (as it was then called) were mammals, chiefly the ornithorhynchus, echidna, and other rare animals. In showing his drawings he generally offered a lens, that you might see every hair distinctly delineated.

"He was a magnificent artist, good alike in drawing and coloring. I have some of his sketches yet, in which, when I was taking drawing lessons from him, he showed me how to outline, for instance, the skeleton of the human figure, then to add the muscular system, then the clothing, drapery, etc. We usually took views from Nature. Although so minute in details of fine paintings, he was equally good in large scenery. For many years we had here the scenes he painted for a Thespian Society of this place, where, amid the forest trees, he had squirrels, birds, etc. Being fond of hunting, he had made to order by a native gunsmith, who was quite a genius, a double-barrel piece, one a rifle, the other a smooth-bore. Gillson, the gunsmith, made the barrels, bored the rifle, made the stock, and an admirable lock; the stock was inlaid with silver and engraved by the same skillful hand, bearing Le Sueur's name and an appropriate device. I do not remember exactly the price, but think it was about a hundred dollars.

"In consequence of his having been with La Pérouse (until, fortunately for his life, he was left to work up the animals of Australia), the French Government gave him a pension, which he drew annually, until they notified him that, unless he returned and gave his time and talents to his native country (France), the pension would be withheld. He went at a time when I was absent, and those who here knew him well have forgotten the date. He became curator of the museum at Havre, and then, after some years, died and was buried there. The exact date of his death those three have also forgotten.

"When he came to New Harmony during the social experiment he was directly from the West Indies, and brought a young lad and a child, both of whom subsequently married, but both are now dead. It was from their relatives that I expected to get dates, but failed.

"When the 'Preliminary Society' (at New Harmony) resolved itself into the (1) Educational, (2) Agricultural, and (3) Commercial Societies, Mr. Le Sueur joined the first, and I have in my box of valuable papers a deed of a lot (for the purpose of erecting a foundry), executed by the Educational Society, and signed by my father-in-law, Mr. Neef, and his family, Drs. Troost, C. A. Le Sueur, William Phiquepal, and a number of others.

"Some of the relatives of those who came with him think there was a notice in some public journal of his death, etc., but I never saw it. I just recall two incidents:

"When we were together, going sketching, I think, we found and killed a large blacksnake, uncommonly distended. Mr. Le Sueur, when we reached home, used a large syringe and injected water into the stomach, from which he then stripped four young rabbits. Another time we obtained a female opossum, and he very deftly dissected it and showed me the young adhering to the small teats in the pouch or marsupium."

EDITOR'S TABLE.

SCIENCE IN EDUCATION.

MUCH as has been written on this subject there seems still to be room for further insistence on the truth that the one living element in every system or scheme of education is science. By this we do not mean—indeed, are very far from meaning—that what is called physical science is the one useful subject of instruction; we mean that except in so far as education is animated by the spirit of science it is dead, and, for all purposes of mental development, useless. An excellent address on Scientific Method in Board Schools was lately delivered in London, England, by Prof. H. E. Armstrong, F. R. S. We shall take an early opportunity of transferring it to our columns, trusting that it may be widely read, as it presents the gist of the matter in comparatively few words. Prof. Armstrong bears testimony to the extreme slowness with which the educational world in England has moved in regard to giving science teaching the place to which it is entitled in school curriculums; but, on the other hand, he is able to speak encouragingly as to the results that have flowed from the intelligent and zealous efforts of a single teacher of scientific method, and he is evidently of the opinion that a better day is dawning for science teaching generally in the secondary schools of the United Kingdom. He refers in terms of high praise to Herbert Spencer's classic work on education. His words are worth repeating here: "It is a book which every parent of intelligence desiring to educate his children properly should read; certainly every teacher should have studied it thoroughly, and no one should be allowed to become a member of a school board who, on examination, was found not to have mastered its contents."

The point, however, which we wish to make to day is not that a certain amount of natural science should form an element in all education, for that is becoming more widely recognized and more fully accepted from year to year; but that all instruction should be pervaded by the scientific spirit, and that the teaching of what is called "science" is of value not only for the knowledge conveyed, but still more as furnishing, in proper hands, a type of what all teaching should be. If science itself is not taught scientifically, it is like salt that has lost its savor, utterly worthless; it becomes in such a case a mere burden on the educational system instead of its prime motor. In the address to which we have above referred, Prof. Armstrong deplores the bookish and unfruitful methods still widely in use in England, and unless we are mistaken the evil is quite as rife in this country. The fact is that even among teachers of science the true scientific spirit is by no means common. To have learned a certain range of scientific facts, and gained some comprehension of the methods by which those facts have been ascertained and by which further advances in scientific discovery must be made is not sufficient; it is necessary that the teacher's mind should be liberalized and quickened by the conception that in every branch of knowledge, in every pursuit, in every industry, in every line of thought and effort, the fundamental distinction of scientific and unscientific holds just as firmly as in the case of the best-explored departments of natural science. Are merely conventional views to be discarded in chemistry and physics? Certainly, the teacher of science will reply. How, then, about history, literature, and politics? It would seem as if a "certainly" would be in place here, too, and doubtless if the question were pressed it would come; but how few among the scientifically trained take home to themselves heartily and thoroughly the truth that if scientific method is good for anything it is good for everything! But no one can be a true and inspiring teacher of science who does not feel in his inmost consciousness this universal applicability of scientific method, and who, in so far as he has been initiated into that method, does not rejoice in a sense of glorious liberty and power. It must be acknowledged that not a few men of "mere letters," as they are sometimes called, have gained a fuller entrance into the intellectual freedom which science bestows than many who have made science their special study. Such men as teachers will be eminently successful; they will have an intuitive sense of the distinction between essentials and non-essentials; they will grasp the roots of their several subjects; their teaching will have a certain organic quality that will cause it to germinate in the minds of others.

If we were asked what is the most characteristically or typically scientific idea that the mind can entertain, we should answer, with little hesitation, *The idea of utility*. Why? Because it involves the two fundamental ideas of the connection between cause and effect, and of the adaptation of means to ends; and because it points to an object apart from which science becomes mere intellectual trifling. It is possible to take an unduly narrow view of utility, but it is in no way necessary. There is nothing in the word itself to call for a narrow interpretation. On the contrary, it suggests the widest possible range of advantage for the human race. The conception of utility is one which we must more and more apply to our systems of education. In regard to any and every branch of study, let us boldly ask, as it is our duty to do, What are its uses? What is it going to do for those who are exercised thereby? Has it a bearing on health of body or of mind, or are its uses exclusively social? In the latter case, do they refer to permanent or to transitory social conditions? If to transitory conditions, how far is it desirable that these should be allowed to mold the education of the rising generation? No harm can come of pressing these questions one and all; and till we have answers to them—careful and satisfactory answers—we shall have no true criticism of modern education. If there is anything in this wide world that should be able to give a most rigorous account of itself it is the education we give our children. We started by saying it should be scientific, and now with equal conviction we declare that the first step toward being scientific is that it should be useful. A useful education—one founded upon and justified by use—is itself a constant training in scientific method and the best possible introduction to the scientific spirit. On the contrary, an education that can not constantly plead the justification of utility makes so far for unscientific habits of thought; for what can possibly be more unscientific than effort without definite and justifiable purpose?

Some persons entertain a vague idea that a dominantly scientific education must be dogmatic in tone, and therefore an unsuitable preparation for practical life, in which so many problems present themselves that require tact and a careful balancing of probabilities rather than the strict methods of the laboratory. Herein we see the fatal mistake of narrowing our idea of science too much. The logic of chemistry is one thing, the logic of politics is another; but each has its logic, each admits of scientific treatment. As we pass from one to the other we simply have to widen our methods of inquiry, and allow for somewhat less of absoluteness in our conclusions; but we need not lower the scientific ideal, and as to the scientific spirit, it can be seen to almost greater advantage in a sphere in which the difficulties of analysis and the chances of error are relatively greater. So long as we only think of science in connection with the so-called natural sciences, the true conception of science will not reveal itself to us, and education in general will remain unfructified by the scientific spirit. But when we reach the point of accepting the methods of physical science as far as they go, and applying them, with such modifications as the case may call for, to all other branches of knowledge, holding ever as our clew the idea of utility broadly and liberally understood, we shall be fairly on the way to that revolution, or rather transformation, of our educational systems which the new age demands.

THE ROYAL SOCIETY AND THE DARWINIAN THEORY.

It will be remembered that Lord Salisbury, in the address delivered by him last autumn as President of the British Association, laid stress on the difficulties which he found in the way of accepting the doctrine of evolution, and quoted in support of his position some observations made several years ago by Lord Kelvin. Lord Kelvin himself has now been delivering an annual address as President of the Royal Society, and part of his duty in connection therewith was to announce that the society had this year conferred the "Darwin Medal" on Prof. Huxley as a "token of the value put by the society on the part of his [Prof. Huxley's] scientific activity bearing more directly on the biological ideas with which the name of Charles Darwin will always be associated." That the Royal Society should have instituted a Darwin medal speaks plainly enough as to the hold which Darwin's theory of the origin of species has obtained upon the scientific world; and that the medal should have been awarded to so earnest and thoroughgoing a champion of that theory as Prof. Huxley is a plain indication that scientific opinion is not taking any backward steps in this matter. In referring to the award Lord Kelvin chose his words with evident care; but no fault could be found, so far as either Darwin or Huxley was concerned, with the following neatly turned sentences: "That advocacy [Prof. Huxley's] had one striking mark: while it made, or strove to make, clear how deep the new view went down, and how far it reached, it never shrank from striving to make equally clear the limits beyond which it could not go. In these latter days there is fear lest the view, once new but now familiar, may, through being stretched further than it will bear, seem to lose some of its real worth. We may well be glad that the advocate of The Origin of Species by Natural Selection, who once bore down its foes, is still among us, ready, if need be, to save it from its friends."

At a dinner which followed the meeting at which these words were uttered, Prof. Huxley having been called upon to respond to the toast of "The Medallists," took occasion to say that the theory propounded by Darwin "has never yet been shown to be inconsistent with any positive observations. . . . I am sincerely of the opinion," he added, "that the views which were propounded by Mr. Darwin thirty-four years ago will be understood hereafter to mark an epoch in the intellectual history of the human race. They will modify the whole system of our thoughts and opinions, and shape our most intimate convictions." In the face of such a declaration, delivered under the circumstances described, it would certainly be well if the honest and worthy people who are always flattering themselves on the strength, generally, of this or that pulpit utterance, that natural selection and the doctrine of evolution are exploded theories, would make up their minds that practical men of science are the best judges as to what theories are helpful, and so far deserving of acceptance, and that the criticisms of theologians and other amateurs, however well meant, are apt to be beside the mark.

AGNOSTICISM.

PROF. MAX MÜLLER contributes to the Nineteenth Century for last December an article the title of which is, Why I am not an Agnostic. Just what the true definition of agnosticism may be we should not care to venture an opinion; but what interests us chiefly in Prof. Muller's article is the extreme similarity between the position he takes up and that of Mr. Herbert Spencer as set forth in First Principles. "If," he says, "we have to recognize in every single object of our phenomenal knowledge a something or a power which manifests itself in it, and which we know, and can only know, through its phenomenal manifestations, we have also to acknowledge a power which manifests itself in the whole universe. . . . *That* it is, we know; what it is by itself, that is out of relation to us, of course we can not know; but we do know that without it the manifest or phenomenal universe would be impossible." This is the Spencerian philosophy exactly, and is also the philosophy, we do not doubt, of a large portion of the thinking world of to day. Mr. Spencer has never professed himself an agnostic. Apart from the objections urged by Prof. Müller, he would probably consider the term one of far too uncertain meaning to serve for a definition of any views which he may hold, whether of a positive or of a negative character.

LITERARY NOTICES.

WOMAN'S SHARE IN PRIMITIVE CULTURE. By OTIS TUFTON MASON. New York: D. Appleton & Co. Pp. 295. Price, $1.75.

THIS is the first volume of an anthropological series under the editorial direction of Prof. Frederick Starr, of the University of Chicago; the works of which, intended to be of popular interest, will be in every case written by authorities who will keep scientific accuracy in the foreground. The present essay sets forth woman's share in the culture of the world by her works, and shows that her achievements have been in the past worthy of honor and imitation and have laid the foundation for arts of which all are now justly proud. The idea is rejected in the very beginning that women are treated with systematic cruelty or are degraded, in any nation, however savage; for "it is not reasonable to suppose that any species or variety of animals would survive in which the helpless maternal half is subjected to outrageous cruelty as a rule," and the taste and skill women show in the arts that fall to their province are against such a supposition. On the other hand, a division of duties generally prevails, which, though it may not accord with the artificial, conventional system of European society, is usually adapted to the circumstances of the tribe, and is not inequitable. In the list of spheres of work, woman is introduced first as the food-bringer, finding supplies in the stores of Nature, taking care of them and preparing them for consumption. In this field she set agoing a multiplicity of industries in prehistoric times, and became of necessity an inventor of experiments, tools, and processes. Next she appears as a weaver, making baskets and the native cloth and mats, and spinning, netting, braiding, sewing, and embroidering, and for each of these tasks having again to find material and to invent and fashion suitable tools. Having to deal with the game killed by the man and to apply all the material to the best use, she becomes a skin-dresser. A bewildering list is given of the animals whose skins native American women knew how to dress; and, "if aught in the heavens above or on the earth beneath, or in the waters, wore a skin, savage women were found on examination to have had a name for it, and to have succeeded in turning it into its primitive use for human clothing, and to have invented new uses undreamed of by its original owner." Here, again, were new tools to be invented. "Women were the first ceramic artisans, and developed all the technique, the forms, and the uses of pottery." In this work and in her textile fabrics woman has had opportunity to develop her faculties as an artist; and examples are given of the patterns that savage women in America have worked out, which for beauty and harmony of design are not more than equaled by the most exquisite specimens of Grecian work in the same lines. American Indian costumes are shown which may be compared with the most picturesque. While there were burden-bearers among the animals before, "the idea of modifying a natural object for the purpose of creating a carrying tool seems first to have occurred to the human female." It is not enough, in speaking of savage women, says the author, "to say that they, as a class, do this or that. It should be also asked how many of these are performed by one woman—in short, by every woman." This thought is introductory to a consideration of the diversity of occupations in which they must be proficient—to a chapter on "The Jack-at-all trades." Woman is further presented as "The Founder of Society," by virtue of her motherhood and what it implies, and as "The Patron of Religion." Finally, "in whatever actions the primitive women excelled—and the number is not small—they surely deserve the apotheosis they have received for their development of the maternal side of life. . . . For the highest ideals in civilization, in humanitarianism, in education, and government, the way was prepared in savagery by mothers and by the female clan groups, and the most commanding positions are at this moment in their possession." The book is good reading, and is abundantly and handsomely illustrated.

Hoofs, Claws, and Antlers of the Rocky Mountains by the Camera. With an Introduction by the Hon. Theodore Roosevelt. Denver, Col.: Frank S. Travis. Pp. 7, with 32 Plates.

This is a book of photographic reproductions from life of wild game—deer, antelope, Rocky Mountain goat, bighorn, puma, bison, bear, etc.—of the Rocky Mountains. Most of the pictures were taken by Mr. and Mrs. A. G. Wallihan, settlers in northwestern Colorado, accomplished sportsmen both, naturalists, and photographers. They were necessarily taken under great disadvantages; for a suitable position had to be secured of animals which would vanish at the least alarm, with favorable light-exposures. It is not wonderful, therefore, that the failures vastly outnumbered the successes. Only successes are given. In order to make the collection of wild animals found in the Rocky Mountains complete, a few photographs taken by others than Mr. and Mrs. Wallihan are used. The text gives sketches of the lives of Mr. and Mrs. Wallihan, by themselves, stories of their adventures among the animals, and incidents of the circumstances under which the several photographs were taken. There is no posing for positions in these pictures; the animals are represented truly as they were found, unwitting that anything was going on, or at the instant when they were startled by the first perception of the novel proceeding. Among them are a buck which has just noticed the photographic apparatus, with his doe still unconscious; a group of deer at the ford on a winter morning; two startled bucks just ready to jump; a doe swimming Bear River; a buck standing alone in his glen; a pair crossing a stream; three alarmed antelopes; herds and groups of antelopes in different attitudes; Rocky Mountain goats on their cliff; elks single and in groups; a puma on the lookout from a tree top, and a puma treed; bighorns startled, a wild cat, and buffalo; bears in the berry patch; beavers at work; sage hens, a wolf in search of breakfast, a jack-rabbit, a prairie-dog colony, listening deer, a rattlesnake coiled to strike, and game pictures. Mr. Roosevelt, who is acquainted with the game, speaks admiringly of the naturalness and accuracy of the attitudes, and believes that the book is "unique and of the utmost value." We think naturalists and artists will agree with him.

Tertiary Rhynchophorous Coleoptera of the United States. By Samuel Hubbard Scudder. Washington: Government Printing Office. Pp. 206, with Twelve Plates.

This work is published as Monograph XXI, of the United States Geological Survey. The author published in 1890 an account of all the Tertiary insects of the country known up to a few years, as far as regarded the lower orders; but the higher orders were nearly untouched. These furnished an immense amount of material, the elaboration of which was begun at once. The present work is a first installment toward a history of our fossil Coleoptera, or beetles, of which one hundred and ninety-three species are treated. Although it can not be supposed that more than a mere fragment of the vast host of insects entombed in the Tertiary rocks has been identified, such a variety and abundance of forms have been discovered as to make it clear that there has been but little important change in the insect fauna of the world since the beginning of the epoch to which they belong. In the earlier Tertiaries we have in profusion representatives of every one of the orders of insects; and every dominant type which exists to-day has been recognized. Even many of the families which have now but a meager representation have been discovered; and though many extinct genera have been recognized, no higher groups, with a single exception or two, have been founded on extinct forms. The parasitic groups are represented, and many of those which in the present time show peculiar modes of life.

Bulletins of the United States Geological Survey. Nos. 97 to 117. Washington: Government Printing Office.

No. 97 is a description of the Mesozoic Echinodermata of the United States, by W. B. Clark; No. 98, an Account of the Flora of the Outlying Carboniferous Basins of Southwestern Missouri, by David White; No. 99, a Record of North American Geology for 1891, by N. H. Darton; No. 100, a Bibliography and Index of the Publications of the Geological Survey, with the laws governing their printing and distribution, by P. C. Darton; No. 101, Insect Fauna of the Rhode Island Coal Field, by S. H. Scudder; No. 103, a Catalogue and Bibliography of North American Mesozoic Invertebrata, by C. B. Boyle; No. 103, High Temperature Work in Igneous Fusion and Ebullition, chiefly in relation to pressure, by Carl Barus; No. 104, The Glaciation of the Yellowstone Valley north of the Park, by W. H. Weed; No. 105, The Laramie and the overlying Livingston Formation in Montana, with map, by W. H. Weed (with report on Flora, by F. H. Knowlton); No. 106, The Colorado Formation and its Invertebrate Fauna, by T. W. Stanton; No. 107, The Trap Dykes of the Lake Champlain Region, by J. F. Kemp and V. H. Masters; No. 108, A Geological Reconnoissance in Central Washington, by J. C. Russell; No. 109, The Eruptive and Sedimentary Rocks at Pigeon Point, Minn., and their Contact Phenomena, by W. S. Bayley; No. 110, The Palæozoic Section in the Vicinity of Three Forks, Montana, by G. P. Merrill; No. 111, Geology of the Big Stone Gap Coal Field of Virginia and Kentucky, by M. R. Campbell; No. 112, Earthquakes in California in 1892, by C. D. Perrine; No. 113, Report of Work done in the Division of Chemistry during the Fiscal Years 1891–'92 and 1892–'93, by F. W. Clarke; No. 114, Earthquakes in California in 1893, by C. D. Perrine; No. 115, a Geographic Dictionary of Rhode Island, by Henry Gannett; No. 116, a Geographic Dictionary of Massachusetts, by Henry Gannett; No. 117, a Geographic Dictionary of Connecticut, by Henry Gannett.

A History of the United States for Schools. By John Fiske, Litt. D., LL. D. With Topical Analysis, Suggestive Questions, and Directions for Teachers, by Frank Alpine Hill, Litt. D. Boston: Houghton, Mifflin & Co. Pp. xxi + 474. Price, $1 net.

It has been said that children's text-books should be written by the best authors, and the wisdom of the remark is evident from an examination of this treatise from the pen of the thoroughly equipped and facile author and lecturer, John Fiske. Prof. Fiske tells the story of America, from the voyages of the Norsemen down to the events of 1893, with such vividness that the pupil is not likely to neglect his history lesson (unless to read ahead), and with such regard for logical connection that he can not fail to gain from it a comprehensive view of the march of events. Indeed, the chief interest of this book from the scientific standpoint is that historical events are arranged in it so as to link them in natural sequence and to aid in teaching the great lesson that every effect has its cause and every cause must produce an effect. The illustrations are a striking and valuable feature of the book. Portraits are especially numerous; they include the bewigged and beruffled worthies of exploration and colonization times, British and American generals of the Revolution, our Presidents and other statesmen from Washington down, Union and Confederate commanders of the civil war, and the chief American authors and inventors. There are also views of ancient buildings, reproductions of ancient maps, and a variety of other illustrations showing objects of historic interest. The growth of the territory of the United States is shown in a number of small maps. Among the materials for reference appended to the volume are the Constitution of the United States, classified tables of the States, lists of books on the history of the several States and on successive epochs, a pronouncing vocabulary, and a note on the calendar. The first chapter of the book is an account of Indian life in America at the time of the discovery.

Biological Lectures and Addresses. By the late Arthur Milnes Marshall, D. Sc., F. R. S. New York: Macmillan & Co. Pp. 363. Price, $2.

There are some scientific books that are dry and technical but have attractive titles, and others with technical titles that are eminently readable: this belongs in the latter class. The thirteen lectures and addresses of which it is made up comprise several delivered by Prof. Marshall as President of the Manchester Microscopical Society, others delivered before students' societies in Owens College and other organizations. Among the topics treated are the influence of environment on the structure and habits of animals, the theory of change of function, butterflies, inheritance, the shapes and sizes of animals, animal pedigrees, and death. Taken together they afford a general view of the recent progress of science in the field of biology. In all the addresses the language used can be comprehended readily, and the ideas presented can be grasped easily by every ordinarily well-read person.

General Lee. By Fitzhugh Lee. Great Commanders Series, edited by General James Grant Wilson. New York: D. Appleton & Co. Pp. 433. Price, $1.50.

Much aid in comprehending the course of events in the civil war, and especially in appreciating the reasons for the various movements on the Confederate side, is afforded by this extended history of Robert E. Lee's military career. But two chapters are given to the first fifty-four years of his life, more than half of which was passed in engineering and cavalry service in the army of the United States. Lee resigned his commission as lieutenant colonel April 20, 1861, and was immediately appointed major general and commander in chief of the State troops of Virginia. His relative and biographer expresses the regret of all students of American history that General Lee never wrote anything concerning his career and campaigns, for an account from his point of view would have settled very many conflicting opinions. He intended to write, not his personal memoirs, but a record of the deeds of his soldiers. He waited for a "convenient season," but as he lived only five years after the close of the war such a time never came. In this volume some of his testimony upon the great events in which he took such a prominent part is furnished by inserting extracts from his private letters, now first published. These letters, also, with others of the period before the war, show what manner of man he was, and nowhere now will it be denied that his character was one to be admired.

Lee was in Richmond hard at work organizing the Confederate forces when the first battle of Bull Run was fought. His own first campaign took place in what is now West Virginia, and was not successful. He was then sent south to apply his engineering skill in improving the defenses of Charleston and Savannah. It was on March 13, 1862, that President Davis appointed him commander of all the forces of the Confederacy. The battles on the Chickahominy in the latter part of June were fought under his orders. From that time to the end of the war most of the hard fighting took place between the northern and the southern capitals, where Lee was actively engaged. Here occurred the battles of Manassas, Sharpsburg, Fredericksburg, and Chancellorsville, and then Lee made his masterly advance that was checked at Gettysburg. After this he operated mainly on the defensive until the great surrender at Appomattox. Lee's phrase in his farewell to his soldiers—"The Army of Northern Virginia has been compelled to yield to overwhelming numbers and resources"—was no farfetched excuse for defeat. While this volume does not aim to provide data for a comparison of Lee's tactics with those of the successive commanders opposed to him, it does show that lack of food, clothing, and munitions of war had a large share in conquering his army. It was an expedition to acquire shoes that precipitated the contest at Gettysburg, and the verdict of a young Irishman, who served on Fitz Lee's staff, concerning the Confederates was, "I never saw men fight better, but they don't ate enough!"

After the war many honorable and lucrative positions were offered to General Lee, but he chose to accept the presidency of Washington College, on a salary of fifteen hundred dollars. In this position he died, and the name of the college was changed to Washington and Lee University in his honor.

A steel portrait by Hall is the frontispiece of this volume; there are also several maps and a notably good index.

Popular Astronomy. A General Description of the Heavens. By Camille Flammarion. Translated from the French by J. Ellard Gore. New York: D. Appleton & Co. Pp. 685. Price, $4.50.

This work, the author says, is written for those who wish to have an account of the things which surround them, and who would like to acquire, without hard work, an elementary and exact idea of the present condition of the universe. M. Flammarion is one of that race of brilliant writers on scientific subjects which France has developed within the past few years, who, endowed with great powers of the imagination and possessed of admirable gifts of style, have the faculty of presenting the truths of their special branches in the most vivid and picturesque language. He is not addicted to the faults, with which some of his school are chargeable, of indulging in exaggeration, and of seeking effect at the expense of exactness. While he falls below none of them in vigor of description and power of interest, he is true to science, and not inaccurate. The present work has had a circulation at home probably unequaled among scientific books, and has received a distinguished reward of merit from the French Academy of Sciences; besides which the author has been given various other honors. The present edition of the Popular Astronomy has been translated, with the author's sanction, by J. Ellard Gore, author of other popular astronomical works, who has also edited it so as to incorporate the results of the discoveries that have been made since the French edition went to press, and has reduced the figures given by the author to English measures. M. Flammarion begins his picture with a presentation of the earth as a body in the sky, and as that one whose position and motions controlled the ideas of the ancients respecting the universe, which, in the ignorance then existing of the relation of the earth to the other bodies, were infected with many errors; and he describes the slow process by which these errors were corrected. The question, How was the earth formed? suggests an outline of the nebular hypothesis, which is given. From this planet the reader is taken to the moon, the nearest body to it, of which are given its astronomical elements and a physical description; then to the planets, in the order of their distances from the sun, with consideration of their apparent and real motions. In connection with the account of Uranus—besides our being told the mortifying fact that the existence of the earth and all its great men and great enterprises is and must always remain unknown to the people thereof—a discussion of the question of life in other worlds is given, with the conclusion that though the conditions in them are not compatible with the life of such beings as we know, we have no right to deny that there may be other beings adapted to those conditions. The discussion is continued in the chapter on Neptune, where the author declares that such a thing as a sterile and uninhabited desert world is contrary to the acts and views of Nature as we know her. The nature and orbits of comets are discussed. Are they really composed of carbon—diamonds of the sky? "Their importance would be much greater still if they should be found to carry in them the first combinations of carbon, for it is probable that it was by these combinations that vegetable and animal life commenced on the earth and the other planets, and thus these vagrant bodies might be the sources of life on all the worlds." From another point of view the author gives reasons for supposing that comets' tails—considering the immense velocities at which they are carried, forty thousand miles a second in the perihelion of the comet of 1843—may be not substantial, but merely representative of a state of ether set in a particular undulating motion by the influence of the comet. The origin of comets may be various—from solar or planetary explosions; from explosions in distant stars, or from the scattered matter in space—any or all of these. Meteoric stones, meteoric showers, and cosmic dust are considered, and an equal variety of possible origins is supposed for them. The sidereal system comes next under review, in the several categories of the constellations, the positions of the stars in the sky, their magnitude or brightness, the measurement of celestial distances, the light of the stars, changes observed in the heavens, double, multiple, and colored stars, the proper motions of the stars, and the structure of the visible universe. A hopeless effort is made to convey a conception of the magnitude of the universe. We might sail forever through it with the velocity of light, and still be only at the beginning of our journey. The last chapter gives a simple lesson in home astronomy—a fitting introduction to Mr. Serviss's Astronomy with an Opera-Glass.

The Life and Inventions of Thomas Alva Edison. By W. K. L. Dickson and Antonia Dickson. New York: Thomas G. Crowell & Co. Pp. 362. Price, $4.50.

This biography, the authors claim, has been prepared "under unique facilities for procuring fullness and accuracy of fact, and thence for creating a living and sympathetic picture of the man. The materials have been obtained from the observations of a close business and friendly association of the authors with their subject for a period of thirteen years, and from the verbal and written data which Mr. Edison has most freely and kindly supplied. To this should be added manuscripts from the leading members of the Edison staff and the inventor's private files of periodicals, covering over thirty years, and embracing the best work of American and transatlantic journalism." Having made careful and discriminating use of this material, the authors believe they have given the first full, accurate, and, to Edison, satisfactory life of the inventor. Besides the matter conventionally appropriate to a biography and the accounts of Edison's numerous and valuable inventions, the book abounds in anecdotes, lively sketches, dramatic passages, and little incidents illustrating the vicissitudes of the subject's career, his peculiar turns of mind, his skill in adaptation and manipulation of already existing mechanism to give effect to his new ideas, and the ever-consistent bent of his genius. The account of his work with the electric light is varied with the descriptions of the journeys of his agents in South America and Asia in search of the best fiber for lamps, occupying two chapters. There are given us here the stories and descriptions of Edison's many experiments and improvements in telegraphy, his vote-recorder, his phonograph and allied instruments, his work in electric railroading, the kinetoscope, and the other applications. The laboratories at Menlo Park and Orange, and the various shops, are noticed in such a way as to give a current view of the development of the electric industry from its modest and doubtful beginnings to its present triumphant prosperity. The tone of the biography is one of enthusiastic admiration, and the book is profusely illustrated.

Defective Speech and Deafness. By Lillie Eginton Warren. New York: Edgar S. Werner, 108 East 16th St. Pp. 116.

This book is written primarily with reference to children, especially in schools, who have a deficient sense of hearing, but whose teachers and even their parents may not be aware of the fact. "Yet the deafness may be serious enough to interfere with progress in their studies. Such children are frequently considered dull and inattentive pupils. Many suffer from catarrhal affections and thereby present a variability of hearing, which makes them appear to better advantage on some days than on others. Thus they add to the teacher's difficulty in distinguishing them from the willfully disobedient. If one ear is defective and the other not, there will be times when the child hears well, and soon after, having turned his head, he fails to understand and becomes indifferent." The number of children troubled with defects in hearing has been found much larger in the schools of several different countries than any one at first thought would be likely to suppose; and the census returns give surprising accounts of the number of totally deaf persons, it being about 300,000 in the United States. There are further those who are somewhat deaf in one ear, those who are obliged to take a forward seat in the church and the public hall, and those who are conscious of a gradual failing of the hearing sense; also children and adults who receive sounds slowly because they lack quick perception, and persons who fail to distinguish particular shades of sound. With these affections the author couples defects of speech, such as stammering, stuttering, lisping, mumbling, and mouthing, as mostly originating in some organic fault. The object of her little book is to show that fluent speech may be obtained and understood by all who suffer from the different phases of deafness and the different degrees of imperfect utterance. In it she considers the cases of the Deaf Mute and the Stammerer; the Very Young Deaf Child; Signs, Finger-spelling, and Speech; Teaching the Dumb to Speak; the Child suddenly Deaf and the Child growing Deaf slowly; the improvement and development of hearing; How the Hard-of-hearing Adult may enjoy Conversation; Dull Pupils; Invented or "Pathological" Language, Lisping, Careless Speech, Stuttering, Stammering, and Cleft Palates. The author has a full understanding of her subject, presents it in a clear and earnest way, and urges the need for its more careful consideration by parents, and educators generally.

Bulletin of the United States Fish Commission, Vol. XII, for 1892. Marshall McDonald, Commissioner. Washington: Government Printing Office. Pp. 478, with One Hundred and Eighteen Plates.

The bulletins are issued under a joint resolution of Congress authorizing the publication, from time to time, for distribution in parts and collection in annual volumes not exceeding five hundred pages each, of any matter furnished by the Fish Commission, relative to new observations, discoveries, and applications connected with fish culture and the fisheries. The present volume contains a bibliography of the salmon of Alaska and adjacent regions, and a life history of the salmon, by Tarleton H. Bean; a paper on the viviparous fishes of the Pacific Coast of North America, by C. H. Eigenman; an account of the fishes of Texas and the Rio Grande Basin, considered chiefly with reference to their geographical distribution, by B. W. Evermann and W. C. Kendall; a report on the salmon fisheries of Alaska, by Marshall McDonald; a summary of the fishery investigations of the Albatross, 1882–'92, by Richard Rathbun; a report on the fyke net fisheries of the United States, and Notes on Fishes of the Northern Coast of New Jersey, by H. M. Smith; an account of the oyster industry of Maryland, by C. H. Stevenson; and two or three papers of more special interest.

Aërial Navigation. By J. G. W. Fijnje van Salverda. Translated from the Dutch by George E. Waring, Jr. New York: D. Appleton & Co. Pp. 209. Price, $1.25

There seems to be good reason for believing that the next great triumph of science will be in the field of aërial navigation. The number and ability of the investigators who are now at work upon this subject, the encouraging results and the widespread interest that their efforts have secured, furnish substantial ground for this belief. After a historical introduction and a discussion of the military importance of aërial navigation, Mr. Fijnje considers the obstacles in the way of navigating balloons, stating the practical results already reached. He then passes to the flight of birds, from the several varieties of which—rowing, hovering, and sailing—the principles of flying machines proper are derived. Three kinds of machines of the "heavier than air" class are described in a brief chapter. Although MM. Renard and Krebs in 1885 succeeded in driving an elongated balloon at the rate of fourteen miles an hour, the author is convinced that balloons must give place to flying machines. Among his conclusions concerning the latter are that a flying machine must be supported by a large and strong aëroplane, which must not be utilized to give forward motion. There must be an independent motor, working continuously, and operating through propelling screws or other device. Some later matter published by the author separately from the foregoing gives the results of investigations by Prof. S. P. Langley, of the Smithsonian Institution, and by Hiram S. Maxim, the English inventor. Colonel Waring has supplemented his translation of Fijnje's book with abstracts of two still later announcements of results by Prof. Langley, and some extracts and illustrations from a study of a practical air ship contributed by Mr. John P. Holland to Cassier's Magazine. The reader may obtain from this volume an understanding of the problems that have to be solved before the air can be navigated, and a knowledge of lines along which these problems are being approached.

A Bird-lover in the West. By Olive Thorne Miller. Boston and New York: Houghton, Mifflin & Co. Pp. 278. Price, $1.25.

Of old the poet Horace warned us that "black Care sits behind the horseman and does not withdraw from the ship," but Mrs. Miller assures us that the way to truly recreate is to leave our hurries and worries behind us and seek some unfamiliar spot where we may commune with Nature. Even with her explicit directions this may not be easily accomplished. Her example is, however, of more practical value than her advice.

It is not the going away, nor change of scene, nor yet strength of will, that dismisses the dark follower, but the substitution of a greater interest for our own petty concerns. If we can not journey to Cheyenne Mountain, there are new worlds to be discovered about us, and this book shows such loving study of bird life that some may be tempted to begin it at home.

Wherever the author finds herself—at the foot of the Rocky Mountains, beside Great Salt Lake, or in "the middle country"—her first inquiries are for her winged neighbors. In the forest and in the cañon she spends days observing the manners and habits of the wren, chat, or blue jay. Incidentally she notes that poets take too much license with the traits of her feathered friends. "The voiceless swallow," "forgetful thrush," and "mourning dove" are base misnomers. The coo of the dove "has a rich, far-off sound, . . . expressing a happiness beyond words," and not one of the swallow tribe can be called mute.

In the arid country the author comes upon a housewife who cooks outdoors. The stove is under an oak tree, while the pots and pans hang outside the house. This is so nearly akin to the ways of the winged fraternity that place is given to a regret that the woman is not a bird to be studied!

In spite of her zeal for bird acquaintance, the flowers do not go unobserved; two chapters are devoted to their changing glories in the wild garden of Colorado. Not only do these surpass the eastern flora in size, color, and fragrance, but also in abundance and variety. In one locality a hundred differing kinds are found in a month, and of these only half a dozen are recognized as old friends.

Altogether, a most inviting field, according to the author, awaits the naturalist in the west.

The Friendship of Nature. By Mabel Osgood Wright. New York and London: Macmillan & Co. Pp. 238. Price, 75 cents.

This little volume depicts a series of New England landscapes. They are rendered with words instead of colors, but an artist would have little difficulty in reproducing them by any medium he might choose. Foreground, background, sky, atmosphere, and foliage are delineated by the faithful eye that neglects no detail.

With the scenic descriptions are given bits of botany, ornithology, and philosophy, quaint legend, and flower lore.

Although employing a prose form, the author delights in rhythmical expression, and many sentences are as easily scanned as the following: "Down from the village runs the dusty road"; "The flush of morning comes upon the sea." Figures are lavishly scattered about; some of these are fresh and effective. Mushrooms are pictured as the gypsy race of plant-land that rears its fungus encampment. Occasionally this love of imagery betrays the author; she writes in regard to the blue gentian: "One dreams that the sky, once molting, dropped its soft-edged feathers on the grass, and earth twined them into flowers." The vision of the vaultless blue shaped like some huge fowl shedding its feathers is too incongruous to be entertained, and we dismiss it to the company of that distressing simile, "And like a lobster boiled, the morn from black to red began to turn."

The author holds that if all were scientists the world would be badly off; spirit would be dried out by system. This is the time-worn libel upon science—science, that breathes a soul into rocks, reads the romance of flower shapes, and gets color and fragrance from a lump of coal!

Even though repudiated, science has informed much of the book with beauty, and it may be commended to country lovers as a dainty calendar of the seasons.

Alexander Winchell's Walks and Talks in the Geological Field has been adopted by the Chautauqua Circle as one of its text-books, and a special edition of the book has been made for this purpose (Flood, $1) It has been revised and edited by Prof. Frederick Starr, of the University of Chicago, who has aimed to retain all the geological material of the original edition, and in the author's own words. Marginal comment has been introduced as a convenience to the reader, and a few footnotes have been added. The editor speaks of this book as intended by its author to hold a position between text-books and books of light reading. It is written in an easy, conversational style, and is free from unnecessary technicalities. Although its forty-nine chapters have independent and picturesque titles, their scope and arrangment is such that the editor is able to group them under these general heads: surface geology, strata, igneous agencies, economic geology, fossils, beginnings of the earth, and history of life and the growth of the continent. A number of illustrations have been introduced.

A very handsome book is *Cheiro's Language of the Hand* (the author, 432 Fifth Avenue, New York, $2). It is in square octavo form, with many illustrations, and is printed with large type and wide margins. It begins with a defense, which is followed by definitions of the square, conic, and various other shapes of hands, definitions of various kinds of fingers, of the "mounts" of the hand, etc. Then follow the meanings that the author assigns to the lines, stars, and other markings on the hand. There are a number of plates at the end, showing impressions of the hands of celebrated persons, and an appendix of testimonials from persons who have had their fortunes told by the author.

The first volume of *The Tannins*, issued three or four years ago by Prof. *Henry Trimble*, has now been followed by a second (Lippincott, $2). It is devoted to the results of investigation by the author on the astringent principles from nine species of oaks and one species each of mangrove, canaigre, and chestnut. The oak barks include a species from England and one from India. A bibliography is appended, which, with that in Volume I, makes up a total of nearly one thousand titles. There are thirty-three illustrations, showing leaves, acorns, and apparatus.

The *First Lessons in Reading* of *Elizabeth H. Fundenberg* (American Book Company, 25 cents) is based on the principle that the first teaching should connect the words already known to the ear with their written or printed forms, leaving the letters and the sounds they represent to a future step. Accordingly, the sentence or word method has been adopted, to give way to the phonic-word method when the child has become familiar with the printed and written forms of a considerable number of the words which are in his oral vocabulary. The *Teachers' Edition* (50 cents) comprises a manual in which each lesson is developed, together with outlines for slate and board work; also full instructions on phonetics and rules for pronunciation and spelling.

A second edition of *Introductory Lessons in English Grammar*, by the same author, is also published by the American Book Company. This is designed for intermediate grades, and will serve better when used to supplement the preceding than if offered by itself as a first course in grammar. Although well arranged, clear, and complete, it savors enough of technicality to arouse perhaps that unreasoning distaste for grammatical study which it is better the young student should never possess.

The *Conversational Method in French* of M. J. Victor Plotton is the fruit of an experience of many years, and is a system in which successful results have been obtained by those who have used it. Its aim is to teach speaking rather than reading, and it proceeds by carefully graduated lessons to take the pupil along unconsciously, as it were, to him, till he is expected to express himself easily in the language. The present volume is a second part, being preceded by one of a more elementary character. The lessons are arranged each to illustrate some special grammatical form, and include a passage to be read, analyzed, and questioned upon, with exercises in adapting various words to the form; and, further along, extracts from French classical authors. (Halifax, Nova Scotia, $1.)

The Daughter of the Nez Percés is a story of Indian life strictly founded on fact, by *Arthur Paterson*. Without desiring to take sides in the questions concerning the troubles in which the Nez Percés have been involved, the author's object has been to describe with what vividness he could certain scenes in the life of a chief—Joseph, still living—"who, whether right or wrong, is unquestionably one of the most remarkable men his race has ever produced." Liberties are taken with the details of Joseph's family life and some incidents not historical are admitted, but, in the main, the true course of events has been followed. Mr. Paterson's endeavor has been to present Joseph as the man he was, and not as a mere ideal of what he should have been. We have found the story very interesting. (Published by George Gottsberger Peck, New York.)

The Epitome magazine (Washington, J. B. Lockwood, manager; *M. Sewell Roy*, editor; monthly, $2 a year) is the outgrowth of the literary club life of Washington, and is expected to perpetuate the best of the essays read at the meetings. It is, however, something else than simply a club magazine, and opens its columns to discussions on all subjects of general interest. The articles in the number before us are varied, fresh, and interesting.

An excellent manual for primary schools is the *First Book in English*, by *W. H. Maxwell*. The method is inductive, the lessons short and novel in character. By observation and comparison of models the pupil learns to recognize and construct the simple sentence. Later he is taught in the same manner to identify the principal parts of speech. Practice is given in drawing and dictation as well as in composition, and with the varied drill afforded there seems no reason why a child should not easily acquire a thorough knowledge of elementary grammar and writing in even less time than the specified three years which allows for very deliberate work in a volume of 172 pages.

The New Science Review is the name of a quarterly periodical undertaken by the Transatlantic Publishing Company, Philadelphia, as a miscellany of modern thought and discovery. In outer appearance it is all that could be asked. In its "announcement" it declares that it will differ from all the scientific periodicals, not attempting to supersede the older and more conservative periodicals, but to supplement them, addressing itself not to specialists but to the public at large, presenting matter of scientific value in popular style; not assuming that the reader has an esoteric acquaintance with the matter in hand, but giving him a preliminary acquaintance with it, explaining before it demonstrates. The first number starts off with an effort of Major-General A. W. Drayson to solve the mystery of the ice age, in which he presents his theory of a second revolution of the pole under the operation of a displacement of the earth's center of gravity, under which the polar circles may be periodically brought down as low as 54° of latitude. The Problem of the Pole—that is, the present status of the attempt to reach it—is lucidly set forth by Charles Morris. Mrs. Bloomfield Moore is allowed to describe the propeller of the Keely air ship, and to glorify its projector in an article entitled The Newton of the Mind; Julian Hawthorne in another article tells how great a man Mr. Keely is; and a long and laudatory notice is given in the second number of the review of Mrs. Moore's book on Keely and his discoveries. Among other articles in the two numbers that deserve or will attract attention are Major Ricarde Seaver's Diamonds and Gold—a description of the South African mines; Lieutenant Patten's account of the eminent electrician, Nikola Tesla, and his works; a summary of Prof. Dewar's lecture on Fluorescence and Phosphorescence; the presentation by W. G. Jordan of "Mental Training—a Remedy for Education;" the Rev. John Andrews's description of the pendulograph and its curious work; symposiumlike discussions of the causes of success of certain works of fiction, the nature of electricity, and What is Science? a summary of Charles Barnard's American Association paper on The Battles of Science; and a number of selected articles. A summary of current scientific discussion is contributed to each number by Prof. Angelo Heilprin.

The second part of the text-book on *Plane Trigonometry*, by *S. L. Loney*, deals with analytical trigonometry (Macmillan, $1). Among the topics treated in this part are exponential and logarithmic series, various operations with complex quantities, Gregory's series, and the principle of proportional parts. A list of the principal formulæ in trigonometry is prefixed to the volume, and the answers to problems are given at the end.

A treatise on *Amphioxus and the Ancestry of the Vertebrates*, by *Arthur Willey*, B.Sc., has been issued as the second volume of the Columbia University Biological Series (Macmillan, $2.50 net). The editor of the series, Prof. Henry F. Osborn, says in the preface that he suggested the course of lectures in which this volume originated, and deems it important that the author should bring within the reach of students and of specialists among other groups his extensive observations upon Amphioxus and other remote ancestors of the vertebrates, as well as the general literature upon this group.

The year ending with September, 1893, is covered by the *Eighteenth Year-Book of the New York State Reformatory*. The book contains the reports of the board of managers, the superintendent, Z. R. Brockway, the technological and military instructors, the superintendent of schools, and the physician. Instruction in thirty-four trades was imparted during the year to a total of eighteen hundred and four inmates. The trades range in character from such laborious occupations as bricklaying, iron-forging, and stone-cutting to such light and intellectual work as frescoing, music, photography, stenography, and typewriting. The year-book itself is a very creditable exhibit of the work of inmates in type-setting, illustrating, and binding. In the schools the instruction ranges from the elements of reading and arithmetic given to illiterates up to lectures in history, science, ethics, political economy, etc. For military drill the inmates constitute a regiment of sixteen companies, with a band. Appended to the reports are a chapter on dietary, one of anthropological observations with illustrations, and an account of innovations made during the year. The board of managers state that much misrepresentation of the system of the institution was made "by a sensational newspaper," and the superintendent reports that his plans for progress were much retarded by a diversion of time and attention to the investigation which followed this attack.

David T. Day's Tenth Annual Report of the Mineral Resources of the United States presents a statement of the mineral products during the calendar year 1893, the industrial conditions affecting those products, and the recent additions to the knowledge of the mineral deposits in this country. Its scope is thus similar to that of the preceding volumes, with the addition of more than the usual references to the condition of mineral industries in foreign countries. It appears from it that the total value of our mineral products in 1893 was the smallest since 1889. It represented $609,821,670, compared with $688,616,954 in 1892—a decline of 11·44 per cent. The decline in value was most conspicuous in pig iron and structural materials, but many other minerals also declined in the amount and the value of the product, the exceptions being gold, anthracite coal, aluminum, phosphate rock, and gypsum. A few other products increased in quantity but declined in value.

The thirty-fifth volume of *Annals of the Astronomical Observatory of Harvard College* contains the first part of the *Journal of Observations* made by Prof. William A. Rogers, at the observatory, to determine the places of stars in the zone between the limits of north declination 49° 50′ and 55° 10′. The catalogue resulting from these observations has already been published in the fifteenth volume of the *Annals*, and the discussion of proper motions derived from the work forms the twenty-fifth volume of the same series.

The report of the *Observations made at the Blue Hill Meteorological Observatory, Massachusetts*, in 1893, mentions as among the investigations that were carried on during the year the comparisons by Mr. S. P. Fergusson of anemometers of different types, and Mr. H. Helm Clayton's studies of the upper air around cyclones and anticyclones, as shown by cloud observations. Curious wavelike oscillations of the barograph records at this and other stations are discussed by Mr. Clayton in the report. Connected with the observatory are a base station four hundred and forty feet below it, and a valley station six hundred feet below it. The whole of the Blue Hill has been taken by the State as a public reservation; but it is not supposed that the operations of the observatory will be interfered with by the act.

The Celestial Writing, or the Normal Script Phonetic Writing, by *W. H. Barlow*, is an abbreviated script phonetic mode of writing the English language, founded on a modified form of the consonant alphabet of Gabelsberger. It is introduced as a labor-saving device for the penman, and is derived from our common handwriting, from which the extraneous superfluities are cut off. Thus M is written with one stroke instead of three, and so on. It is claimed that the art of writing it can be acquired by a person of ordinary capacity within a week.

PUBLICATIONS RECEIVED.

Agricultural Experiment Stations. Reports and Bulletins. Cornell University: Apricot-growing in Western New York. Pp. 24.—Massachusetts: Commercial Fertilizers and Fodder Articles. —Michigan: Millet. Pp. 64.—Fattening Lambs, Rape, Swamp Lands, and Insects of the Clover-field. Pp. 64.—New York: Twelfth Annual Report. Pp. 760.—North Dakota: Weather and Crop Service, October, 1894. Pp. 15.—Ohio: Strawberries. Pp. 20.—Purdue University: Wild or Prickly Lettuce. Pp. 32, with 2 Plates.—University of Illinois: Stock feeding and Index. Pp. 16.—University of Nebraska: Nebraska Beet-sugar Industry. Pp. 32.

Alabama. Report of the Insane Hospital at Tuscaloosa, for 1893 and 1894. Pp. 46.—Geological Map, with Explanatory Chart. E. A. Smith, State Geologist.

L'Album Industriel. Weekly. Montreal. Pp. 16. $2.50 a year.

American Forestry Association. Proceedings at the Tenth, Eleventh, and Twelfth Annual Meetings. Vol. X. Pp. 45 to 92.

Anthony, Gardner C. Elements of Mechanical Drawing. Boston: . . C. Heath & Co. Pp. 98, with 32 Plates. $1.50.

Arthur, J. C. President's Address to the Indiana Academy of Science, 1893. The Special Senses of Plants. Pp. 12.

Bailey, L. H. Electricity and Plant-growing. Boston: Massachusetts Horticultural Society. Pp. 28.

Customs Law of 1894 compared with the Customs Law of 1890, with Rates of the Mills Bill of 1888 and the Wilson Bill of 1894. Washington: Government Printing Office. Pp. 280.

Eigenmann, Carl H., and Beeson, Charles H. A Revision of the Fishes of the Sub family Sebastinæ of the Pacific Coast of North America. Smithsonian Institution. Pp. 32.

Entomology, Division of, United States Department of Agriculture. Reports of Observations and Experiments in the Practical Work of the Division. Washington. Pp. 59.

Edwards, Rev. Jonathan. Marcus Whitman, M. D., the Pathfinder of the Pacific Northwest and Martyred Missionary of Oregon. Spokane, Wash. Pp. 48.

Fox, T. W. The Mechanism of Weaving. New York: Macmillan & Co. Pp. 472. $2.50.

Gaye, Selina. The Great World's Farm. Some Account of Nature's Crops and how they are Grown. New York: Macmillan & Co. Pp. 365. $1.25.

Geological Society of America. Seventh Annual Meeting, December 27, 28, and 29, 1894. Preliminary List of Papers. Pp. 8.

Giberne, Agnes. Radiant Suns. A Sequel to Sun, Moon, and Stars. New York: Macmillan & Co. Pp. 328. $1.75.

Hepner, Adolf. Good Night, Schatz! Drama. St. Louis, Mo.: St. Louis News Company. Pp. 47.

Hill, R. T. Notes on the Tertiary and Later History of the Island of Cuba. Pp. 16.

Hopkins, Rufus C. Roses and Thistles (Poems). San Francisco: William Doxey. Pp. 480. $2.

Hale, Edwin M., M. D. Primary and Secondary Symptoms and their Relation to Dose. Pp. 11.

Illinois State Laboratory of Natural History, Champaign. Biennial Report of the Director, 1893-'94. Pp. 36, with Plates.

Interstate Commerce Commission. Sixth Annual Report on the Statistics of Railways in the United States, to June 30, 1893. Pp. 620.—Synopsis of the Eighth Annual Report. Sheet. Washington: Government Printing Office.

Kinney, Abbot. Money. Los Angeles, Cal.: Stoll & Thayer. Pp. 24. 10 cents.

McCook, Henry C. American Spiders and their Spinning Work. Vol. III. With Descriptions of Orb-weaving Species and Plates. Philadelphia: The Author. Pp. 285, with 29 Colored Plates.

McMurrich, J. Playfair. A Text-book of Invertebrate Morphology. New York: Henry Holt & Co. Pp. 661. $4.

Magazine, The, of Travel. Monthly. Vol. I, No. 1. Pp. 96. 25 cents, $3 a year.

Marshall, A. Milnes. The Frog: An Introduction to Anatomy, Histology, and Embryology. Fifth edition. Manchester and London, Eng. Pp. 163.

Mason, Otis Tufton. North American Bows, Arrows, and Quivers. Smithsonian Institution. Pp. 50, with 57 Plates.

Michigan. Twenty-sixth Annual Report of Births, Deaths, and Marriages. Lansing. Pp. 375.

Missouri Botanical Garden, St. Louis. Sixth Announcement concerning Garden Pupils. Pp. 10.

New York State Veterinary College of Cornell University. Pp. 7.

Owen, The Rev. Richard. The Life of Richard Owen. New York: D. Appleton & Co. Two Volumes. Pp. 409 and 393.

Pancoast, Henry S. An Introduction to English Literature. New York: Henry Holt & Co. Pp. 473.

Peabody Education Fund. Proceedings of the Trustees at their Thirty-third Meeting, October, 1894. Pp. 62.

Philadelphia, City of. Annual Report of the Superintendent of Schools. Pp. 100.

Phillipson, John. The Natural History of Hell. New York: The Industrial Publication Company. Pp. 109. 25 cents.

Pick, Albert. A Practical System of Studying the German Language. Newtonville, Mass.: Pick & Tanner. Twelve Parts. Pp. 176.

Pope Manufacturing Company, Hartford Conn. Calendar for 1895.

Preece, Louise. A System of Physical Culture for Public-school Work. Syracuse, N. Y.: C. W. Bardeen. Pp. 193, with Plates. $2.

Prosser, Charles S. Kansas River Section of the Permo-Carboniferous and Permian Rocks of Kansas. Pp. 54.

Saville, Marshal H. The Ceremonial Year of the Maya Codex Cortesianus. Pp. 4.—A Comparative Study of the Graven Glyphs of Copan and Quirigua. Pp. 12.

Sergi, Giuseppi. The Varieties of the Human Species. Principles and Method of Classification. Smithsonian Institution. Pp. 61.

Scripture, Edward W., Editor. Studies from the Yale Psychological Laboratory. Vol. II, November 1, 1894. Pp. 124. $1.

Shaler, N. S. Sea and Land. New York: Charles Scribner's Sons. Pp. 252. $2.50.

Smithsonian Institution. Annual Report of the Board of Regents to July, 1893. Pp. 763.

Stokes, Anson Phelps. Joint-Metallism. New York: G. P. Putnam's Sons. Pp. 198.

Thomas, Cyrus. Report of the Mound Explorations of the Bureau of Ethnology. Washington: Government Printing Office. Pp. 742.

Trotter, Spencer. Lessons in the New Geography. Boston: D. C. Heath & Co. Pp. 182.

Union College Inauguration of the Rev. Andrew V. V. Raymond, D. D., as Ninth President. Pp. 41.

United States National Museum. Baur, G. The Relationship of the Lacertian Genus Anniella, Gray. Pp. 8.—Lænnberg, Einar. Reptiles and Batrachians collected in Florida. Pp. 30.—Lucas, Frederick A. Anatomy and Affinities of Certain American Birds.—Ridgway, Robert. New Birds from Aldaba, Assumption, and Gloriosa Islands, collected by Dr. W. L. Abbott. Pp. 3.—Twenty-two New Species of Birds from the Galapagos Islands. Pp. 16.—True, Frederick W. On the Rodents of the Genus Sminthus in Kashmir. Pp. 3.—Diagnosis of some Underground Wood Rats. Pp. 3.—Diagnosis of New North American Mammals. Pp 3.—Verrill, A. E. New Species of Starfishes and Ophiurans, etc. Pp. 52.—Walcott, Charles D. Discovery of the Genus Oldhamia in America. Pp. 3.

POPULAR MISCELLANY.

A Discussion on Variation.—One of the most interesting sectional meetings of the British Association was one at which a series of papers was read dealing with questions connected with evolution and Darwinism, such as the real nature and cause of variation; the inheritance of acquired characters; the adequacy of natural selection to affect variation sufficiently to explain the great range of animal and plant structure. The first paper was by Prof. D'Arcy Thompson, on Some Difficulties of Darwinism, which was an attempt to deal with the third of these questions. Prof. Thompson suggested that the mechanical and mathematical principles of growth itself may have affected the form of animal life. He instanced the spiral shells of the nautilus and the conical eggs of the guillemot as probably deriving their shape from this principle. The second paper, by Prof. Riley, of Washington, dealt with the very interesting habits of the social insects—ants, bees, wasps, and termites—and showed how all the fresh knowledge accumulated since Darwin's time only corroborated his views, to the effect that in this case the "struggle for existence" of the colony as a whole must be substituted for that of the individual. An interesting point was made by Prof. Haycraft, to the effect that the true function of sex was to keep down variation—that by the combination of two individuals to form a new individual, a mean between the two was always obtained, and that in this way the race was kept constant; whereas, if the new individual could be produced from only a single parent, the limits of variation would be unduly extended. The other papers were by Mr. F. A. Dixey, on Some Fresh Points with Regard to Mimicry in Butterflies; and by Prof. Osborn, of New York, on Certain Variations met with in the Dentition of Fossil Mammals. Prof. Osborn showed how two teeth might come eventually to resemble one another closely, although the stages through which they passed had been widely different. The discussion which followed these five papers was of an animated character, and was participated in by a considerable number of members. Prof. Ray Lankester complained that most of the difficulties suggested had been long ago dealt with by Darwin himself, whose works were insufficiently studied by the younger generations of biologists. The discussion was finally summed up in a most lucid speech by Sir Edward Fry, who complained of the absence of clear issues, and of the consequent difficulty of forming a judgment on most of the points brought forward.

Cambodian Arithmetic.—The Cambodians have a quintesimal system of enumeration, yet they use nine digits and a cipher, and are able to count in practice about as if their system was decimal. Their methods of adding and subtracting are curious. Suppose one wishes to add the numbers 247,372, 53,723, 975,642, 278,383, the sum of which is 1,555,120. The Cambodian writes the first two numbers one above the other, draws a vertical line to the right of them, and

writes the sum, 301,095, to the right of the line. Under this number he places the third number of the series (975,642), and adds that in just as he did the first two; and so on till the process is completed. The process is longer than ours, but gives more opportunity for deliberation and the detection of errors. Where whole numbers and fractions are both involved, two series of additions are gone through. In subtraction, they write the lesser number over the larger, and begin at the left; thus, to subtract 657,869 from 786,422, they write
657,869 |
786,422 |
and proceed, 6 from 10 (a fictitious number which they use for convenience) leaves 4; adding 7 (the first figure of the minuend), gives 11, and $11 - 10$ leaves 1, the first figure of the remainder. For the next digits, 5 from 10 leaves 5; adding 8 gives 13; this less 1 gives 12, the first two figures of the remainder. Then, 7 from 10 leaves 3, adding 6 to which gives 9, which less $1 = 8$; $10 - 8 = 2 + 4 = 6 - 1 = 5$; $10 - 6 = 4 + 2 = 6 - 1 = 5$; $10 - 9 = 1 + 2 = 3$. Whence, if the numbers are set down as they are found, the remainder appears correctly as 128,553. In multiplication they place the multiplier over the multiplicand and multiply successively each of the figures of the multiplicand by each figure of the multiplier, obtaining a large number of partial products which they have painfully to add together. The process of division is likewise absurdly complicated.

The Utilitarian Side of Botany.—Botanists, said Prof. I. B. Balfour, in his British Association address, do not seem to have realized, except in the case of medicine, that modern botany has an outlet. Chemists and physicists seek practical aims. Zoologists help the fishing industry. But where is the practical outcome of modern botany? The work of Marshall Ward is full of purpose to many large industries, and that of Oliver has bearings on horticulture; but the trend of botanical work in England has not been utilitarian. It was, however, its utilitarian side that gave the first impetus to the scientific study of botany. The plant world, as the source of products of economic value and drugs, attracted attention, and out of this grew by natural development the systematic study of plants. The point of view was that botany was an essential branch of medical study. A practical outcome was the establishment of botanic gardens, now in many instances appendages of teaching establishments, or mere pleasure grounds. But the gardens at Kew still maintain the old tradition of botanic gardens as a center through which botany renders scientific service to national progress. Under the Darwinian influence the biological features of the plant world replaced technical diagnosis and description as the aim of teachers and workers. Pharmacy is removed from the functions of the physician; but botanical study on the lines of modern teaching is part of the university training essential to medical students. There is still danger of modern teaching being strangled by its terminology, of narrowing the field of vision and mistaking the name for the thing, of elaborating the minute details of a part at the expense of its relation to the whole organism. This mechanical attitude is a consequence of specialization. But it must be counteracted if botany is to be aught else than a mechanical study. Modern botany has not yet found its full application. It has not rendered the service due to the state. In horticulture and agriculture it should find a sphere of application by which it may contribute to the national well-being. Botanists must be the apostles of forestry; and forestry in turn will react upon their treatment of botany. Botany can not thrive in a purely introspective atmosphere; it can live only by keeping in touch with the national life.

The Uses of Illuminating Gas.—Many are the advantages of gas for household purposes, says William Paul Gerhardt, and its disadvantages are comparatively few, and for this reason it is probably more used in houses at the present day than any other form of artificial illumination. Gaslight is relatively cheap, although kerosene oil, *per se*, is probably cheaper. It is convenient, and saves domestic labor by being always ready for lighting. It is superior in point of cleanliness to oil lamps and candles. It is brilliant, easily controlled, and not difficult to manage by persons of ordinary intelligence. It is much safer than candles or lamps in which colza oil or kerosene is burned. Gaslight, finally, creates, in proportion to the light developed, less disagreeable heat and is less unhealthful when proper ventilation of rooms is provided than candles or oil lamps. Among other purposes to which gas has in recent years been applied, Mr. Gerhardt mentions its use in warming rooms, heating sadirons, and heating water; in roasting, baking, steaming, frying, boiling, and broiling. It is adopted as fuel to drive small domestic motors, for various industrial purposes; and it is employed for artificial ventilation conducted by means of gas jets burning in exhaust flues, or by the use of sun-burners. Much has been said about the injurious influence of gaslight upon health; of the vitiation of the atmosphere of rooms; and of the destructive effects of gas, when imperfectly consumed, upon the furniture and decorations of a room, and the smoking up of ceilings and walls. But notwithstanding the rapid development of electric lighting, and notwithstanding the recent return in dwellings to the use of oil lamps, and of extensive and costly paraffin and wax candles, the use of gas in dwelling houses, offices, and stores is undoubtedly so convenient and comparatively safe that for many years to come it will constitute the chief means of artificial illumination.

Are Civilized Races Superior?—Proud of his wonderful achievements, civilized man looks down upon the humbler members of mankind. He has conquered the forces of Nature and compelled them to serve him. He has transformed inhospitable forests into fertile fields. The mountain fastnesses are yielding their treasures to his demands. The fierce animals which were obstructing his progress are being exterminated, while others which are useful to him are made to increase a thousandfold. The waves of the ocean carry him from land to land, and towering mountain ranges set him no bounds. His genius has molded inert matters into powerful machines, which wait a touch of his hand to serve his manifold demands. What wonder, asked Dr. Franz Boaz, in his address before the Anthropological Section of the American Association, that he pities a people who have not succeeded in subduing Nature, who labor to eke an existence out of the products of the wilderness; who hear with trembling the roar of wild animals; who remain restricted by ocean, river, or mountains, and who strive to secure the necessaries of life with the help of few and simple instruments? What wonder if civilized man considers himself a being of higher order than primitive man? If it is claimed that the white race represents a higher type than all others? When we analyze this assumption it will soon be found that the superiority of the civilization of the white race is not a sufficient basis for it. As the civilization is higher, we assume that the aptitude for civilization is also higher, and as the aptitude for civilization presumably depends upon the perfection of the mechanism of body and mind, the inference is drawn that the white race represents the highest type of perfection. In this conclusion, which is reached through a comparison of the social status of civilized man and primitive man, the achievement and the aptitude for achievement have been confounded. Furthermore, as the white race is the civilized race, every deviation from the white type is considered a characteristic of the lower type. That these two errors underlie our judgments of races can easily be shown by the fact that, other conditions being equal, a race is always described as the lower the more fundamentally it differs from the white race.

The Problems of Archæological Relics.—The purpose of Mr. Gerard Fowke's Notes on the Archæology of Ohio is to present in a compact form conclusions based upon a careful study of the earthworks and the relics associated with them; embodying a summary of the results reached by all who have been engaged in the investigation. The very wide range of forms and relics—as is shown by the author—the diversity of material, and their unlikeness to almost everything belonging to the present inhabitants, have caused some misapprehension or confusion as to their probable uses. This is especially the case with the great number of objects whose manufacture may be considered the outcome of æsthetic or religious ideas. They are made of nearly all the different kinds of shell, bone, metal, and stone, especially slate and steatite, accessible to their fabricators. Under such names as gorgets, crescents, wands, tubes, banners, stones, amulets, pendants, butterfly gorgets, ear bobs, bracelets, breastplates, beads, buttons, headdresses, labrets, nose rings, charms, and a score of others, they are delineated in many volumes. To ascribe a purpose to any pattern, unless a similar one has been seen in actual service, would be as presumptuous as the attempt by a person entirely ignorant of modern secret societies to explain the meaning of badges, pins, or regalia. No doubt some of them owe their form to a whim or fancy of the maker; others were purely decorative; while many of them were symbolic, or for use in the manifold dances, parades, celebrations, superstitious ceremonies, and other observances so dear to the minds of an uncultured people. The manner of perforation in some indicates that they were for suspension by cord; in others, that they were to be placed upon a staff; still others, unperforated, may have been secured in various ways. Nearly all are made of material that would break if carelessly handled; many are of such size or shape that no particular use for them can be imagined. There is less trouble in regard to the utensils, weapons, or implements for ordinary work, comprising articles necessary in agriculture, hunting, warfare, or domestic affairs. What sort of work the prehistoric people may have done in wood, textile fabrics, feathers, fur, robes, skins, or other perishable material, can never be known; but judging from the few scraps remaining, and from such other specimens as have been preserved, it was probably on a par with that of the present day among tribes but little changed from their condition when first known to the whites. Mr. Fowke's notes are published, with plates, by Robert Clarke & Co., Cincinnati.

Roger Bacon's Dream of Steam and of Air-Ships.—An essay by Roger Bacon, published in 1618, has been brought to attention by M. de Fonvielle, which contains dim predictions of steam power and the navigation of the air. "Instruments," the author says in this essay, "may be made for navigating without any men pulling the oars, with a single man governing, and going quicker than if they were full of pulling men. . . . Wagons can also be made, that without any horse they should be moved with such a velocity that it should be impossible to measure it. . . . It is possible also to devise instruments for flying, such that a man being in the center if revolving something by which artificial wings are made to beat the air in the fashion of birds. . . . It is also possible to devise instruments which will permit persons to walk on the bottom of the sea. . . . All these things have been done in old times and in our times, except the instrument for flying, which I have not seen, and I have not known any man who saw it done."

The Test of Exactness.—Admitting that the prevailing opinion that great advances have recently been made in astronomy is correct so far as the fields of spectrum analysis and the measurement of minute quantities of radiant heat are concerned, Dr. William Harkness showed in his vice-presidential address at the American Association that the solution of the vast majority of astronomical problems depends upon the exact measurement of angles, and in that little or no progress has been made. Bradley, with his zenith sector a hundred and fifty years ago, and Bessel and Struve, with their circles and transit instruments seventy years ago, made observations not sensibly inferior to those of the present day, and indeed it would have been surprising if they had not done so. The essentials for accurately determining star places are a skilled observer, a clock, and a transit circle, the latter consisting of a telescope, a divided circle, and four micrometer microscopes. Surely no one will claim that we have to-day any more skillful observers than were Bessel, Bradley, and Struve, and the only way in which we have improved upon the telescopes made by Dollond one hundred and thirty years ago is by increasing their aperture and relatively diminishing their focal distance. The most famous dividing engine now in existence was made by the elder Repsold seventy-five years ago; but, as the errors of divided circles and their micrometer microscopes are always carefully determined, the accuracy of the measured angles is quite independent of any small improvement in the accuracy of the divisions or of the micrometer screws. Only in the matter of clocks has there been some advance, and even that is not very great. On the whole, the star places of to-day are a little better than those of seventy-five years ago, but even yet there is great room for improvement. One of the commonest applications of these star places is to the determination of latitude, but it is very doubtful if there is any point on the face of the earth whose latitude is known certainly within one tenth of a second. Looking at the question from another point of view, it is notorious that the contact observations of the transits of Venus in 1761 and 1769 were so discordant that from the same observations Encke and E. J. Stone got respectively for the solar parallax 8·59 seconds and 8·91 seconds. In 1870 no one thought it possible that there could be any such difficulty with the contact observations of the then approaching transits of 1874 and 1882, but we have found from sad experience that our vaunted modern instruments gave very little better results for the last pair of transits than our predecessors obtained with much cruder appliances in 1761 and 1769.

Women in the Higher Education.—The facts presented in a special report on women's education, given in the University Convocation Proceedings for 1893, show that women are gaining in every educational field. The secondary schools of the State returned in that year 23,556 girls of academic grade to 18,243 boys; and of 438 honor credentials issued, 298, or more than two thirds, were to girls. The number of women in colleges had risen to 2,923, of whom 2,078 were in the eight specifically women's colleges, besides 880 in subfreshmen classes. The professional and technical schools returned 4,043 women, and the special schools 3,308. The number of girls entering college from regents' schools was eighty-four per cent greater than the year before, and the increase promised to continue in the current year. Of the teachers in the New York common schools 28,869 were women. In the United States there were in 1890, 125,525 men and 238,397 women teachers. Two years later the number of men had decreased 3,974, and the number of women had increased 14,383. Women are more and more employed as teachers in the grammar and higher schools and in colleges and the university; more of the graduates from women's colleges are entering the medical profession; progress is making in the legal education of women; and opportunities are now offered them to take a theological course.

An Old Book of the Weather.—The first of a series of reproductions of old books on meteorology and terrestrial magnetism undertaken by Dr. D. Hellmann, of Berlin, is the *Wetterbüchlein*, or Little Book of the Weather, of L. Reyman, the oldest German book on meteorology. It was published at Augsburg in 1505, and passed through seventeen editions in thirty-four years. It has also been translated into English. It is essentially an elementary manual for foretelling the weather from the rudimentary data which the science of the time possessed. The barometer and thermometer were not known, and the principal rules found in Reyman's book are drawn from the appearance of the sky and clouds, the optical phenomena of the atmosphere, the direction of the wind, the phases of the moon, and other like signs. Most of them were known to the ancients and the Arabs, from whose writings the author has derived them—expressing them always concisely and intelligibly to the public. The book is much superior in scientific character to the weather-predicting almanacs of our time; for, instead of pretending to foretell the weather a year in advance, as they do, it has simply given the signs by which its course may be foreseen a short time in advance.

Play and Study.—In a paper on Child Study in Summer Schools, President G. Stanley Hall observes that practically we have to act as if there were no such thing as pure thought. Children have no thought without motion. Motion and thought go together, and if you make them sit still they can not think. Their minds will not move unless their bodies move along with them. We weaken thought if we try to eliminate motion. In the child study at the summer school one thousand children's games were selected and studied, then arithmetic games and geography games, and those that gave strength to the shoulders and hips, "and we had everything that was taught in the whole grammar course without any exception and a good deal more. We cut down these games to one hundred and fifty or two hundred, and found that everything could be taught by historic plays and games. Then we began the history of games, and found that education used to be play, and now it has become hard work. A little while ago older people used to play. It was the spontaneous activity. We have composed a programme of all the school studies taught only by plays and games. I won't say that it is yet practicable; I simply say it can be done. It shows that spontaneities have done everything, just as in the world everything we know has originally been spontaneity, either of geniuses or great discoverers or inventors. I do not go so far as some enthusiasts, but we are realizing that everything in Nature is to be found in the child. Nations as well as associations, institutions as well as colleges and schools, religions and everything else, when judged by the highest standard of right and wrong, will be pronounced good or evil exactly in proportion as they have ministered and conformed to the nature and needs of childhood, adolescence, and growth. That civilization, that school, that college, is best that has devised the most efficient methods for this."

A White Bear's Bath.—The bath of the younger bear in the London Zoölogical Gardens is thus described in Mr. C. J. Cornish's recently published Life at the Zoo: "Fresh water is let into the bath two or three times a week, and as soon as the bottom is covered the younger bear rolls in and 'cuts capers,' to use the keeper's phrase. She always prefers to take a 'header,' but not after the orthodox fashion; for when her nose touches the bottom she turns a somersault slowly, and then floats to the surface on her back. Then she climbs out, shakes herself, and gallops round the edge of the bath. In spite of her bulk, this bear is as active as a cat, and can go at speed round the circle without pausing or missing a step. Her next object is to find something to play with in the water. Anything will do; but if nothing else is handy, she usually produces a nasty bit of stale fish, which she seems to keep hidden in some handy place, and dives for it, coming up to the surface with the fish balanced on her nose, or on all four paws. If the water is still running in, she will lie under the spout, and let it run through her jaws. But the most amusing game which the writer has seen was played with a large round stone. After knocking it into the water and jumping in to fish it out, she took it into her mouth and tried to push it into the hole from which the water was still running. This was a difficult matter, for the stone was as large as a tennis ball, and the pipe was not much wider. Several times the stone dropped out, though the bear held it delicately between her lips and tried to push it in with her tongue. At last she sat up and, holding the stone between her fore paws, put it up to the pipe and pushed it in with her nose. This was a great triumph, and she retired and contemplated the result with much satisfaction. Later, being apparently tired of this achievement, she threw water at it with her head, and, failing to wash it down, picked it out with her claws and went on diving for it in the bath."

Nature's Commerce.—Even before the first human commerce Nature, as Prof. O. T. Mason shows in his Technogeography, had her great centers of superabounding material, and took pains to convert this excess into supply against scarcity. Thus, all over the earth bees gather honey from ephemeral plants that man can not eat, and store it away in enduring form to be used in time of need. In certain regions of California the piñon seeds grew so abundantly that the Indians could not gather them; but the squirrels laid them up in vast quantities, fed on them in winter, and were themselves eaten by the savages at a time when meat diet was most necessary. They thus gave the Indians a lesson in economy and storage. As an example of the way in which Nature uses the excess of one locality to supply the dearth of another locality, Prof. Mason cites the case of the wild rice, which covers thousands of acres in some places along the Great Lakes and feeds millions of waterfowl. These same creatures are the source of food for the Eskimos, who never saw a spear of grass or ate a mouthful of vegetable diet. Seeds of plants enter into migration by a natural transportation through rivers and ocean currents, by means of winds and the agency of birds, and set up in their progeny new centers of supply on distant shores. The most marvelous of these commercial enterprises of Nature is that in which she converts apparently inaccessible and unutilizable material into inexhaustible supplies for every industry of man A wonderful example of this is found in the littoral feeding grounds. There is a bench of land under the sea skirting every shore and reaching under all estuaries. It is not deep. Indeed, it is the connecting link between the land and the profound sea. Upon this plateau the *débris* of the fertile lands and of the fresh waters is daily poured, and myriads of the lower plants and animals are developed. Here are nourished cod, shad, herring, salmon, oysters, clams, and so on. The fish after attaining maturity actually swim up to men's doors to be captured. Also upon this feeding ground are nourished the sea mammals which have been indispensable to the life and happiness of our northern aborigines. It is true that every useful plant is converted by Nature out of material which men can not use. Long before Texas cattle were bred in one place and driven hundreds of miles to market Nature reared fish and walrus upon her enormous pasture lands under the sea and drove them to market herself.

Effects of Occupation on Eyesight.—The effects of certain occupations on eyesight are manifested, according to Mr. Simeon Snell, who has made a study of the subject, in a variety of ways. Workers in India-rubber factories are troubled by the fumes of bisulphide of carbon, which is used in the vulcanizing process. The vapor of this substance was formerly employed as an irritant of the conjunctiva and a promotive of abundant lachrymation, and it tends to produce amblyopia. Amblyopia, or dullness of vision, is brought about in the manufacture of explosives by dinitro-benzyl. While the toxic action of tobacco when chewed seems to be established, the assertion that persons working in tobacco factories are subject to disorders of vision has not been confirmed. The prejudicial action of lead is well known, but to the usual experiences in the matter Mr. Snell adds the curious instance of amblyopia produced among the file-cutters of Sheffield by inhalation of the particles of lead that fly off from the lead bed on which the file is laid to be struck. The statements that glass-blowers are subject to cataract from exposure of their eyes to the intense heat and light of the furnaces are not supported by the later observations. Mr. Snell has found that men can look at metal in the furnace with comparative ease, so long as its temperatare is not greatly above 2,000° F.; but when it approaches 3,000° F. they have to wear colored glasses. At cast-iron furnaces, where the heat of the metal is between 1,800° and 2,000°, the men take no special precautions; but the heat of molten steel is between 2,700° and 2,800°, while the heat of the gases in the furnaces would be about 200° or 300° more, and the men in attendance have to wear dark-blue glasses to protect their eyes. The heat of the metal in the Bessemer process is greater still, increasing to 3,000° or 3,200°, but the metal does not have to be so long or so carefully watched as in the Siemens furnace. In none of these cases has Mr. Snell been able to associate any deep or superficial eye lesion as the result of exposure to intense light and heat. Exposure to the light employed in electric welding causes sharp conjunctivitis, with great pain and tear-shedding, and, if it be allowed to enter the eye, optic neuritis, with retinitis and a central scotoma in the vision. The effects are due to the chemical rays, and the men are obliged to use screens made of dark ruby, non-actinic glass.

Geological Work of the Atmosphere.—Believing that too little attention has been given by American geologists to the work performed by the atmosphere in erosion, transportation, and sedimentation, Prof. J. A. Udden, of Augustana College, has considered the subject in a brief paper. He begins by assuming that as an agent of erosion air is far less efficient than water—because of its small weight, it being only $\frac{1}{813}$ as heavy as water, and because it exerts no wave motion on the surface of the earth. The erosive action of wind therefore becomes important only in certain localities, under the favoring conditions of a dry climate and a topography of abrupt and broken reliefs. Since the speed of the wind is lowest near the surface of the ground, materials to be transported any considerable distance by the atmosphere must be by some means lifted through and over this zone of low velocity. This condition is furnished by whirlwinds and reliefs which cause eddies or give the wind an upward direction. To be subject to transportation by the atmosphere, rock materials must be finely comminuted; and the author has ascertained by experiment that the average largest diameter of quartz particles that can be sustained in the air by ordinary strong winds is about one tenth of a millimetre. But the capacity of the air for transporting particles below this size is very great, and is estimated to be per cubic foot at an average velocity of five miles an hour, one thousandth that of water. The whole atmosphere over the Mississippi Valley, if the wind blows ten times as fast as the river runs, may transport one thousand times as much dust. Atmospheric currents being loaded, for the most part, only to the extent of an insignificant fraction of their capacity, their sediments will be better sorted —the fine material will be more completely separated from the coarse—than deposits from water currents, which are more often loaded to their full capacity. That deposition of dust will take place where wind is caused to slacken its speed is self-evident, and is observed every day in the accumulation of dust on the windward side of a closely built-up street.

Boarding Schools and Infection.—The Agency of Boarding Schools in Disseminating Infectious Diseases was the subject of a paper by Dr. Clement Dukes at the Congress of the British Institute of Public Health. The author charges boarding schools with not having exercised sufficient care in the protection of society against sanitary detriment from influences they might control. The conditions of boarding schools, with their regular vacations and occasional leaves of absences, are such that there is almost a perpetual to-and-fro communication between them and the home. Then, when pupils become ill they are sent home, if practicable; and when general illness breaks out in the school, those who have as yet shown no symptoms of it, or only the beginnings of them, are sent home. These pupils, possibly bearing the seeds of infection, travel in the public conveyances in contact with unsuspecting passengers, or to be followed by such, to whom disease may be communicated. The spread of infectious diseases by boarding schools is admitted to be, unfortunately, to a certain extent, necessary by virtue of the existing system and the susceptibility of the pupils. Beyond this, such diseases are often disseminated ignorantly and thoughtlessly by the operation of motives in which such result is not contemplated, or wantonly. As remedies for the evil the author suggests bills of health to be given by parents on sending their children to school and by teachers on sending pupils home; and that schools should make adequate provision for the treatment of illness of their pupils and for the retention of all patients till they are absolutely free from infection.

Mistaken Diagnoses.—Common Diseases Mistaken or Mistreated is the subject of an address recently delivered before a medical society by Dr. J. F. Goodhart, of Guy's Hospital. It concerns the diagnosis and treatment in every-day practice of cases which practitioners must see regularly, which are yet frequently mistaken and mistreated. Infantile scurvy, for instance, is a very common complaint, but is often not recognized, and allowed to pass as rickets or rheumatism, or injury, or temper. Another disease which, although very common, varies much in severity and in the mode in which the pain manifests itself, is angina pectoris. It is often mistaken for indigestion, neuralgia, rheumatism, flatulence, etc., and fatal results have often followed from the wrong treatment having been adopted. Other instances of error occur in the confusion of the passage of urates with that of uric acid, in the adoption of a rigid form of dieting to get uric acid out of the system, when it is the individual that should be treated, and his malady, individualized in him, through him; and in the treatment of renal colic and chlorosis. The author emphasizes the fact that many of the methods and aims of medicine are faulty by reason of the ready assumption that their bases are unassailable; that men are constantly driven back upon their own experience, and compelled not to accept it but to question it.

Tests for Old Plumbing.—The tests usually applied in inspecting old plumbing work, as named by William Paul Gebhard, are the peppermint test, the smoke test, and sometimes an air-pressure test. The water test is not practically applicable to plumbing work in actual use, because it necessitates the disconnecting of all fixtures, and even then there is risk in applying it of flooding parts of the house. "The peppermint test is useful in a measure, but unless great care is taken in applying it the results are at times misleading. It is, therefore, in the hands of inexperienced or unscrupulous persons a rather dangerous and somewhat objectionable test. It is not always possible to define by it the exact position of the leak, or to determine exactly what the defect is. In the more positive smoke test, on the other hand, any leakage becomes apparent to the senses of smell and sight; in fact, in nearly all cases, except where leaks are very slight, the issue of smoke will indicate the exact point at which plumbing is unsafe. In order to have continued assurance that the plumbing and the drainage and the gas-piping remain safe, it is advisable to repeat the tests from time to time. The walls of a building settle, the pipe joints may become untight, or the joints may open by expansion when much hot water passes through the waste, or pipes may break, or traps may sag or tip over, rubber gaskets of floor joints may disintegrate and rot, leaving open cracks through which sewer air may pass, or joints made with brass couplings may become loose, and rubber or leather washers may rot; in short, there are numerous points which in a plumbing system may become defective after it is in use for some time. Hence the necessity of periodical re-inspection, which is just as desirable with plumbing work as it is with steam boilers or other machinery."

The Electric Arc.—In a lecture at the Royal Institution on Electrical Illumination Prof. J. A. Fleming exhibited the formation of an arc between carbon rods, and said that it had been experimentally proved that the arc could not be started unless either the rods were first brought into contact or the insulating power of the air between was broken down by an electric spark. An immensely magnified image of the arc was projected on the screen, so that its interior structure was rendered visible. It was seen, for instance, that the positive carbon rod becomes most intensely hot at the extremity and hollowed out into the form of a crater, from which about eighty per cent of the total light is emitted. The negative carbon does not become so hot. The space between the two, or the true arc, is filled with vapor of carbon. In the central space a brilliant violet axis is seen, violet being the color of incandescent carbon. Outside this is an aureole of carbon vapor of yellow or golden color. With the use of a prism the central axis of the arc gave a spectrum marked by two brilliant violet bands. It was next shown that the rise of electric pressure in the arc takes place chiefly at the surface of the crater, which is in fact the place where the work is done in evaporating the carbon. The light emitted is therefore due chiefly to the incandescence of the carbon in the crater. Hence the light is not given off equally in every direction. It is most intense in that direction in which the largest area of crater can be seen.

Humming Birds as Carriers of Pollen.—The agency of humming birds in transferring pollen from flower to flower is shown in a paper by Joseph L. Hancock to be parallel in importance with that of insects. The common ruby-throated humming bird, though it is not endowed with specialized structures for the specific performance of this office, has in its mouth parts and feathers means for harboring the pollen. The anatomical peculiarities of its head permit access to flowers of a wide range of forms. The bill, by virtue of its flexibility, is capable of probing to the bottom of most of the common forms of flowers; and in the feeding process the flower is often bent over. The various ways in which pollen is carried to this bird were revealed on microscopic examination of some dead specimens. On the lower mandible just in front of the angle of the mouth, overshadowed by the nasal scale when the bill is closed, a faint yellowish line marks the deposit of pollen grains resting, clustered together, in a small groove. Pollen grains work their way free to the summit or vanes of the feathers, and are caught up by the barbs of the feathers along the sides of the chin and lores, where they remain ready to be deposited when a more suitable surface is presented. A second receiver of pollen is the deep median groove under the lower bill, the point of meeting of the rami. Four ways have been observed by the author in which pollen becomes engaged or held by the feathers. In flowers, the pollen of which is carried by the wind, the grains are small, light, and more or less dry and spherical; in flowers in which it is carried by insects they are variously adapted to adhere to the under side of the carrier's body; in those whose pollen is distributed by birds it is carried in so various ways that this circumstance combined with other data indicate the possibility of the humming bird being the most wonderful distributor of pollen known to the animal world.

In an Engineering Laboratory.—The work of an engineering laboratory, observed Prof. A. B. W. Kennedy in his British Association address, is in intention and in essence different from that of the physical laboratory. The aim of the latter is to make its problems as simple as possible, to eliminate all disturbing elements or influences, and to obtain finally a result which possesses the highest degree of absolute accuracy. In most physical investigations the result aimed at is one in which practical absolute accuracy is obtainable, although attainable only if infinite pains be taken to get it. It is the business of the physicist to control and modify his conditions and to use only those which permit of the desired degree of accuracy being reached. In such investigations it sometimes becomes almost immoral to think of one condition as less important than another. Every disturbing condition must be either eliminated or completely allowed for. That method of making the experiment is the best which insures the greatest possible accuracy in every part of the result. The business of the engineer, on the other hand, is to deal with physical problems under conditions which he can only very partially control, and the conditions are a part of his problem. Perhaps the whole matter may best be summed up by saying that in a physical laboratory the conditions of each experiment are under the control of the experimenter and are subservient to the experiment. In an engineering laboratory the conditions form part of the experiment. Whenever the whole matter seems to be mastered from one point of view, it is only to find with a little more experience that from another point of view everything looks different and the whole criticism has to be started afresh. Machines can not be finally criticised—that is to say, they can not be pronounced good or bad simply from results measurable in a laboratory. One wishes to use steam plant, for instance, with which as little coal shall be burned as possible; but clearly it would be worth while to waste a certain amount of coal if a less economical machine would allow a larger saving in the cost of repairs, or it might be worth while to use a machine in which a certain amount of power is obviously lost if by means of such a machine the cost of attendance can be measurably reduced.

NOTES.

A South Jersey Woodmen's Association has been formed, with headquarters at May's Landing, N. J., the objects of which are stated to be to improve and protect the forests of the southern counties of New Jersey; to prevent all wanton and needless destruction of forests; to adopt such methods of cutting as will increase and prolong the yield of timber and cordwood; to insist upon the enforcement of the laws in relation to forests and the punishment of malicious and careless fire-setters; to encourage the planting and seeding of valuable trees on Jersey waste land and elsewhere wherever practicable; and to encourage such methods of forest management as will tend to conserve and increase our water supply and protect the wild animals of the woods. A monthly pamphlet—The South Jersey Forester—is to be published as the official organ of the association.

A new species of giraffe has been discovered in Somaliland by Major Wood, of the British army, who has killed one specimen and seen seven others. It is distinguished by a complete and whole body covering of rich bright chestnut, hardly separable by very fine, almost invisible, lines of creamy white.

Of garden vegetables described by Prof. Bailey in a Bulletin of the Cornell Agricultural Experiment Station, the cabbage, Pe Tsai, is described as a plant with a loose, lettucelike head of crisp leaves, which may be used in the same way as cabbage. A mustard producing an enormous quantity of herbage is excellent for greens. California pepper grass is apparently a finely cut leaved form of mustard, and is an excellent plant for spring greens. Other mustardlike plants are the Pak-Choi, used as greens and for the thick white leaf stalk, and the tuberous-rooted mustard grown for its small turniplike root. The fruit of the wax gourd, Zit-Kwa, is excellent for conserves. The La-Kwa, or momordica, has merit as a curiosity and an ornamental vine. The Luffas, or dish-cloth gourds, are of two species, and yield a spongelike fiber useful for household purposes.

That was a curious objection to the use of anæsthetics in surgery, and especially in midwifery practice, that is recorded as having been urged by some clergyman in the early days of chloroform. The reverend gentleman denounced the drug as "a decoy of Satan, apparently offering itself to bless woman, but in the end it will harden society and rob God of the deepest cries which arise in time of trouble for help." The religious objection was based on Genesis, iii, 16. To us such a plea for perpetuating pain sounds too quaint for serious argument; but Sir James Simpson set himself to prove that the word translated "sorrow" is really "labor," "toil."

An appropriation has been made by the American Association for the maintenance of an investigator's table at the Biological Laboratory of Cold Spring Harbor. The table will be held under the same conditions as that at Woods Hole—namely, the persons applying must either be, or must subsequently become, members of the American Association, and must be accepted by a committee of the association which has been designated for the purpose. Applications for the table for the ensuing year should be made to Prof. H. W. Conn or to Prof. Hooper.

The Copley medal of the Royal Society has been awarded for 1894 to Dr. Edward Frankland for his eminent services to theoretical and applied chemistry; the Rumford medal to Prof. James Dewar for his researches on the properties of matter at extremely low temperatures; the Royal medals to Prof. Joseph John Thomson in recognition of his contributions to mathematical and experimental physics, especially to electrical theory, and to Prof. Victor Alexander Haden Horsley for his important investigations relating to the physiology of the nervous system and of the thyroid gland, and to their applications to the treatment of disease; the Davy medal to Prof. Cleve, of Upsala University, for his researches on the chemistry of the rare earths; and the Darwin medal to Prof. Huxley for his researches in comparative anatomy, and especially for his intimate association with Mr. Darwin in relation to the origin of species.

From Predmost, near Preran, in the Austrian Empire, where large numbers of bones of the mammoth have been found in the past, comes a report of the discovery by Conservator Maschka, of Teltsch, of the well-preserved fragments of "the skeletons of a whole diluvial family of six persons." The skeleton of the man is wonderfully complete, and is of gigantic proportions. If this find is adequately verified, it will afford a contradiction to the assertion of the Danish expert, Steenstrup, that no man lived upon the earth at the same period as the mammoth.

The experiments of Drs. Petri, Kolb, and Friedrich, who inoculated one hundred and seventeen guinea pigs with dust collected in railway carriages, and who also examined the dust bacteriologically, have proved that it contains pathogenic germs. How admirable are the arrangements of railway passenger cars for collecting this dust and setting it flying into the lungs of travelers! The case calls for reform and for the provision of seats and car trimmings that will not so readily collect the dust and may be more easily cleansed than the usual plush cushionings.

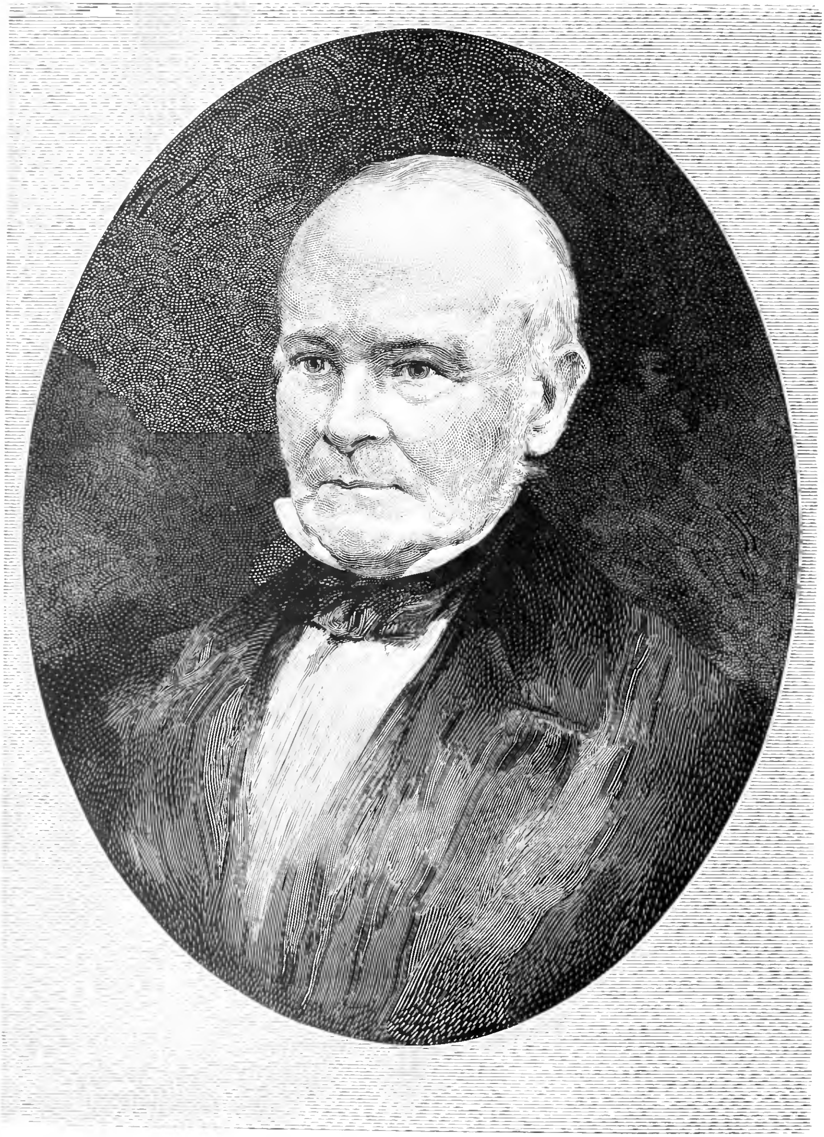
The first steps have been taken for the organization of a society for the purpose of scientific research in the State of Michigan, to be known as the Michigan Academy of Sciences. At a meeting held in Ann Arbor, June 27th, a list of officers was chosen, with W. J. Beal as president, to serve and act as an advisory board till a permanent organization can be effected; and a meeting for the latter purpose is to be called some time during the winter. The suggested plan of work for the society is comprehensive, and is capable of enlargement as occasion may require.

A Society of Friends of French Explorers has been established in Paris in affiliation with the French Geographical Society. It contemplates the foundation of a fund in aid of explorers and assistance in the publication of the scientific results of their researches.

In Brittany, when foreign substances get into the eye, the sufferer calls one of his friends to his relief, who gently licks out the grain with his tongue. A similar practice is in use among the doctors of Annam, who employ the tongue for conveyance into the eye afflicted with purulent conjunctivitis the healing powder which is their specific for the disease.

M. Desprez, of Saint-Quentin, France, suggests as an improvement in shoeing horses the interposition of a cushion of gutta percha between the shoe and the hoof, to give elasticity and nullify the shock of the incessant blows on the stone of the pavement.

A new disease has appeared among horses in Australia grazing in the pastures along the Darling River. It is manifested by a gradual weakening of vision, ending in its extinction. Its origin is traced to eating the leaves of a native tobacco plant (*Nicotiana suaveolens*). The plant has only recently appeared in the region, where it has originated from seeds brought down by freshets from near the sources of the river. Its growing abundance and the prevalence of the eye disease seem to be coincident.



THOMAS NUTTALL.

THE

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THE BIRTH OF A SICILIAN VOLCANO.

By Prof. A. S. PACKARD

OUR hope in planning a brief journey to Sicily was to ascend Mount Etna, which, as everybody knows, is the highest volcano in Europe, and whose history and appearance have been recorded from the days of Homer. Although we did not ascend to the very summit, we had the unexpected pleasure of tramping up the ash-cone of one of the many minor volcanoes or monticles which stud the flanks of the majestic mother volcano, who looks down from her serene heights upon a numerous progeny scattered about her skirts.

Monte Gemellaro is the youngest of the brood. It is situated four thousand six hundred and fifty feet above the Mediterranean, and the crater itself is four hundred and fifty feet in height above the side of the parent mountain.

This symmetrical, double-headed cone, too recently upheaved to have been much despoiled by rains and frosts, suddenly appeared after a few days' disturbance, and nearly each stage in its rapid development was studied by experienced observers, or at least in a more careful manner than any of its predecessors, since so much more attention than formerly is now paid to the study of volcanism.

In May, 1886, just three years previous to our visit, and within the short period of twelve days—days of fear and suspense to the inhabitants of the hamlets and villages below—the cone was formed by the upheaval of great masses of lava, ashes, and slag, accompanied with clouds of steam and deadly gases, the lava stream threatening Nicolosi, the highest town on the flanks of Etna, and which during the eruption of 1669 was leveled to the ground. Then a period of rest and quiet ensued, and the scene three years later was one of utter desolation, the eye within a radius of two or three miles resting only on vast wastes of volcanic sand, slag, and ashes, with the rugged wild lava streams below.

Late in the afternoon of a day in the middle of April we left Naples, then cold and raining, with thunder and lightning; and after a particularly rough and disagreeable night in a steamer without ballast, which bobbed about on the chopping sea like a cork, we landed early in the morning at Palermo. The day was spent in visiting the fine zoölogical museum, and in wandering through the attractive botanical garden of that beautiful city.

The traveler who would see Etna to the best advantage should approach it from the west and south as well as the north. Leaving Palermo the next morning by an early train we soon reached the junction of Termini. At this point the railroad turns south and runs into the interior; but before we left the coast we could see, some eighty miles distant, heavy clouds of steam and ashes drifting from the eastward, and we were sure that they arose from the island of Volcano, then in eruption, although inquiries from our fellow-travelers as to whether this were so failed to meet a response; either they were stupid or our limited Italian vocabulary was at fault.

It was not until we reached the neighborhood of Castrogiovanni that we had a good view of the noble cone of Etna, distant some forty miles. From this point of view, almost directly west, the grand mountain mass is seen to rise by a very gradual ascent from the regions below, its upper third snow-clad, its steepest slope toward the south. It has undergone little change since the days of Pindar, who nearly twenty-five hundred years ago sang of "the snowy Etna, the pillar of heaven—the nurse of everlasting frost, in whose deep caverns lie concealed the fountains of unapproachable fire—a stream of eddying smoke by day, a bright and ruddy flame by night; and burning rocks rolled down with loud uproar into the sea" (First Pythian Odes). It was the 16th of April, and the season was a late one, but the poplars were leaved out and the vines were much more advanced than in Naples. The green fields were crowded with poppies, wild peas, and other spring flowers in profusion, while farther on in our route, in the outskirts of Catania, the almonds and figs were fully formed on the trees, though still green.

Not stopping at Catania, we took the night steamer for Malta, where we spent a most interesting day, returning by night to Syracuse—a memorable trip one should not miss—and the morning of the 19th found us at Catania.

After lunch we drove through the long, straight Strada Etnea which by a gradual ascent of ten miles ends in Nicolosi, whence tourists start for the ascent of Etna. Passing beyond the city limits, past the lava stream of 1669 on the left, through villages and hamlets surrounded by vineyards and orange trees, we finally not long after sunset drew up at the door of the Hôtel d'Etna in Nicolosi.

It was Good Friday, and as we stepped out of our carriage a festal, torchlit procession issued from a church near by, and passed up a street parallel to ours amid blazing red lights and the explosion of noisy fireworks, toward another church at the upper end of the village. A *gamin* eagerly accosted us, gesticulating and shouting in our ears, "*Jesu Cristo morte!*" and appealing to us to follow on with him. Hastily leaving our traveling bags in the hotel, we walked up the street in the gathering gloom and by a short cut entered the church just before the procession reached the door. To the beat of muffled drums and amid glaring, smoking torches entered a priest, followed by a company of men bearing a rude image of the body of Christ stretched on a bier; then poured in a motley crowd of men, women, and children, each wearing a crown of thorns, to be succeeded by a standing image, life-size, of the Virgin dressed in black, and borne by women, also in mourning garb. Not waiting to witness the final ceremonies, we left the church resounding with the music of the brass band, reeking with the lurid smoke of pitch-pine or tar torches, and betook ourselves to the hotel.

It was a jovial company assembled in this wayside inn. Half a dozen German teachers and physicians were making merry over the wine of the country, and cordially invited us to ascend the mountain with them the next day. But we had heard of the new volcano, and had made our plans to visit that. At a late hour, all the rooms having been taken by them, we slept on cots in the dining room.

The morning of the 20th was light and clear, and the unclouded summit of the volcano was like polished alabaster. After an early breakfast the guide and myself, mounted on mules, took the road for Monte Gemellaro. Leaving on our left the old lava stream of 1669, which looked like an unused railway embankment rising about twenty-five feet in height, we soon came to the forked end of the stream, or *sciarra*, of 1886. To our left towered the double-headed cone of Monte Rosso with its retinue of monticles around its base. The vines were still in full leaf, and the apple trees in blossom; but we soon rode into a cooler zone, where the vines had just begun to leaf out, and they formed the only vegetation except clumps of yellow-flowered broom, with copses of leafless, slender chestnuts. Over the reddish volcanic soil ran nimble lizards—not the beautiful green ones of the regions below, but, chameleonlike in their adaptation to their environment, they were dull reddish brown.

Lunching at the last house, an empty wooden structure, we soon passed beyond the groves of low, slender chestnut trees, above all vegetation, into the desert zone, and, leaving the mules, ascended the crater cone of Monte Gemellaro. The mountain or hill is an ash heap or cinder cone, the loose material likened by M. Émile Chaix to coke or black powdery scoriæ, with lava underneath, and it rises upward of four hundred and fifty feet above the sides of Mount Etna, with a diameter of about six hundred feet. The crater is estimated to be one hundred and twenty-five feet deep, with two fissures at the bottom three or four yards wide. It was named after the distinguished geologist and student of volcanism, the late Prof. Gemellaro, of Catania.

On the way up we passed small fissures, still steaming, and their edges incrusted with deposits of sulphur and arsenic. Such fissures are called *solfataras*. Small heated masses of rock and clay, still warm, lay scattered about. The structure of the inner walls of the crater is simple, reminding us of the upper edge of the crater of Popocatepetl. Under the bed of ashes the rim of the cone is made up of irregular layers of lava which slope away from the center down the sides. In fact, a crater of this sort is formed by the upthrust of masses of lava; and the repeated showers of stones, bombs, ashes, and lapilli, or coarse gravelly ashes, falling down vertically over the vent, give the regular conical shape to the crater, while the sloping sides of the funnel of the crater are formed by loose ashes rolling down the incline of the irregular vent or fissure at the bottom, which is kept clear by the passage of steam and showers of ashes during the progress of an eruption. The origin of the lava stream which threatened Nicolosi and the other towns below was mostly covered up by the thick layer of ashes. It should be understood that by the term "ashes" is meant the fragments of lava and clay, often with obsidian or volcanic glass, shattered during the more violent throes of the crater; the earthquakes and tremblings being due to the expansion of the steam pent up in the subterranean cavities and reservoirs of lava deep down in the bowels of the earth.

From the accounts published in the scientific journals we gather the facts for the following history of this eruption.

After a series of outbreaks, both from the crater of Etna and at other points below, on the 19th of May the lava began to stream down toward Nicolosi, accompanied by severe earthquakes. The stream divided, and the eruption assumed terrific proportions. The lava advanced over three kilometres in eight hours, steadily pushing on toward the village. On the 20th ten other craters opened. A dispatch stated: "Three of the craters are raging

Lava at Altarelli, Etna.

fearfully, emitting huge stones to a considerable height, and the roar and tumult are terrible"; meanwhile the central crater on the summit of Etna continued to vomit great columns of steam and ashes. "On Sunday the eruption had greatly diminished, but on Monday morning it broke forth with great violence, and a fresh crater sent out a stream of lava one hundred and fifty metres wide and twenty-three deep, which flowed down at the rate of one hundred and sixty to one hundred and ninety feet an hour toward Nicolosi. On Monday evening the news was very disquieting. The violence of the eruption was then greatly increasing, and Nicolosi seemed doomed to destruction. The noise at a considerable distance is described as resembling a continuous cannonade." On the 19th Prof. Amico recorded ninety-two earthquakes; on the following day, only twenty; but afterward the number rose from twenty-five to thirty, twenty-seven, twenty-five, and finally to fifty-two on the 25th. The eruption reached its height on the 31st of May, and the people were so alarmed that the town was evacuated.

The great lava stream which threatened Nicolosi divided into two, one advancing toward Altarelli and the other descending on the east side of Monte Rosso, and on the 3d of June stopped within three hundred and seventy metres of the town, parting just behind a structure like that seen in the accompanying picture. The inhabitants affirm that this was in direct answer to the prayers of the clergy, who with their parishioners in solemn procession marched toward the advancing lava when the danger seemed most imminent.

According to Prof. Silvestri, the lava stream of 1886, like that of 1883, flowed from the rent or fissure which was opened in 1875 in the flank of the volcano, and extended in a northeast and southwest direction.

In the September following it was safe to visit the scene, and the Count L. dal Verme estimated that during the eruption Gemellaro ejected about sixty-six million cubic metres of eruptive matter, covering a space of five square kilometres and a half on the flank of the mountain, and approaching within less than half a mile of Nicolosi, situated near the upper limit of the vine. The vineyards were destroyed to the extent of some twenty thousand lire.

In 1890 M. Émile Chaix, of Geneva, ascended Mount Etna, camping out several days on or near its summit. From his bright and interesting account, entitled *Une Course à l'Etna*, originally contributed to the *Journal de Genève* for September, 1890, we quote the following description of the crater of Gemellaro as it appeared the summer succeeding that in which we visited it:

"It still gives out a little sulphurous vapor, and is carpeted with the red, yellow, and white products of the solfatara. But the richest volcanic colors are seen in a solfatara opening in an eminence on the outer and southern side of the volcano. An explosion has laid bare a vertical wall above a mysterious opening, and from this opening different gases have passed out and coated the walls with yellow, white, orange, red, and violet incrustations; these hues are remarkably bright and are enhanced by the setting of ebony which surrounds them.

"The inundations of lava poured out from a series of pits or *bocche di fuogo* situated in a line below the cone, on the rent from which escaped all that overflowed from Etna in 1886. They are empty monticles, which have the appearance of having been formed of burned coke. They are two, three, and ten metres high, and it is difficult to believe, on looking at them, that they could have given birth to this immense sea of lava which has climbed cones thirty to forty metres high, and which rises with a formidable hill in its middle.

"All this coke which we see is not lava, it is only slag. But this slag, these scoriæ, cover everything up, though it would not have been visible had there not been a deep excavation along the course of the lava stream, next to the pits. This great ravine, nearly a kilometre in length, thirty to fifty metres in width, and from four to twelve metres deep, with vertical walls, enabled us to see the internal structure of a lava stream. It is formed by the superposition of alternating layers of compact lava, a yard thick, with black ashes. In certain places we could count five or six layers, one over the other.

"It appears, then, that the lava stream, itself the result of the eruption, is formed of sheets of lava, which flow out one after the other and pass one above the other, each covering the scoriæ, or rather a part of the scoriæ of the surface of the preceding layer, without filling the interstices. But while layers of ashes or scoriæ only ten to twenty inches thick separate the lava layers, the sides and ends of the lava streams form great heaps of large pieces of loose coke, amid which one can detect the compact lava."

We had left our mules some distance down the mountain, and, while the guide went for them, as we were to return by a different route, I strolled about, enjoying the wondrously beautiful scene far below. A gentle sirocco was blowing, and far down beyond the fields of ashes and cinders a soft, delicate haze hung over the land of the vine and orange, and spread over the deep blue Mediterranean beyond.

We returned to Nicolosi in the hot afternoon sun, passing around by the south of Monte Rosso, skirting the right side of the eastern lava stream, whose entire length was about four miles, and whose rough, broken surface is so well represented by the

Eruption, seen at a Distance of Fifty Metres, on the 20th of May, 1886, at 1.30 p. m.

photograph here reproduced. The stream ceased flowing when within three hundred and seventy yards of the building nearest the volcano.

It was interesting to observe that the stream did not actually plow up the loose volcanic earth of the vineyards, but simply rolled or flowed over the surface without throwing up the soil. The angle of the sides of the stream is steep and the sides are rough, like frozen foam or congealed slag from a furnace.

The same afternoon we returned to Catania, visited the university, and the next day found us on our way to Taormina, catching from the window of our car fine views of Mount Etna. The accompanying picture will give a faint idea of the wondrously fine view of the volcano as seen from the walls of the interesting ruins of the Greek-Roman theater at Taormina, as well as the town itself, and the flanks of Etna studded with villages and hamlets. It is a view said to be the finest in all Europe, and the claim we will not dispute. Certainly a more magnificent outlook, combining the attractions of a land with a history so rich and varied, of so majestic a volcano, of so fair a sky, and of a sea so beautiful as on that bright sunny April day, never met our gaze.

And then the view of Etna at sunset, from the terrace of the Hôtel Timeo, and again when its cone was lit up by the rising sun, were memorable scenes. The volcano was also kind enough to flame up at night, the light of the glowing but subdued volcanic fires at the bottom of the crater being reflected in the darkness upon the clouds of steam hovering above.

The fires of Etna have subsided, only to be succeeded in that beautiful island by a far more terrible social upheaval; the burden of agrarian wrongs, inflicted by the wealthy landholders, and of the too heavy taxes causing a sudden and widespread volcanic uprising on the part of the downtrodden peasants. Let us hope that by timely concessions and patient readjustments of the relation between landlords and tenants a calm as serene and pervasive as to outward appearance at least reigned over the fair island a few years ago, may speedily return.

The Rev. Lorimer Fison explained the classificatory system of relationship to the British Association by an examination of the descendants of two brothers and two sisters to the third generation. The Fuegian terms of relationship were taken in the first place as an example of the system. These divide the sexes in any one generation into groups of non-marriageable persons and other groups of marriageable persons. Next, the same relations and their descendants in an Australian tribe were taken, when precisely the same groups appeared as the result of the division of the community into two exogamous intermarrying divisions. It was inferred that wherever the classifactory terms appeared these divisions had existed in the past.

THE LESSON OF THE FOREST FIRES.

By BELA HUBBARD, LL. D.

VOYAGERS on the upper lakes in August last were involved in clouds of smoke which settled over the waters. These were often so dense as to render navigation dangerous and to occasion frequent collisions. They obscured the sun, which appeared a dull red ball in the sky. This smoke extended as far east as the Atlantic and south to Georgia. The cause was soon apparent: forest fires were raging in the lands about the lakes.

By these fires in lower Michigan property to the extent of thousands of dollars was destroyed; in the Upper Peninsula the burned area is reported at over one thousand square miles.

But these devastations were insignificant compared with those in Wisconsin and Minnesota, in each of which States the losses amount to many millions of dollars. In Wisconsin the areas burned over ranged from fifty to one hundred and forty miles in extent. Individual lumbermen lost in standing pine from ten thousand to five hundred thousand dollars. All this was accompanied with the destruction of entire villages and crops as well as great loss of human life. A witness reports, "The bodies which dot the heated and black expanse give the scene the appearance of a battlefield."

From Minnesota the news is even more appalling. Between Pine City and Carleton, a distance of one hundred and thirty miles, whole towns were swept out of existence. In one alone, Hinckley, at least two hundred people perished. Nineteen villages are wholly or partially destroyed, and many million feet of lumber. It is fairly computed that in this State alone five thousand square miles in area have been thus devastated. Minnesota contains about seventy thousand square miles; supposing two thirds of this area to be timbered land, one may count on the fingers of his two hands how many years of such devastation will deprive this State of every vestige of its timber.

Terrible as has been the destruction from forest fires in 1894, the phenomena to which it has borne witness have been by no means unprecedented in our history during the last half century. I will recall those of a single year only.

The present generation can not have forgotten the year 1871, made memorable by the great fire in Chicago, preceded by forest fires in Wisconsin and Minnesota and followed by similar fires in Michigan. From July to November, a period of five months, the rainfall in the latter State did not exceed six inches, and the entire precipitation of the year was only two thirds the normal amount. Early in October disastrous fires overspread portions of Wisconsin and Minnesota, burning over three thousand miles of territory. On the 8th of October occurred the great fire which consumed a large part of Chicago. On the same night the cities of Holland and Manistee, in Michigan, were laid in ashes, and during the week succeeding came news of devastating fires in other parts of the State. The new county of Huron was almost entirely swept over, and a large part of Sanilac County. Nearly all the villages on the Lake Huron coast were destroyed, and at least five thousand inhabitants left houseless. Houses, fences, crops, timber, all were burned; and many people perished, being unable to escape the rapid march of the flames and smoke. Not less than two thousand square miles of country, wholly or partially timbered, were completely burned over in Michigan during this disastrous year. The Lower Peninsula contains forty-four thousand square miles. If we estimate about one half, or twenty thousand square miles, as timbered, it would require but ten such fires as that of 1871 to sweep the State clean.

Forest fires nearly as disastrous have occurred in other States and other years, but these will suffice for our purpose.

What is the origin of these forest fires? Are they preventable? Upon whom lies the responsibility? These questions open a large field of inquiry and involve the whole subject of our forest system, or want of system, and management good or bad of our woodlands, from the first settlement of the country. This is too large a subject to be treated as it deserves in a single paper, but even a brief consideration may make clear facts of the greatest scientific importance and serve to inculcate a lesson which can not be too strongly enforced.

The extent and magnificence of the forest growth of the United States at the beginning of our existence as a nation surpassed that of any land of equal extent on the globe. In the number of species and the size of its trees, both deciduous and evergreen, it exceeded by five times that of Europe. Such a forest spread almost unbroken from the Atlantic to the Mississippi. An equally dense forest, mostly conifers, and many of a size before unknown, occupied the Pacific slope; while between stretched an almost treeless region comprising nearly half the territory of the United States. What a treasury of wealth belonged to the new nation in its woodlands if properly husbanded! But to its first possessors these were an incumbrance, to be got rid of as speedily as possible, in order that place might be made for another source of national wealth—agriculture.

Since that early period how great has been the change! The forest area, which seemed to its first possessors so vast, and such an obstacle to civilized progress, has in a single century almost disappeared.

Computations have been made, from time to time, by competent persons, including our efficient forestry chief, Prof. Fernow, of the number of cubic feet of wood of all kinds annually used by our people for all purposes. Into these I do not propose to enter. It must suffice to say that the total annual consumption has been variously estimated at from four to eight million acres of woodland. Forest fires are responsible for ten million acres more, or nearly double all other causes combined.

The United States east of the Mississippi contains about five-hundred million acres. Assuming one half to be timbered land, and that ten million acres cover the actual annual consumption and destruction, our woodlands will practically last only another quarter of a century.

A peculiar feature about this excessive depletion of our forests is the wasteful and improvident manner in which it has been accomplished. Nowhere else has such waste been witnessed. Lands have been so cheaply obtained, and their resources have appeared so boundless, that it seems hardly to have occurred that there could be any limit. Not only have no means been resorted to for renewal of the woodlands, but all who have had to do with the forests—whether lumber barons or poor settlers—alike have looked to personal gain, with no regard to the future. Especially has this been the case with lumbermen in the pine districts. A noble pine tree is felled; one, two, or three saw logs are cut off, and the remainder left to litter the woods and to decay. Nor have the unsold Government lands escaped. Universally have these been plundered, as if Uncle Sam had no rights in his forest domain which his family were bound to respect. Nor has it been easy, if possible, to exact justice against plunderers, for juries will seldom convict, and are likely themselves to be *particeps criminis*. Besides, the law, or at least custom, allows settlers to take whatever timber they need for their buildings and fences, and the question is seldom asked where sawmills in a sparse community obtain their supplies.

Forest fires have accompanied the lumbermen, and it will be observed that the most extensive and disastrous ones have occurred in the pine districts. Nature's records show that before the advent of the white settler fires often swept the prairies and oak openings, and doubtless the peculiar character of these is largely due to this fact. The Indians were hunters, and the needs of the chase were met by the annual burning of the grass, which harbored game while it hindered the chase. Usually the damage to timber thus occasioned was but little, though in the course of years many a fine tree succumbed to repeated attacks. But the Indians never ruthlessly destroyed the woodlands. The white hunter, too, who roamed the woods before they were occupied by the tiller of the soil, left behind him no disastrous traces of his presence, or, if a conflagration sometimes followed his camp fires, it occurred but seldom, and was never intentional. Both the aboriginal wood-dweller and his venatic successors looked upon the forest as the gift of the Great Spirit, to be reverenced by man as a sign of the bounty of a beneficent Creator, and not to be wantonly desecrated.

The practice of burning the old and dry grass in unoccupied lands, in order that a younger and more tender growth may give pasture to cattle, is still common in some of our States, and its results, though of benefit to a few, are disastrous to the general welfare. In Florida the cattle men have long been omnipotent. They have sway in the Legislature, which enacts laws to suit their wishes, even to the extent of prohibiting towns and villages from passing ordinances to prohibit the running at large of cattle. A considerable portion of the State is thus annually burned over. Nor is it the grass alone that burns, but fire communicates to the pine trees, thousands of which yearly succumb. Meantime fences must be maintained to keep out cattle commoners, only to be often burned in their turn. Worse than all, the *humus* in the sandy soil is burned out, and the future wealth and resources of the State are destroyed, to privilege a few, whose entire interests are not a thousandth part in value of the ruin they accomplish. At this day and everywhere may be encountered tracts of utterly barren and worthless land, in the midst of comparatively fertile, whose fertility has been thus destroyed. In northern California similar aggressions are committed by the sheep-herders, and the Government reserves have to be protected by the army, acting as patrols.

There is another aspect more important even than the value of the pecuniary loss to the country from the extraordinary and rapid consumption of its forests, and which still more strongly concerns the future of the nation. I refer to the effects of deforestation upon the climate and soils.

Although there is not entire agreement among scientists as to the effect of the removal of forests upon the climate, and especially the rainfall, the following propositions seem to be well established:

1. That the temperature is *hotter* in *summer* and *colder* in *winter* than when the country was covered with forests. This is a natural result of exposure of the soil to more active radiation and consequent frost.

2. The *winds have a more uninterrupted sweep,* and so the country is both dried up and refrigerated.

3. The *rainfall* is either *less in amount,* or its advantages are to a great degree lost. Forests retain the moisture that falls and do not allow it to go to waste.

4. The *humus* in the soil, and the soil itself on the hills and slopes, are washed away by the rains, and carried to the lower lands and to the rivers, a large part being lost altogether.

Abundant examples from the Old World might be adduced to fortify this position, and to show how numerous and great have been the changes from fertility to barrenness by the neglect to heed the warnings of Nature. But these are so well known to even the unscientific traveler and reader that I forbear.

Most of us who have lived in America, even a single generation, will recall many facts that warn us how closely we are following the path that has led older countries to ruin. Streams with which we were familiar in childhood have shrunken or dried up. Springs have failed; the hills are bare and desiccated. How different the aspect of the older settled portions from what they appeared to eyes that beheld them less than a century ago! How real this description by Bryant:

"Before these fields were shorn and tilled,
Full to the brim our rivers flowed;
The melody of waters filled
The fresh and boundless wood;
And torrents dashed, and rivulets played,
And fountains spouted in the shade."

Now these woodlands no longer echo the song of the poet, and the melody of waters is exchanged for the rush and roar of the torrent.

Droughts are now the rule rather than the exception. Our pastures dry up and are of little service for several weeks during the year. The more tender fruits can not be successfully grown where abundant crops greeted the days of old. Many of the most hardy trees and shrubs are killed by the depth to which frost penetrates the soil.

So great and so indiscriminate has been and continues to be the destruction of the protecting woods as to create in the statesman and the philanthropist a well-founded alarm lest our country be soon reduced to the condition of those regions of the Old World to which I have alluded.

Let us now inquire, What has been done in this country for the protection and preservation of the forests? In all the chief governments of Europe elaborate systems of forestry have long been established, to the end that the timber should be safe from all unnecessary destruction; that it shall be allowed to grow in situations where experience has proved its importance in the amelioration of climate and the preservation of the sources of river supply, and to secure the timber supply by replanting. In this country the general and State governments have only slowly awakened to the importance of legislative control and the establishment of a forest policy.

The first important forest movement began with the enactment by Congress of the Timber Culture Act of 1873, having reference to the comparatively treeless region west of the Mississippi River. By this act the planting to timber of forty acres of land conferred the title to one hundred and sixty acres of the public domain. Even this law was in advance of real knowledge on the subject of forestry and of other conditions. It failed to produce the expected result, and after a few years was repealed.

The first act of Congress looking toward a definite forest policy, enacted in 1876, required the Commissioner of Agriculture to appoint "some man of approved attainments, with a view of ascertaining the annual amount of consumption, importation, and exportation of timber and other forest products; the probable supply for future wants; the means best adapted to the preservation and renewal of forests; the influence of forests upon climate; the measures successfully applied in various countries, and to report upon the same." In 1878 Mr. Franklin B. Hough made his first report, a volume of six hundred and fifty pages. He alludes to acts of Congress, passed as early as 1817 and 1827, under which reserves were made of such lands as had a growth of live oak and cedar for shipbuilding purposes; and that in 1854 the heads of the several land offices were authorized to investigate the repeated spoliations of public timber, to seize any timber found cut without authority, and to bring the offenders to the attention of the proper officers of the law.

Many of the States had before this taken hold of the subject, so far as to offer premiums for the planting, and in some cases exemption from taxes, especially to encourage the planting of trees along the highways, and also laws for the preventing of forest fires. In some of these States, as in Michigan, forestry as a science is taught in the colleges, though as yet no school of forestry has been established, as is done in every country in Europe, in which the general or local government are owners of woodlands.

State forestry associations have also been formed, Minnesota claiming the first, in 1878. In 1875 a National Forestry Association was formed, which since 1882 has met yearly, in widely separated localities. All these have been instrumental in arousing public interest, in issuing information on forest subjects, and in procuring legislation, especially regarding public reservations.

This movement has resulted in the enactment of a law by Congress permitting the setting aside, by proclamation of the President, of portions of the public lands, in the Western States and Territories, for permanent forest reservations. Previous to

1892 the General Government had made several extensive reservations, as parks, for preserving and opening to pleasure-seekers some of the natural wonders of our land, besides others for military purposes—viz.:

Yellowstone Park, Wyoming, containing................	2,888,000 acres.
Yosemite National Park, California, containing..........	960,000 "
Sequoia National Park, California, containing............	100,000 "
General Grant National Park, California, containing.......	3,000 "
Hot Springs National Park, Arkansas, containing..........	2,529 "
In all..	3,953,529 acres.

During the administration of President Harrison several other and large reserves were added to these, so that we now have in all over seventeen million acres.

In the memorial presented to the President by the American Forestry Congress it is declared that the object of such reservations is to increase the sum total of the productiveness of our territory, the lands reserved being those that are unfit for agriculture, but capable, under wise management, of producing a greatly increased amount of forest products annually. Neither *bona fide* settlement of agricultural land, nor the right of prospecting for and opening mines, are to be interfered with. Demands for wood material are to be satisfied in a large and equitable manner; while it is sought to minimize the destruction by forest fires and wasteful and erroneous methods. The association further declared that such reservations *would no tsatisfy the needs* of forest protection unless the number is sufficiently large to *embrace practically all the remaining public woodlands.*

Several of the States have also recognized the importance of setting apart reserves of woodlands. In the great State of New York this sentiment had become so strong by 1872 that a commission was appointed to inquire into the expediency of legislation for vesting in the State the title to the timbered Adirondack region, and converting it into a public park. But public opinion was not sufficiently ripe, and the destruction of timber and absorption by corporations and individuals went on as before. It was not until 1893 that a bill was passed which provides for the acquisition by the State of the control of large districts, in addition to the half million already owned by the State, to be held in forest for the preservation of the sources of the chief rivers; for its future timber supply; for game preservation, and for the free use by the people for health and pleasure. Nearly one million acres have thus far been set aside. How far this legislation if perfected will prove valuable depends upon the wisdom of the management. In its inception there is the highest wisdom.

Notwithstanding the public interest awakened and the laws enacted, both by the General Government and the States, very little has yet been accomplished toward the restriction of waste, the preservation of timber, protection from plunder, or prevention of forest fires.

Senator Dawes, in speaking of the invasion of the public lands, declared that "the ingenuity of the lawmaker has not yet equaled that of the spoliator." And even Mr. Fernow has pronounced, as his private opinion, that the United States has not yet reached the stage in the depletion of its forests when it is possible to carry out a really protective forest policy, and that this will not be accomplished until the country is reduced to the same condition of deforestation that the countries of the Old World had attained before remedial means were adopted. If this be true, we can only sit with folded hands and pray that this consummation may be speedily reached. Others, too, have joined the pessimistic strain, and argued that, "so long as the present conditions continue, the destruction of the forests is inevitable, and any policy of forest preservation is impossible."

I, for one, will not believe that our citizens are so blind to experience, or so indifferent or so powerless in this matter.

It is true that no government can prevent wasteful methods of lumbering so long as timbered lands are held as private property, and virgin forests can be bought at a rate so cheap that careless management will still leave a profit. But governments can control the process on land owned by them, by withholding the land from market, awaiting the time—not far distant—when the timber can be sold under such regulations as will make the most of its resources. If this were done, lumber owners would soon find their interest to lie in more provident methods; and increased values would make them saving of their resources. As to forest fires, since no plea of the public welfare avails to induce lumbermen to burn their *débris*, or to get rid of it in any way that is not directly repaid, and appeals to patriotism or a regard for the interests of their neighbors are unheeded, the strong arm of the law must be stretched out to compel.

Why this has not been done it is hard to say: common if not statute law gives redress, and holds the owner of land accountable to his neighbor for negligence that endangers him. Is there warrant, either in a court of law or of common sense, that the owner of land may cut his timber and pile up the remnants to dry and become combustible material, with danger to his neighbor's timber or other property in case of fire, without being held accountable to him for the damage? Probaby the legal aspect of the case is not well understood, and the results have been so long submitted to—perhaps because the injured are themselves similarly situated toward others, and therefore can not come into court with clean hands—that sufferers have come to believe that such disasters are unavoidable.

It should be the practice of forestry associations to disseminate wholesome instruction on this head, and to present practicable plans for meeting the difficulties of the situation. Whatever the remedy suggested, it should ever be borne in mind that the owner of forest property, and especially corporations, have purchased for the purpose of converting the timber into money in the cheapest and most rapid manner possible, and that they are, as a rule, indifferent to the future of the region. They must also inculcate the principle that no legislation is effective, unless well-organized machinery is provided for its enforcement.

The mere holding of a man or a railroad liable in damages for such acts of carelessness and indifference as I have mentioned, and for setting fire to woods, is not sufficient. Infraction of the law should be made a criminal offense, punishable by the severest penalties. It should be made the duty of counties and townships to appoint fire wardens, as is provided in Pennsylvania and Maine—paid officials, who should exercise a vigilant watchfulness, and use extra precautions in exceptionally dry seasons. At such times the town should take upon itself the work of clearing away litter and all combustible material that add to the danger of fire. These should be burned or got rid of under constant inspection, at a time when the fire is not likely to spread. In case of a conflagration started, the wardens should be empowered when necessary to summon assistance. In France safety belts of trees not readily burned are planted on each side of the railway track where it passes through a pine forest. Roads, trenches, and cleared spaces are also so constructed as to prove a safeguard; the cost is paid partly by the authorities and partly by the landowners. Heavy penalties are imposed for kindling fires within certain prescribed limits.

Among many suggestions for a forest policy in the older States, that for Pennsylvania commends itself, in a bill now before the Legislature of that State. It provides that the Governor shall appoint a commission of two persons—a competent engineer and a practical botanist—who shall examine and report upon the important watersheds of the State, for the purpose of determining how far the presence or absence of the forest covering may affect the water supply; also the amount of standing timber, and a measure for securing timber supply in the future. The Pennsylvania Forestry Association, in recommending the bill, points out the fact that the vast forests once covering all the head waters of the principal streams are nearly gone; the splendid oak and other timber is almost exhausted; fires destroy two million dollars' worth of timber each year; timber thieves escape unpunished; cattle kill the young growing timber, and no effort is being made to protect and renew the forest growth.

There is not a State in the Union that does not need to adopt similar precautionary measures, and these should be accompanied with some practical plan for management. It would be well for each State to have a single forest commissioner appointed by the Governor, whose duty it should be, in addition to the collecting of such statistics as above, to organize in each county and township a *system of fire wardens or patrols;* to see that special precautions are taken in cases of unusual peril; to ascertain the causes of fires and who is responsible, and to prepare evidence. He should be a man fully instructed and thoroughly competent, should be well paid, and should be held personally responsible. All officials appointed to such service should be *removed as far as possible from political affiliations*, should be under civil-service rules, and the position should be permanent during good behavior.

The adoption by the General Government of a national forest policy can not be much longer delayed, although Congress is very slow to act. In the sale of the treeless portions of the public domain the Government may require that a certain portion be planted in trees as soon as the proper conditions, means of irrigation, etc., exist, and that a certain proportion of the timbered land be kept in timber, the title to be dependent upon the stipulated conditions. Whether the United States will eventually come to adopt the methods of administration of the timbered lands in vogue in Europe is a question that time must determine. The country has as yet few persons that have been educated to forestry as a profession, and simple rules must suffice for the present. Both the General and State governments possess, in the right of eminent domain, the power to preserve and condemn where necessary such lands as it shall be decided the public benefit requires to be maintained as forest in perpetuity. Private rights must give way to public utility. The owners of premises which have become a menace must be made to contribute their proper share of the expense of protective measures and forest police.

A forest policy is at last taking form. A bill, introduced by Senator Paddock at the close of the Congress of 1892, provides in the first place for a survey to determine the extent and location of all forest lands, after which the President is to withdraw from sale all such lands, except those found to be more favorable for agriculture than for forest—these reserved lands to be transferred to the Department of Agriculture, where a Forestry Bureau exists.

It provides for a Commissioner of Forestry, to be appointed by the President, with consent of the Senate, who shall have control of all the forest reservations and timbered lands, subject to supervision of the Secretary of Agriculture, who shall appoint inspectors as assistants.

Each reservation to have one superintendent, who shall have full charge and control of the reservation for which he is appointed, and be responsible to the central bureau, and have such assistants as may be needed.

Rangers to be appointed by the Commissioner of Forestry to act as police, against trespass and fires, and to supervise the timber operations.

Full details of forest management are specified, into which I shall not here enter.

To create as quickly as possible an efficient protective service, the army may be employed for this purpose, as has already been done in the Yellowstone and California Parks. The system proposes a separate and complete administration, conducted by competent men under expert instruction, and, while the protecting of watersheds is of sufficient importance to warrant expenditure out of Government funds, the service should be made to pay for itself by the sale of surplus forest material.

The suggestion that the army be employed for policing the public forests is an admirable one. It has already done good service in this direction, and it will prove to be a constabulary force in which the country has full confidence. Military training has given the army a thorough organization and an *esprit de corps*, and it is free from political influence. Officers of the army made the best commissioners in Indian affairs which the country has ever had, and gained for themselves a just reputation for faithfulness, honesty, and courage. They will be equally good custodians of our forest domain. Were our army twice as large as it now is, it would be too small for war, but would find too little employment in time of peace, unless its services are used in civil channels. To supply qualities that are wanting for this particular service a chair of Forestry should be established at West Point, to give such instruction in forestry science as the case requires.

If the reforms here outlined, whether embodied in the Paddock bill or the McRae bill, or commended to our situation by foreign experience, shall be persistently urged by forestry and other associations, and the United States Government, heedful of the danger of neglect or delay, shall respond with promptness and energy and a proper regard for the future of the nation, a forestry policy will be inaugurated which will meet present requirements, and which may be extended and improved to serve all future needs.

Then the lesson of the forest fires will not have been learned in vain.

COPPER, STEEL, AND BANK-NOTE ENGRAVING.

By C. W. DICKINSON.

HOW few of the many people who are fortunate enough to have a dollar bill in their pocket think of it as a work of art! Two hundred years ago this piece of paper would have been of almost incalculable value, and have awakened an interest among the artists of that day which we can scarcely realize. Look at the portrait on the left of the face of the note. Here we have a beautiful specimen of pure line engraving—much better work than most of that done by some of the old masters and now considered classic. Then there are on both face and back the fine, delicate effects of light and shade produced by the ruling machine and geometrical and cycloidal engraving lathes. Further than this can be seen elegant designs in scroll work and lettering.

This may be a piece of "the root of all evil," and we know it is often "filthy lucre," only worth one hundred cents to us, yet it may be profitable to inquire as to how it is made.

Steel and copper plate engraving does not, as is generally supposed, owe its origin to the woodcut, but to the chasing on goldsmith's work. Look at any article of jewelry ornamented with incised designs, and there will be seen the true origin of line engraving; and although this work was not done—as was the steel or copper plate engraving—for the purpose of producing copies by printing, still it was by this engraving on jewelry that the art of printing from an incised line was, like a great many other good inventions, accidentally discovered.

The goldsmiths of Florence, in the middle of the fifteenth century, were in the habit of ornamenting their works by means of engraving, after which they filled up the hollows produced by the graver with black enamel (made of silver, lead, and sulphur), the result being that the design was rendered much more visible by the contrast of the enamel and the metal.

An engraved design filled up in this manner was called a *niello*, and our modern door plates are really *nielli* also, for in these, too, the engraved lines are filled with black. The word *niello* comes from *nigellum*, and simply refers to the color of the enamel.

While a *niello* was in progress, the artist could not see the effect of his work so well as if the enamel were already in the lines; and, on the other hand, he did not like to put the enamel in the unfinished engraving, as, when once it was set, it could not easily be got out again. He therefore took a sulphur cast of his *niello*—in progress—on a matrix of fine clay, and filled up the lines in the sulphur with lampblack, thus enabling himself to judge of the effect of his engraving thus far.

At a later period it was discovered that a proof could be taken on damp paper by filling the engraved lines with a certain ink and wiping it off the surface of the plate, sufficient pressure being applied to make the paper go into the hollowed or engraved lines and bring the ink out of them. This was the beginning of plate printing, but nobody at first suspected the artistic and commercial importance of the discovery. The *niello* engravers thought it a convenient way of proving their work, as it saved the trouble of the sulphur cast, but they saw no further into the future. They went on engraving *niello* just the same, to ornament jewelry and furniture; nor was it until the next century that the new method of printing was carried out to its great and wonderful results. Even in our day the full importance of it is only understood by persons who have made the fine arts a subject of special study.

The earliest engravers on metal for the purpose of multiplying by printing, of which we have reliable information concerning names and dates, were the German artists, Martin Schongauer and Albert Dürer. Schongauer was the earlier artist of the two, as he died in 1488, while the date of Dürer's death is 1528, just forty years later.

Schongauer, though a generation before Dürer, was scarcely inferior to him in the use of the graver, but Dürer has a much greater reputation—due in a large measure to his singular imaginative powers. Schongauer is the first great engraver who is known to us by name, although he was preceded by an unknown German master who is called "the Master of 1466." He had Gothic notions of art, but used the graver skillfully in his own way; conceiving of line and shade as separate elements, yet shading with an evident desire to follow the form of the thing shaded, and with lines in various directions.

Schongauer's art is a great stride in advance, and we find in him an evident pleasure in the bold use of the graver; his outline and shade were better blended, the shade being done more by the use of curved lines than is found in the works of those before him.

Dürer continued Schongauer's curved shading with increasing delicacy and skill, and as he found himself able to perform feats with the graver which amused both himself and his buyers, he overloaded his plates with quantities of living and inanimate objects, each of which he finished with as much care as if it were the most important thing in the composition.

The engravers of those days had no conception of any necessity for subordinating one part of their work to another; they drew—like children—first one object and then another, and so on, until the plate was furnished from top to bottom and from right side to left.

In Dürer, all objects are on the same plane! In his Saint Hubert, the stag (Fig. 1) is quietly standing on the horse's back,

FIG. 1.—DÜRER'S SAINT HUBERT.

with one hoof on the saddle, and the kneeling knight looks as if he were tapping the horse on the nose while bowing before the crucifix. The artist seems to have noticed the mistake about the stag, for he put a tree between us and the animal to correct it, but the stag is on the horse's back nevertheless.

There is no reason why steel engraving should be used only to translate painting. The early engravers were often original artists who worked out designs of their own, but in course of time a commercial reason prevailed over originality. It was found that a well-known painting assured the sale of an engraving from it beforehand, whereas an engraving which stood entirely on its own merits came into the world without advantages, and had its own way to make. Besides this, the engraver who copied a picture saved himself all the trouble of thinking out and composing the design which he found ready to his hand.

This is why we have to-day so very few original artists in steel engraving and etching; although there has been a great revival of etching in the last twenty years, especially in Europe, and many artists have acquired great skill in this mode of engraving (Hayden in Europe and James D. Smillie in America being considered the best in their respective countries), it has nearly all been copying.

We can not but deplore this subordination of engraving to painting, and when we look back to the great engravers of past times, who composed and invented their own works, it is with a feeling of regret that they have left so very few successors; for steel engravings have found a place in the hearts of the people of this country that no other class of art can ever replace.

Before leaving this subject of early engravers and their works, let us look at the influence exerted upon them by Raphael and Rubens.

In Italy, Marc Antonio was considered one of the great artists and copied Dürer, translating more than sixty of his woodcuts in metal (for Dürer was also a wood engraver).

It is one of the most remarkable things in the history of art that a man who had trained himself by copying northern work—little removed from pure Gothicism—should have become, soon afterward, the great engraver of Raphael, who was much pleased with his work and aided him by personal advice. Yet, although Raphael was a painter and Marc Antonio his interpreter, we must not infer that engraving had as yet subordinated itself to painting.

Raphael himself evidently considered engraving a distinct art, for he never once set Marc Antonio to work from a picture, but always gave him drawings, which the engraver might interpret without going outside of his own art; consequently, Marc Antonio's works are always original engravings. A school of engraving was thus founded by Raphael through Marc Antonio, which cast aside the minute details of the early schools for a broad, harmonious treatment.

Another school—which marked a new development—was known as the engravers of Rubens. That great painter understood the importance of engraving as a means of increasing his fame and wealth, and directed Vorsterman and others, as Raphael had directed Marc Antonio. Rubens's theory of engraving was that it ought not to give accurately the local color of the picture, which would appear wanting in harmony when not associated with the hues of the painting; and it was one of his anxieties so to direct his engravers that the result might be a fine plate independent of what he had painted. To this end he also helped his engravers by drawings, and he sometimes went so far as to indicate what he thought the best direction for the lines.

Previous to the year 1830 only copper plate was used by engravers, because up to that time it was not thought possible to make steel soft enough to cut easily and smoothly. The first plate produced—that could be used—was called "silver steel." Later there was manufactured the "Prussian steel" plate, which was a slight improvement in fineness of grain. Other and greater improvements followed, until now steel has almost entirely superseded copper.

Decarbonated cast steel is used for general engraving purposes and must be of very fine grain, and very soft as compared with natural cast steel. The plates are rolled out from bars of steel in its natural state, then decarbonated and cut to about the size desired, leaving enough margin to square the edges, which are finished with a wide bevel. After the plate has been cut to size, it is flattened by laying it upon a copper anvil and hammering with a wooden mallet until it is as flat as is possible to get it by that process. A uniform thickness and perfectly flat surface are then given to the plate by grinding—sometimes by hand, usually by machine—the latter process being the better, as it is the more perfect in its results. By grading the stones used in this grinding from coarse to fine, the plate is left ready for the final finish, which is given by burnishing and rubbing with very fine emery leather made for the purpose, from the finest grade of emery that can be had.

Copper plate is still used to a considerable extent for visiting cards, invitations, and such small work as calls for only a limited number of impressions, for copper will not stand nearly as much wear as steel, often wearing out in one thousand impressions, while ten or even fifteen thousand can be taken from steel, and, if the plate is hardened, as is often done, one hundred thousand have sometimes been pulled before the plate has entirely given out. Copper is also used in some cases for the cheaper classes of picture work, such as book illustrations, but it is usually coated with steel or nickel by precipitation, this facing taking the wear instead of the copper.

The tools used in steel engraving are about the same as those used on wood, excepting the heavier wood scaupers, as they are called (chisels or gouges would perhaps give a better idea of what they are). These could not be used on steel, because the hand of the artist could not force them through the line to be cut; so a more delicate graver is used, and a great many cuts are taken in the same line, thus making it broader and deeper by degrees.

There are several kinds of picture engraving and etching, the most prominent of which are aquatint, mezzotint, stipple, rouletting, and line engraving.

Aquatint is a kind of etching used to get the effect of drawings in India ink, and at one time it was greatly made use of in rendering the drawings of Paul Sandby and our early water-color painters, and particularly prints for drawing-books.

There are many ways of preparing a plate for this work, but the following is the best: Have three different solutions of rosin in rectified alcohol, making them of various degrees of strength, but always thin enough to be quite fluid, the weakest solution being almost colorless. First pour the strongest solution on the plate, which has previously been very carefully cleansed from all oil and grease that would prevent the acid acting upon the steel. When this strongest solution dries it produces a granulation, and you may now bite or corrode the steel with acid through these granulations for your darker tones, stopping out with a varnish made of sealing-wax dissolved in alcohol where the acid is not to operate, or the acid may be applied with a brush where the dark tones are desired. After cleaning the plate as before you proceed with the weaker solutions in the same way; the weakest giving the finest granulations for skies, distances, etc.

The process requires a good deal of stopping out and some burnishing and scraping for the high lights in finishing.

Another style of aquatinting is done by placing a clean plate in an air-tight box where there has been a dust of rosin circulated by means of a bellows attached to the box. The finest of the particles of rosin are allowed to settle on the plate, which is then heated until this dust of rosin sticks to it where it has fallen. The acid is now put to work as before. This gives an even tint something like the other process, the difference being in this case that the acid bites the plate between the particles of rosin, making a black around a white, whereas in the first process the acid acts through the granulated rosin, producing a black surrounded by a white. An impression of either of these plates, taken in the condition the acid leaves them, would resemble a tint or wash of color on paper.

David Allan engraved his celebrated illustrations of the Gentle Shepherd in this manner. This style of engraving has now gone almost entirely out of use, having been—like engraving in imitations of drawings in chalk or pencil—in a great degree superseded by lithography.

Mezzotint is said to have been invented by Prince Rupert, or by Leivis Siegen, a lieutenant in his service, in or about the year 1611, and to have been suggested by the rust on a weapon which a soldier was cleaning.

The plate is prepared (before any design is made upon it) by means of an instrument or tool called the "rocker" (see Fig. 2). This "rocker" is rocked to and fro upon the plate in all directions, and the teeth in the sharp, beveled edge of the tool make a small dent in the copper or steel and raise a corresponding "burr." The whole plate is gone over with this instrument about eighty times before it is in a fit condition to be worked upon. When sufficiently prepared it presents a fine, soft-looking, and perfectly even grain, and if in this state a proof is taken from it by the usual process of plate printing the result is the richest possible black.

Fig. 2.—The Rocker.

On this plate, after a tracing has been transferred, the engraver goes to work, with tools called "scrapers" and "burnishers," working from dark to light by removing the dents and burrs, and exactly in proportion as he removes them the tint becomes paler and paler, those parts most smoothed being the lightest and the part the least operated on producing the deepest shadows. As the process is from dark to light, the engraver has to be very cautious not to remove too much of his grain at once, for once he has it too light it would be impossible to restore the color without destroying the surrounding lights. He proceeds from dark to half dark, from half dark to middle tint, from middle tint to half light, and from half light to light. When the work is good the result is soft and harmonious, well adapted to the interpretation of some painters, but not of all.

More than one hundred engravers in mezzotinto employed themselves on the portraits of Sir Joshua Reynolds, and the best of their works are now valued as the classics of the art which is connected with the name of Reynolds, just as line engraving is connected with that of Raphael.

In engraving in "stipple," which was much in vogue in the end of the last century, the drawing and effect are produced by small dots in place of lines (Fig. 3).

These dots follow at first the outlined shades, starting with a double dot where the darker shades are desired. Smaller dots are placed close to these double dots on the side nearest the largest space. Lights are had by using very fine dots, and high lights by leaving them out altogether.

Ryland, Bartolozzi, and Sherwin excelled in this style of engraving. It is well suited for portraits; several of Rasburn's have been capitally engraved in "stipple" by Walker. It involves much more labor than any other kind of work in this line of fine arts, except line engraving, and is now little practiced.

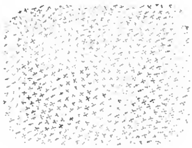

Fig. 3.—Stipple.

Rouletting is done with a tool very much like those sold on the streets nowadays for cutting glass. A small hardened steel wheel is set in the end of a pencil-like handle (Fig. 4). On the edge of this wheel is cut the pattern desired by the artist—notches, lines, dots, or whatever may be called for by the subject to be treated. This wheel is rolled on the plate, leaving an indentation like the marking on its edge.

This peculiar style of engraving is used, in connection with others, where particular effects are desired, pencil and charcoal lines being imitated in this way, thus securing that beautiful sketchy style better than can be obtained by any of the others.

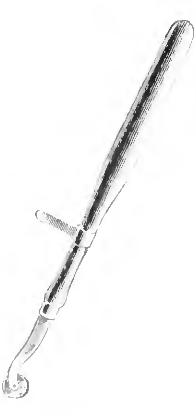

Fig. 4.—The Roulette.

We now come to consider line engraving, the most important as well as the most difficult of them all, and the only kind that can be used successfully in bank-note work (Fig. 5).

It is so called because the effect is produced by a combination of lines or interrupted lines. The more harmonious these lines are in shape or direction, spacing, and texture, the better will be the effect and the more valuable the work. Because of the requirement of this accurate spacing and harmony of texture mechanical as well as artistic skill is called for in producing a first-class line engraving. Many good artists in other lines fail in this art for want of this mechanical skill.

Line engravings have always ranked the highest in this branch of the fine arts, some people preferring them to water colors or oil paintings.

As stated before, this is the only picture work that can be used successfully in bank-note work, for it is much more difficult to imitate, and consequently gives greater security, being less liable to be counterfeited. This is so also because a line cut with a graver is smooth, sharp, and clean, whereas an etched or bitten line is ragged and rough.

Line engraving is the most expensive, for it takes much more time to produce a picture by this process than by any other. Some of the large plates by the late James Smillie, father of the James D. Smillie mentioned earlier in this paper, and who was the best artist of his time in America, cost as high as ten thousand dollars, and took the greater part of two years to complete.

FIG. 5.—LINE ENGRAVING.

BANK-NOTE ENGRAVING.—For the sake of convenience we will divide bank-note engraving into two classes: 1. Lettering. 2. Picture and scroll work.

Lettering may be described under three heads—large lettering, such as bond titles; small lettering, like that done on coupons, cards, and tickets; and script or writing. Some engravers can do good work in all of these branches of lettering, but in large establishments each man is kept employed at that style in which he excels.

In bonds and stock certificates the titles and script are usually done on the plate from which they are to be printed, but there is a lot of small work, common to jobs of that kind, which is done on what are called "dies" or "bedpieces," and transferred from the rolls to the plates. This will be more fully de scribed later.

In large lettering a drawing of the outline of the letters is made on paper to get the shapes, curves, and spacing correct. A tracing of this outline is then made on gelatin, and, after filling this with vermilion, a thin coating of wax is laid on the plate and a transfer of the gelatin tracing put on the wax. Next the outline is carefully marked through the wax on to the plate; the wax is taken off and the artist is ready to begin his cutting.

Lettering on bank notes, if there is to be more than one note on a plate, is engraved on "dies" or "bedpieces" and transferred to the plate. This insures the exact duplication of the material of each of the notes, and also makes it possible to reproduce and retouch the work at any time.

PICTURE AND SCROLL WORK.—Picture and scroll work is the most expensive connected with the bank-note business, and is divided into three classes, viz., scroll, portrait, and vignette engraving. It is a very unusual thing to find a man who is a first-class artist in more than one of these branches, and there are none that are even good in all three. This is one of the safeguards of the bank-note business, as no one man can finish a note completely, but must find some one to help him.

The dies and bedpieces mentioned above are pieces of annealed steel—that is, steel that has been softened without decarbonizing—on which work has been engraved that is to be used several times on the same "job," or for a number of different plates. These dies, after "proving," are hardened by heating in cyanide of potassium, which is used in all hardening processes connected with the bank-note business. After these dies are hardened a roll made from very soft steel is rolled over the work under a pressure of from six to twenty tons to the line. This pressure is had by means of a machine called a transfer press,

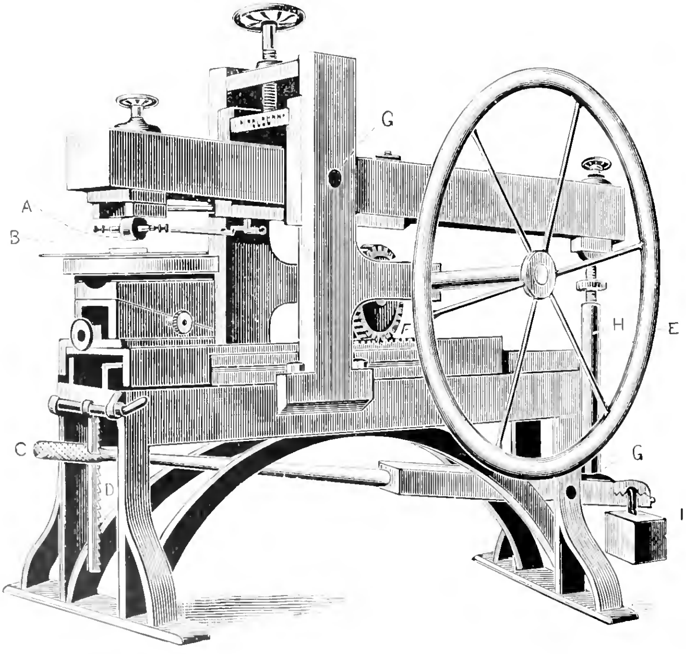

Fig. 6.—Transfer Press. A. Roll in carrier; B, die or bed piece; C, foot lever; D, rack to fasten lever down; E, side wheel by which bed of press is moved back and forth; F, rack and pinion connecting them; G, G, fulcrum pins of upper and lower levers; H, connecting rod between two levers; I, counter balance.

which, by a combination or compounding of levers, multiplies the pressure exerted by the operator from one hundred to one hundred and fifty times (Fig. 6).

By means of the large wheel on the side of the press, the shaft of which is geared into a rack fastened to the bed of the press, the roll, with this tremendous pressure still on it, is rolled back and forth on the die until the fine grain of the soft steel is forced into every line of the work. This gives the reverse of the die on the roll. Even the finest and faintest scratch of a diamond point can be taken up this way and retransferred to another piece of steel and printed to the paper, so little is lost in the operation.

The roll is now put through the same process of hardening previously used on the die, and we are then prepared to make a great many duplicates of the original. One hundred or more facsimiles of the die can be made in less time than it took to produce the original. For instance, it takes a picture engraver about six weeks to engrave a portrait like that of Martha Washington on the left of the one-dollar United States note, and it can be reproduced in fifteen minutes by means of the transfer press and a roll taken from the original die.

Imagine, if you can, the work it would be to engrave by hand the two hundred postage stamps that are usually put on the plate from which they are printed, or the forty or fifty coupons of a bond. An endless job, you say, and yet that is just what would have to be done if it were not for the transfer press. And not only is it possible to thus readily multiply facsimiles of the original, but the reproductions are exact in every respect and detail, excepting the almost imperceptible loss in the process, which is natural and unavoidable.

Transferers work from a paper model made with prints from the original dies, which are very carefully put together in such a way as will give a very good idea of the effect of the finished work. These models are also submitted to and accepted by the party for whom the work is to be done.

After the plate is transferred it shows hollows around the work, made by the pressure of the roll, which must be brought back to a flat surface again; otherwise a clean proof could not be taken. These hollows are flattened by first carefully marking the outline of the work on the back of the plate, by means of "calipers" made for the purpose, then laying the face of the plate on a polished hardened-steel anvil and hammering around the outline. All scratches, guide lines, and marks that have been used by the transferer are then removed by burnishing the surface, and the plate is ready for the engraver's hands, for there is always some flourishing and finishing to be done before the plate is ready for the printing press.

Plate printing is the opposite of block or woodcut printing in this respect: The line that is to print the color is cut into and below the surface in plate work, and may be so fine that it can not be seen without the aid of a strong magnifier, and yet print perfectly clear and unbroken, while in block the line is left standing and must have some appreciable thickness. For this reason wood engraving can never be as delicate as plate, for it could not be printed. And not only does an impression from plate excel in delicacy but also in force and depth of color.

There never was and never will be a woodcut line having the power of a deep line in a plate, for, in an impression from wood, the print is only a blackened surface of paper, whereas that from plate is a cast with an additional thickness of ink, for the damp paper is forced into the line and brings out the ink upon its embossed surface.

Plate ink is soft and thin as compared with that used for surface prints, and the body of it is ground carbon mixed with oil for black; and colored ink is made from white lead mixed with dry colors and very finely ground in oil. Some inks are much more wearing on the plates than others, green being about the worst in this respect.

Retouching, or "re-entering," as it is called in the trade, is done by re-entering the roll upon the lines of the transferred work and putting the pressure on, as in the original transfer. This sharpens and restores the line, making it print as good as when new.

The very best linen fiber paper is used in printing bank notes, bonds, stock certificates, etc., and it is dampened before printing to make it more pliable, and it also takes the ink better in this condition. After printing the sheets are placed on racks in a drying room heated by steam. When they are thoroughly dry they are found wrinkled and curled, so they are placed between Bristol boards and put under a hydraulic pressure of several hundred tons and kept there for a few hours, then taken out ready for trimming, numbering, and shipping. Each time the impressions are handled they are counted and kept track of, good or bad, so there shall be no possibility of loss or theft.

There are some very delicate machines used in bank-note work, known as ruling machines and cycloidal and geometric lathes. The straight and curved line ruling machine is used in making the background of portraits and vignettes, shade and ruled faces of letters, background of panels, and is capable of ruling three thousand six hundred lines to the inch with great perfection and regularity, but is seldom set as fine as this.

The cycloidal ruling machine is more complicated than the plain line ruler, having from one to four "eccentrics," or "cams," in connection with the forward and back movement of the bed, and is used for producing fine tints to print over other colors and work. The principle of its operation is readily understood. A diamond point is arranged in the machine and given a circular motion by the action of the "cams." Now, while the point is revolving, let a forward movement be given to the plate and the line traced by the point will assume a form like this (Fig. 7), which is called a "cycloidal line," and may be described as that line produced by a point revolving about a moving center. The shape of the curved line depends upon the relative rate of speed of the two motions, the circular one of the point and the forward

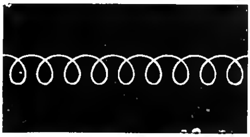

FIG. 7.—OPEN CYCLOIDAL LINE.

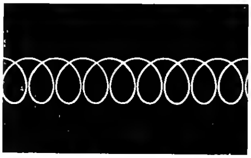

FIG. 8.—WIDE CYCLOIDAL LINE.

one of the plate. If the latter is comparatively slow, the cycloid will take this shape (Fig. 8); if still slower, the curves will cross each other instead of nearly touching. If the motion of the plate is comparatively rapid, the cycloid will take the form of Fig. 9, or one still more open.

By repeating these lines and causing them to overlap each other beautiful lacelike effects can be had, very difficult to imitate by hand (Fig. 10). The patterns can be varied almost endlessly.

Machine engraving of a far more intricate character is produced by the "geometrical lathe," which is one of the most delicate and complex machines ever invented (Fig. 11).

Americans have particularly distinguished themselves in mechanical engraving, and, in fact, it was one of our people—a Mr. Spencer, of Philadelphia—who introduced the "bank-note engraving machine" in the early part of this century. This machine, however, was very primitive, as it had but one "cam," and consequently was very limited in its possibilities as compared

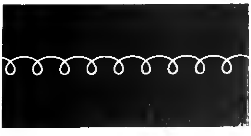

FIG. 9.—CYCLOIDAL LINE

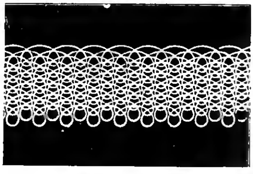

FIG. 10.—CYCLOIDAL PATTERN.

with those built in the present day, which have seven cams as well as other attachments not dreamed of by Spencer.

The geometrical lathe of the present day can not be described so as to be perfectly understood, but something of an idea of its working can be gained from the following:

A tool, mechanically sharpened and shaped, made of hardened steel, is used on this machine and is fixed solidly and immovably in a rest, or carrier, over the chuck of the lathe. If the chuck were now revolved the result would be a plain circle cut into the steel plate; or, if the oval slide which is built into the chuck is in operation, the result would be an oval (Fig. 12).

The several cams, when in use, cause the "beds" (of which there are two, laid on rollers) to move back and forth, or to the right and left, as the operator may desire, once for each revolution. Now, suppose one cam was geared to revolve eight times while the chuck is revolving once, we would then have eight

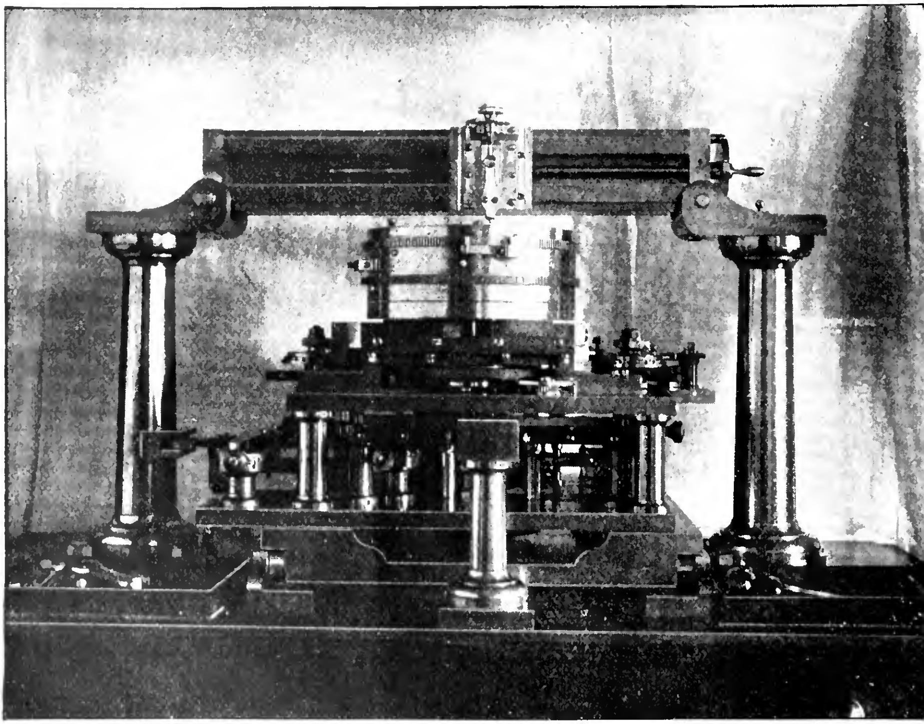

FIG. 11.—GEOMETRICAL LATHE. From "Paper and Press," by the kindness of W. M. Patton.

vibrations of the "bed," or eight waves in the line which was before a plain circle; therefore, we would now have an eight-sided figure, or a circle with eight bulges in it. (See inside line of the figure below.) If we now put another cam in motion, geared to revolve twenty-four times to the chuck once and the first cam's eight times, we would have twenty-four waves upon eight waves upon a circle, giving a line like that of the outside in the same figure (Fig. 13).

This has given us one of the many beautiful and perfectly geometrical forms that this wonderful and almost human machine is capable of producing under the management of a skilled artist.

Figs. 14 and 15 will show some of the more complicated designs and effects that may be had from one of these lathes. These look to be very complicated, but are, in reality, quite simple: Fig. 14 having but five continuous lines, including the two plain circles

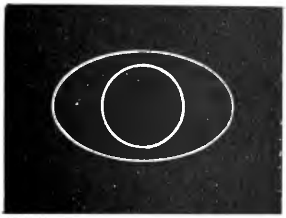

FIG. 12.—CIRCLE AND OVAL LINES.

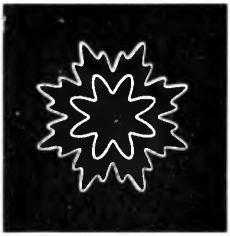

FIG. 13.—EIGHT WAVE AND 8 24 WAVE FIGURES.

of the outside, and Fig. 15 has but two; the beautiful effects being produced by the crossing and interlacing of the lines.

Some of the cuttings used for bank notes appear to have thousands of lines, but very few of them have more than twenty, and most have but three or four.

The above diagrams have been engraved for this article by the lathe itself. They have been purposely made much more simple than those used in the bank-note business, in order that the general form may be more readily distinguished. Any one with a

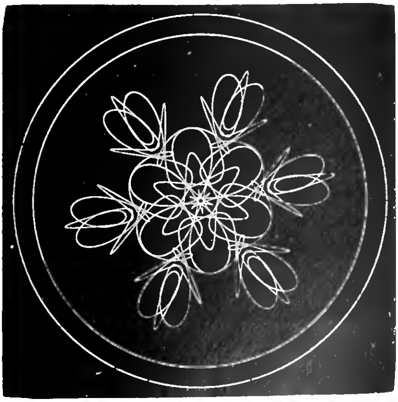

FIG. 14.—LATHE WORK.

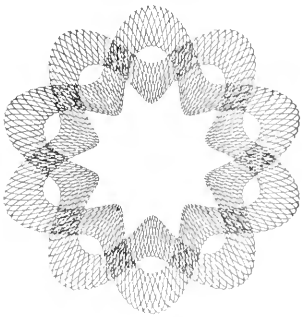

FIG. 15.—LATHE WORK.

glass and a sharp point may follow the lines which compose these figures.

One peculiarity of lathe-work should be noted. We said, in a former paragraph, that in steel-plate engraving the line cut by the graver prints black. In most of our diagrams, as well as on the notes themselves, the line is white—the interspaces being black.

The reverse would be the case if this lathe-work was printed from the plate as it is engraved by the machine. This reversal (making that sunk on the plate which is left raised by the lathe, and *vice versa*) is effected by a process that is one of the carefully guarded secrets of the trade, and therefore can not be described here. Its effect, however, is evident.

We may suppose, for instance, that a very careful engraver might possibly cut upon a plate a very fair imitation of the lines forming the figure in our last diagram, but these cut lines, remember, would print black and would give an entirely different effect; therefore the black diamonds between the white lines must be cut and the line left standing; and what hand, be it ever so skillful, could cut these black interspaces and leave the white lines in their purity and regularity? Yet this is just what the engraver must do who would reproduce on steel this figure; and, we repeat, this is far less elaborate than those in actual use on bank notes.

The tool which cuts these delicate lines is made of the finest steel; made very hard and very carefully tempered. It passes through each line of the cutting about twenty times, cutting down about one three-thousandth part of an inch each time, then continues going over the line about fifty times more to clean out the burr and polish the work. The machine must, therefore, work with perfect precision, for a deviation of one tenth part of a hair's breadth would destroy the whole cutting.

On account of this required precision, these lathes are made adjustable in every part—that any loss-motion caused by wear may be taken up. They are so sensitive as to be affected by a sudden change of temperature in the room; and if a partially finished line should be entered by the tool after such sudden change, the result would be a defective piece of work.

We may watch one of these machines for hours and each moment discover some new movement. In the hands of a skillful operator (for, after all, the machine itself, to produce the required effects, must be under the direction of human intelligence) it will produce almost any form desired.

There are only three or four first-class operators of these machines in the world, and they are all Americans. Only one of these is able to make a cutting from a pencil sketch and figure out the required combination of wheels, set the lathe, and know it is properly set and adjusted before turning a wheel. The turn of a screw, the substitution of one wheel for another—with the variation of a single cog—the shifting of the axis of an eccentric, will produce an entirely new effect; it may give distortion where perfect regularity is demanded; therefore a perfect and long familiarity with the machine is necessary to the successful handling of it.

These machines cost about five thousand dollars, and are built by the inventor, Mr. C. W. Dickinson, Sr., of Belleville, N. J., who has invented and improved several other kinds of very useful bank-note machines.

It is said the American Bank-note Company, of New York, has a lathe, built by the company some years ago, which took about three years to build and cost more than ten thousand dollars.

The variety of forms that can be produced on one of these lathes is endless; and if Spencer could have had one of these, instead of the crude one he had, and could have started with the opening of this century and cut a new form every day, Sunday included, and every hour of each day up to the present time, he would still have possibilities enough left to fill out the next century.

This machine and its work have been thus minutely described because it is considered a most important security against counterfeiting; not exceeded in value even by the artistic perfection of the vignettes, or portraits, and lettering.

Doubt as to the character of a bank note has often been settled by a microscopic examination of the lathe-work. Even by means of the lathe on which a cutting has been made, it could not be absolutely reproduced; so, of course, it could not be done by hand or by another lathe. Possibly, after reading this article, some one will look upon a bank note as something more than simply cash.

The results of observations taken by Mr. Hallock, of the Smithsonian Institution, at depths extending to 4,462 feet, in a nearly dry well at Wheeling, W. Va., were communicated to the British Association by the Committee on Underground Temperature. When the observations taken in 1891 were concluded, the well was plugged. The plug was withdrawn in July, 1893, and the observations were resumed. The well, which had been dry before, was filled with fresh water to within forty feet of the top. The results of measurements at various depths between 1,586 feet and 3,196 feet were practically identical with those obtained two years previously, when the well was full of air, the greatest certain difference being only one fifth of a degree. The temperatures at 103 feet, 206 feet, and 300 feet were also observed with suitable thermometers, the temperature at 103 feet being 52·53°, which is 1·2° higher than the true temperature of the soil at that depth, as determined by other observations in the immediate neighborhood.

The four-hundredth anniversary of the establishment of the earliest Slavonic printing press in the country was celebrated throughout Montenegro in July, 1893. The press was set up at Obod by the ruling prince in 1493, before either Oxford or Cambridge had a permanent press. Some of the books printed then are still to be seen at the Monastery of Cajnice, just over the Bosnian frontier. On the occasion of the celebration, universities and learned societies of Europe, including the University of Oxford, sent addresses of congratulation.

SCIENTIFIC METHOD IN BOARD SCHOOLS.*

By Prof. H. E. ARMSTRONG, F. R. S.

AT the request of my friend and former pupil, Mr. W. M. Heller, I have undertaken to say a few words by way of introduction to the course which he is about to give here to assist a number of you who are teachers in schools in the Tower Hamlets and Hackney district under the School Board for London—a course of lessons expressly intended to direct your attention to the educational value of instruction given solely with the object of inculcating *scientific* habits of mind and *scientific* ways of working; and expressly and primarily intended to assist you in giving such teaching in your schools.

Nothing could afford me greater pleasure, as I regard the introduction of such teaching into schools generally—not board schools merely, but all schools—as of the utmost importance; indeed, I may say, as of national importance; and I now confidently look forward to the time, at no distant date, when this will be everywhere acknowledged and acted on. Personally I regard the work that I have been able to do in this direction as of far greater value than any purely scientific work that I have accomplished. At the very outset of my career as a teacher I was led to see how illogical, unsatisfactory, and artificial were the prevailing methods of teaching, and became interested in their improvement. My appointment as one of the first professors at the Finsbury Technical College forced me to pay particular attention to the subject and gave me abundant opportunity of practically working out a scheme of my own. I was the more anxious to do this, as I soon became convinced that if any real progress were to be made in our system of technical education, it was essential in the first place to introduce improved methods of teaching into schools generally, so that students of technical subjects might commence their studies properly prepared; and subsequent experience has only confirmed this view. Indeed, it is beyond question, in the opinion of many, that what we at present most want in this country are proper systems of primary and secondary education—the latter especially. Now, most students at our technical colleges, in consequence of their defective school training, not only waste much of their time in learning elementary principles with which they should have been made familiar at school, and much of our time by obliging us to give elementary lessons, but, what is far worse, they have acquired bad habits and convictions which are

* From a revised address delivered at the Berners Street Board School, Commercial Road, London, on October 9, 1894, and published in Nature.

very difficult to eradicate; and their mental attitude toward their studies is usually a false one.

The first fruits of my experience were made public in 1884, at one of the Educational Conferences held at the Health Exhibition. On that occasion, and again at the British Association meeting at Aberdeen in 1885, in the course of my address as president of the Chemical Section, after somewhat sharply criticising the methods of teaching in vogue, I pointed out what I conceived to be the directions in which improvements should be effected. Others meanwhile were working in the same spirit, and consequently, in 1887, a number of us willingly consented to act as a committee "for the purpose of inquiring into and reporting upon the present methods of teaching chemistry." This committee was appointed at the meeting of the British Association in York, and consisted of Prof. W. R. Dunstan (secretary), Dr. J. H. Gladstone, Mr. A. G. Vernon Harcourt, Prof. H. McLeod, Prof. Meldola, Mr. Pattison Muir, Sir Henry E. Roscoe, Dr. W. J. Russell (chairman), Mr. W. A. Shenstone, Prof. Smithells, Mr. Stallard, and myself. A report was presented at the Bath meeting in 1888, giving an account of replies received to a letter addressed to the head masters of schools in which elementary chemistry was taught. In 1889 and 1890 reports were presented in which were included suggestions drawn up by myself for a course of elementary instruction in physical science.

Let me at once emphasize the fact that these schemes were for a course of instruction in physical science—not in chemistry alone. The objects to be accomplished by the introduction of such lessons into schools have since been more fully dwelt on in a paper which I read at the College of Preceptors early in 1891, printed in the Educational Times in May of that year. After pointing out that literary and mathematical studies are not a sufficient preparation in the great majority of cases for the work of the world, as they develop introspective habits too exclusively, I then said, in future boys and girls generally must not be confined to desk studies; they must not only learn a good deal *about* things; they must also be taught how to *do* things, and to this end must learn how others before them have done things by actually repeating—not by merely reading about—what others have done. We ask, in fact, that the use of eyes and hands in unraveling the meaning of the wondrous changes which are going on around us in the world of Nature shall be taught systematically in schools generally—that is to say, that the endeavor shall be made to inculcate the habits of observing accurately, of experimenting exactly, of observing and experimenting with a clearly defined and logical purpose, and of logical reasoning from observation and the results of experimental inquiry. Scientific habits and method must be universally taught. We ask to be at once admitted to equal rights with the *three R's*—it is no question of an alternative subject. This can not be too clearly stated, and the battle must be fought out on this issue within the next few years.

Well, gentlemen and ladies, you have the honor of forming part of the advanced guard in the army which is fighting this battle—for the fight is begun in real earnest, although as yet on a small scale; nevertheless, in this case, the small beginning *must* have a great ending.

I had long sought for an opportunity of carrying the war into the camp of elementary education, and this came about four years ago when my friend Mr. Hugh Gordon was appointed one of the Science Demonstrators of the London School Board. During at least three years prior to his appointment, Mr. Gordon had been doing research work in the laboratory of which I have charge at the City and Guilds of London Institute Central Technical College, where he had also taken part in our elementary teaching, and he was already an ardent advocate of the educational policy of which I am so strong a supporter. Under the London School Board he achieved a marvelous success, and the work that he has done as a pioneer can not be too highly appreciated. He secured your confidence and sympathy, and interested his pupils; and working in a most unpromising field, under conditions of a most unsatisfactory and often depressing character, he has proved that to be possible, even easy (to the competent and willing teacher!), which my friends in higher grade schools have often scoffed at and declared to be impossible. In future, no public school will be able to excuse itself, except on the ground of want of will to give such teaching. I have often been told that our scheme was too costly, that much special provision must be made to carry it into effect, and that it requires so much time and such an increase in the teaching staff: my friend Gordon, with your assistance alone and no other addition to the staff, by successfully teaching, I believe, in seventeen of your schools, has given all these statements the lie. But I confess that as yet there are few who could accomplish so much; few equally well fitted and prepared for the work, so imbued with the right spirit, so convinced that the cause is a great and holy one, gifted with sufficient energy and enthusiasm to overcome the difficulties. The little book he has written, in which the first part of the course of teaching he adopted is broadly outlined,* although containing a few slight blemishes which mar its otherwise logical character—blemishes which will be very easily removed in a second edition—appears to me to be

* Cf. Nature, 1893, vol. xlix, p. 121.

a most important contribution to educational literature, and will render great service to our cause. But I count as his greatest achievement the introduction of a proper balance—calculated to inspire confidence and respect—into the schools, for I believe the discipline of learning to weigh carefully and exactly to be of the very highest value to a child, and one of the most effective means of leading children to be careful and exact in their work generally. I envy my friend his success, as I have in vain tried to get proper balances introduced into schools of far higher grade in place of wretched contrivances costing but three or four shillings, *which can be of no service in forming character,* although I have no wish to deny that such may be made use of in illustrating principles.

Mr. Gordon, I believe, was appointed to teach mechanics under what I will venture to call an antiquated and wooden syllabus, but he had the courage to burst the bonds imposed upon him, and from the outset determined to teach what was likely to be of real service to his pupils. I have said that he gained the confidence and sympathy of the teachers with whom he was associated and whose work he was appointed to supervise and direct; but I believe that he did more, and achieved success in a task of greater difficulty—that he actually made converts of some of her Majesty's inspectors whose sympathies had previously lain with literary studies.

I have thought it desirable thus to sketch the history of the introduction of our British Association scheme into school-board circles. Let me now further emphasize the importance of teaching *scientific method,* which after all is recognized by very few as yet. Let me endeavor to make clear what I mean by scientific method: that when I speak of scientific method I do not mean a branch of science, but something much broader and more generally useful. We may teach scientific method without teaching any branch of science; and there are many ways in which we may teach it with materials always close to hand.

I have very little belief in the efficacy of lecturing, and it is always difficult to persuade those who are not already persuaded —I would therefore refer those of you who are not yet with me to a book from which they may derive much information and inspiration. I mean Herbert Spencer's Essay on Education.* It is a book which every parent of intelligence desiring to educate his children properly should read; certainly every teacher should have studied it thoroughly; and no one should be allowed to become a member of a school board who on examination was found not to have mastered its contents. But as Herbert Spencer says—

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* Published by D. Appleton & Co. Paper, 50 cents; cloth, $1.25.

and the times are not greatly changed since he wrote—although a great majority of the adult males throughout the kingdom are found to show some interest in the breeding, rearing, or training of animals of one kind or other, it rarely happens that one hears anything said about the rearing of children. I believe the subject is seldom mentioned in school-board debates. Hence it happens that Herbert Spencer's book has had a smaller circulation than many novels, and that the 1893 edition is but the thirty-fourth instead of the three hundred and fortieth thousand. After very fully discussing the question "What knowledge is of most worth?" he arrives at the conclusion that science is, and eloquently advocates the claims of the order of knowledge termed scientific. The following are eminently instructive passages in his essay: "While every one is ready to indorse the abstract proposition that instruction fitting youths for the business of life is of high importance, or even to consider it of supreme importance, yet scarcely any inquire what instruction will so fit them. It is true that reading, writing, and arithmetic are taught with an intelligent appreciation of their uses. But when we have said this we have said nearly all. While the great bulk of what else is acquired has no bearing on the industrial activities, an immensity of information that has a direct bearing on the industrial activities is entirely passed over. For, leaving out only some very small classes, what are all men employed in? They are employed in the production, preparation, and distribution of commodities. And on what does efficiency in the production, preparation, and distribution of commodities depend? It depends on the use of methods fitted to the respective natures of these commodities; it depends on an adequate acquaintance with their physical, chemical, and vital properties, as the case may be: that is, it depends on science. This order of knowledge, which is in great part ignored in our school courses, is the order of knowledge underlying the right performance of those processes by which civilized life is made possible. Undeniable as is this truth, there seems to be no living consciousness of it: its very familiarity makes it unregarded. . . . That which our school courses leave almost entirely out, we thus find to be that which most nearly concerns the business of life. Our industries would cease, were it not for the information which men begin to acquire, as they best may, after their education is said to be finished. And were it not for the information from age to age accumulated and spread by unofficial means, these industries would never have existed. Had there been no teaching but such as goes on in our public schools, England would now be what it was in feudal times. That increasing acquaintance with the laws of phenomena which has through successive ages enabled us to subjugate Nature to our needs, and in these days gives the common laborer comforts which a few centuries ago kings could not purchase, is scarcely in any degree owed to the appointed means of instructing our youth. The vital knowledge—that by which we have grown as a nation to what we are, and which now underlies our whole existence—is a knowledge that has got itself taught in nooks and corners; while the ordained agencies for teaching have been mumbling little else but dead formulas."

Some improvement there has been since Herbert Spencer wrote, but chiefly in technical teaching: and there is yet no national appreciation of what constitutes true education: fashion and vested interests still largely dominate educational policy.

Another advocate of the teaching of scientific method to whom I would refer you is Charles Kingsley, the celebrated divine, but also a born naturalist possessed of the keenest powers of observation, a novelist of the first rank, and a poet. Read his life, and you will find it full of inspiration and comfort. Study his scientific lectures and essays (Volume XIX of his Collected Works, Macmillan & Company) and you will not only learn why "science" is of use, but will have before you a valuable model of method and style. A friend—a member of the London County Council—to whom I happened to send some of my papers, noting my frequent references to Kingsley, remarked, "How very fond you are of his writings!" Indeed I am, for they seem to me to display a truer grasp of the importance of scientific method and of its essential character than do any other works with which I am acquainted. I recommend them because they are pleasant as well as profitable reading, and because our text-books generally are worthless for the purpose I have in view. Any ordinary person of intelligence can read Herbert Spencer's and Kingsley's essays and can appreciate them, especially Kingsley's insistent application of the scientific principle of always proceeding from the known to the unknown; but few can read a text-book of science—moreover, the probable effect of most of these would be to dissuade rather than persuade.

Kingsley's great point, and Herbert Spencer's also, is that what people want to learn is not so much what is, still less what has been, but how to *do*. And the object you must set before yourselves will be to turn out boys and girls who, in proportion to their natural gifts—for, as every one knows, you can not make a silken purse from a sow's ear—have become inquiring, observant, reasoning beings, ever thoughtful and exact and painstaking, and therefore trustworthy workers. To turn out such is the whole object of our scheme, which chiefly aims at the development of intelligence and the formation of character. In your schools information must be *gained*, not imparted. After describing how the intelligent mother trains her young child, Herbert Spencer remarks: "To *tell* a child this and to *show* it the other is not to teach it how to observe, but to make it a mere recipient of another's observations, a proceeding which weakens rather than strengthens its powers of self-instruction, which deprives it of the pleasures resulting from successful activity—which presents this all-attractive knowledge under the aspect of formal tuition. . . ." You must train the children under your care to help themselves in every possible way, and give up always feeding them with a spoon. Abolish learning lessons by rote as far as possible. Devote every moment you possibly can to practical work, and, having stated a problem, leave it to the children if possible to find a solution. Encourage inquisitiveness, but suggest methods by which they may answer their own questions by experiment or trial or by appeal to dictionaries or simple works of reference, part of the furniture of the schoolroom, and lead them to make use of the public library even; in after life you will not be at their elbows, but books will always be available, and if they once grow accustomed to treat these as friends to whom they can appeal for help, you will have done them infinite service and will undoubtedly infuse many with the desire to continue their studies after leaving school. Under our present system school books are cast aside with infinite relief at the earliest possible moment, and the desire for amusement alone remains. Teach history, geography, and much besides from the daily papers, and so prepare them to read the papers with intelligence and interest, and to prefer them to penny dreadfuls and the miserable, often indecent, illustrated rubbish with which we are nowadays so terribly afflicted. At the same time make it clear to them that the editorial "we" is but an "I," and that assertion does not constitute proof. If such be your teaching, and it have constant reference to things natural, you will also—as Herbert Spencer points out in a very remarkable passage—without fail be giving much *religious* culture, using the word in its highest acceptation, for, as he says, "it is the refusal to study the surrounding creation that is irreligious." As I have already said, one great—indeed the great—object of our teaching is the formation of character: and if you teach your pupils to be careful, exact, and observant, and they become trustworthy workers, you are giving much training of the highest excellence; and if they have enjoyed such training, what does it matter what facts they know when they leave school?

In the course that you are about to attend under Mr. Heller—the demonstrator upon whom has fallen the mantle previously worn by Mr. Gordon, and who is equally desirous of promoting and devising rational methods of teaching—you will in the first place devote your attention to exercises in measurement, including much that is ordinarily taught under mechanics and physics, the prime object of which is to teach accuracy of observation. You will then study a series of problems, mainly chemical, which have been arranged chiefly in order to cultivate reasoning powers and to teach the research method. In fact, what we want to do is, as far as possible, to put every scholar in the position of the discoverer. The world always has and ever will advance through discovery; discoveries, however, are rarely made accidentally—indeed, we all pass from ignorance to knowledge by discovery, and by discovering how to do things that we have not done before we ever increase our powers of usefulness: we all require, therefore, to be taught how to discover, although we may never be called on to make original discoveries or have the opportunity. But as you proceed I trust that you will realize that the method which you are learning to apply is one which can be made use of in all your work—that the course has a broad educational value far transcending its special value as an introduction to physical science.

Lastly, I should like to take this opportunity of calling attention to the very great value to girls, as well as to boys, of teaching such as you are about to give. I fear that much that girls are being taught under the guise of domestic economy is of slight value educationally or otherwise, and that they are but having imparted to them little tidbits of information which they are as likely as not to misapply. Nothing is done by way of increasing their intelligence and forming their characters. Lessons which would lead them to be observant, thoughtful, and, above all, exact—lessons in method—would be of far higher and abiding value. They would then carry out their household functions with greater ease; there would be far less waste; less unhealthiness; far more comfort. I believe the need for such training to be indeed far greater in the case of girls than in that of boys. Boys are naturally apt in many ways, and, even if neglected at school, perforce develop when they go out into the world; but girls are of a different disposition, and rarely seem to spontaneously acquire the mental habits which a training in scientific method can confer, the possession of which would be of inestimable value to them. Extraordinarily little has been done as yet on their behalf, and they have been cruelly sacrificed at examinations—for which, unfortunately, they appear themselves to have an insatiable natural appetite. It is to be hoped that the new board will give the most serious attention to this matter, and that it will take steps to secure the teaching of scientific method in all the schools under its charge, whether boys' schools or girls' schools. Unhealthy buildings have attracted much attention; but the existence of a far more serious evil—the absence of healthy teaching suited to the times—has not even been noticed.

THE MOTHER AS A POWER FOR WOMAN'S ADVANCEMENT.

By Mrs. BURTON SMITH.

THERE are still thoughtful, liberal-minded men and women who persistingly declare that there should be no woman question; that women have now all the rights and opportunities which should be theirs, and that a just appreciation of what they have already would leave no time nor desire for further demands. There is a great deal of truth and justice in this position, as there is generally in any honest view of any really serious question; but the unalterable fact remains that there is a woman question, and that a discussion which has had the earnest attention and advocacy of so many high-minded, well-balanced men and women must have had its origin in the real needs of some portion of humanity. Surely, no matter what the point of view, the cause of woman's advancement on the best and broadest lines, whatever may be its highest expression to the individual, will have at least sympathy from every thoughtful human being. In this cause, with all its wide-reaching consequences, in all its breadth and fullness, motherhood has just now a peculiar call for effort.

In all great questions which set the world thinking and listening, which touch men's hearts and stir their brains, there is a necessary tendency to extremes. The very force of conviction and power of feeling which go to make the prophets and leaders, carry them away from lines of moderation. But when thought and agitation have developed into real activity, conservatism, as much as enthusiasm, is needed in any movement for reform.

Just at present the woman question is a most convincing illustration of these truths. The ardor of each side has carried its advocates to extremes, which have probably never been equaled in sociological discussion. There are women who affirm that there is no intellectual, social, or professional advancement for woman except as she asserts her independence of man, and arrays herself against him as the enemy of her sex; there are others who declare all marriage slavery, all married life under the existing state of things mere bondage. Such women are as far from the truth as the novelist who has recently attempted to illustrate in her heroine the "soul-destroying" influences of the higher education for women; or the woman who declares, "With the new school of thought, and the new class of woman it has bred, we have lost both the grace and the sweetness, both the delicacy and the virtues, of the real womanly ideal." Such rash generalizing on either side simply balances against rash generalizing on the other; and the result, as far as their power is concerned, is a standstill, frequently followed by positive retrogression. Those whose work or sympathy might otherwise be enlisted in some branch of woman's development, simply look on such extravagances with amusement or pity, and await the next edition of feminine fantastics. A little more conservatism is needed to tip the balance in favor of sure and steady progress. There is no longer need for the agitator, when the question, in its different phases, is being discussed in legislative halls and by the fireside, by thoughtful men and women the world over; but there is great need for the conservative moderator, and in just that capacity should the mothers of the land make their power felt. They occupy a position, by its very nature, powerful beyond the possibilities of any other position on earth—powerful with God-given rights, which admit of no question and need no acknowledgment. They are burdened with responsibility, it is true, but any responsibility rightly met is a power in itself. There is no class of women who stand upon such vantage ground, who can so well exemplify all that is essentially feminine, and at the same time demand, by their rights and responsibilities, any outside aid, whether it be of higher education or suffrage, or whatever it be. There is no class of women who know so well the delights of all the dear feminine prerogatives, the power of those exquisite qualities, grace, delicacy, and sweetness, and at the same time who feel more deeply the need of any and all means of enlightenment and advancement. There are no women better fitted to temper the present discussion; none who can better offer sympathy, yet counsel moderation, to those restless sisters whose demands so often grow out of bitter personal experience and too often rise to a discordant clamor. Of course, this view has been of mothers as a class. There are, alas! pitiful exceptions—women who do not admit the responsibilities of motherhood, and women who dare not demand the rights which motherhood gives them. Such women present problems which can not be dealt with here. Certainly these remarks may apply to every mother who will exercise a certain just self-appreciation, who will devote a little time and attention to the consideration of this question, and her own duties and responsibilities in relation to it. Is it not possible for such women to show that womanliness does not mean weakness—that the very life of all lives the most womanly needs for its right living not goodness only, but wisdom, knowledge, and freedom? On the other hand, ought they not to demonstrate that in this womanliness essentially, in the clinging to it and emphasizing it, they will gain a peculiar power which nothing else can give? It is surely a strength and freedom, not to be left behind in the march onward to new strength and new freedom. It is a quality which must be cultivated and emphasized in this "new era." It is an emotional superiority, a God-given essence, which we can not afford to lose, in our new grasp upon the intellectual forces within us. If every intelligent mother in this land could bring herself to an accurate realization of these truths—a realization of the power for broad yet conservative advancement which lies merely in her position in the plan of society—what an immediate uplifting of womankind there would be! And beyond this, too, reaching away off into the future, is the influence she exerts upon her children, and through them upon an ever-widening circle. She has great power for good in this never-ending, ever-expanding influence, which must go out to the world from her, through her children, as well as in the strong and right expression of her individuality.

Mutual understanding and sympathy, both so potent in the relation of parent and child, must be established before the woman, as mother, can, through her children, do her part in this progressive age. With that much accomplished (it is the first step, a difficult but a necessary one), let us, then, in our strength, as mothers, push on to this important expression of our work for woman's advancement—the emancipation of our daughters from the slavery of half-developed bodies and unhealthful clothing. There exists to-day a painfully small number of women who have the physical endurance necessary for the right living of any life, whether domestic or professional. All women who have felt the hampering influence of weak bodies would cry out if it would help them, "Give us strong backs and good circulation, and we can do the rest ourselves." Whatever life we contemplate for our girls, whether in college halls or kitchen—whether as lawyers, teachers, doctors, or mothers—in every work, they need physical endurance, and with us, their mothers, rest the opportunity and ability to give them great help or hindrance. It is indisputable that a good circulation and fine digestion have much to do with a normal, healthful, mental development; and no one will deny that a well-developed body, with all its possibilities of symmetry and beauty, with all its suggestions of noble appropriateness, can, and frequently does, have a material effect on the character. The buoyancy, the feeling of mastery over all problems, the exaltation mental and spiritual, which come with perfect health, are not only helps but inspirations in any work. And even if we can not attain perfection, is not an approximation worth striving for? It is a rare case where the watchful care of a mother can not do much, by prenatal as well as postnatal influence, to counteract inherited weakness, cultivate desirable qualities, and bring her child to a full fruition of its physical possibilities. This branch of the mother's work, including as it does the development of a just appreciation of what is appropriate and healthful in dress, deserves separate and careful consideration. It is only possible here to outline those powers for the good of humanity, and of womankind especially, which have always belonged to the mother, and to emphasize the necessity for her use of them just now, when there seems to be a call which she is peculiarly fitted to answer.

Following upon a fine physical development, which is the first object to be obtained, we may expect a truer and more natural expression of tastes and tendencies, and just in that expression we must look for our guide posts and follow to some extent certainly, in the education of our daughters, the roads toward which they point. To repress all evil inclinations, whether inherited or acquired, is an accepted duty to both sons and daughters; but the careful study of capabilities, the consideration and cultivation of special talents, are privileges accorded, as a rule, only to our sons. There is no work which can not be better done with education and special cultivation than without it; and in woman's work especially, from cooking, all through the literary and professional scale, up to motherhood, the greatest and most important work of all, there is necessity for the high development—for the information, skill, discernment, and wisdom — which such advantages bring. With the possible responsibilities of the suffrage, too, either open to women as a privilege or thrust upon them as a duty —according to the individual view of the matter—the daughters of to-day have need of an education not only thorough in its details but broad in its scope. Mrs. Elaine Goodale Eastman wrote recently of a young woman who had attained " real distinction in the sciences." In writing a letter to a friend on the birth of a child, this exponent of the higher education for women uses these significant words: " Your letter brings news which never fails to thrill me. I am sure that any woman would rather hold her own child in her arms than attain to any degree of eminence in science or learning." So long as such an expression of the poet's ideal of woman can come from one who has attained " real distinction in the sciences," we need not fear the consequences of a higher intellectual development for women. The danger lies elsewhere in the derision brought upon the advancement of women by the extravagancies of some unwise enthusiasts, and in the encouragement of a spirit of antagonism between man and woman—a spirit contrary to all the laws of God, and death to the best development of mankind. This last danger was forcibly illustrated in a recent magazine article which demanded that every father should share with the mother the responsibility of the mental and physical training of his children, and entitled Modern Woman *versus* Modern Man—a most excellent subject, the very central thought of which proves the necessity for *working together*. It was well developed too; but oh! the spirit indicated by that title. That the mother, as a member of society and the guide of future generations, can do more than any other woman to meet these dangers and counteract them, is the conviction which I believe will be born of a just valuation of her powers. In considering the growth of opportunity for women, it is natural that we should give special attention to the needs of our daughters and to the development of which they are capable. But our sons are no less important "seed fields." Even viewing woman's higher development as it affects herself individually, there is need for an influence upon the man of the future, which will awaken in him a spirit of helpful sympathy with the earnest woman who is trying to dignify and broaden her life and work. And considering this increasing earnestness in woman in its wide-reaching effect upon all mankind, it is evident that, without a kindly fellowship and encouragement from men, which will make the working together possible, the future will not bring the great results which are hoped for. Would it not be well to infuse some of this spirit into our sons while their natures are still plastic material?

In writing recently of woman's work, Miss Agnes Repplier said with admirable force, "Now as in the past character is the base upon which all true advancement rests secure," a truth which must commend itself especially to every conscientious mother. It is through a better physical and mental development, it is true, but mainly through them as leading up to a growth in character, that we must look for the best results. If there is to be a "new woman," let us have her by evolution, not revolution.

Let us free our daughters from the unwholesome physical restraints which unnecessary conventionalities would impose, and educate them as *human beings*, with all ordinary possibilities latent, besides those womanly qualities which set them apart. Let us cultivate in them all that is strongest and most forceful, all that is sweetest and best and most womanly; and then, with the realization that neither marriage nor a career is the essential, "the destined end," there will come to them a growth in strength and goodness which will enable them to do any work in life better than they have done it in the past. It is certainly not incredible that such women should be able to counteract every retarding influence, and hand in hand with broad-minded men as husbands, brothers, or co-workers, demonstrate the beauty and strength of united force.

Is it too much to hope that in the near future there will arise in the minds and hearts of mothers a whole army of thoughts and inspirations with which they may do battle for that high development, that noble expansion, which we are pleased to call "the advancement of woman"?

WELLNER'S SAIL-WHEEL FLYING MACHINE.

By Miss HELENE BONFORT.

ONE of the latest and most ingenious schemes for solving the problem of aërial navigation is that devised by Prof. G. Wellner, of Brunn, Moravia, who has sought to bring in the application of a new principle. He calls his apparatus the "sail-wheel flying machine" (*Segelrad-Flugmaschine*), and regards the mechanism of it as a kind of cross between those of the screw-propeller and of the kite, combining the advantages and avoiding the inconveniences of both. His system has won approval and confidence from eminent engineers and experts in aërial navigation to such an extent that the Vienna Association of Engineers and Architects is having experiments and observations made which will show very soon the degree of practicability and value possessed by his invention.

In his paper on the subject, Prof. Wellner describes his line of thought and the result of his researches, prefacing them with a summary of the experiments and investigations of his co-workers.

The oblong form of balloons chosen by Giffard in Paris in 1852, by Dupuy de Lôme in Vincennes in 1872, by Tissandier in 1883, and by Renard and Krebs at Chalais in 1885 for their balloon "La France," conquered to a considerable degree the resistance of the air and thus increased the velocity (Fig. 1). They contained electro-dynamic motors with a galvanic column so admirably suited to the apparatus as to secure the greatest possible power with the least weight. Various improvements made obviated the danger of pitching. The "La France" almost completely fulfilled the condition that the balloon must return to its point of departure; in seven ascents a return was five times made to the starting point, showing that five times a complete control of direction had been gained. A speed of 6·5 metres per second (about fourteen miles per hour) was reached. Efforts have been made by the French military department to double this velocity, making it thirteen metres per second. This would be important, as in aërial navigation direction can be controlled only by velocity. But the weight of the motor required for such great power must constitute a serious embarrassment. Moreover, the pressure of air currents and the resistance of the wind endanger the balloon constructed of light material.

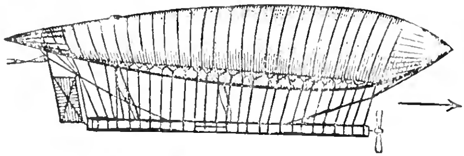

Fig. 1.—Air-ship La France.

These circumstances lead to the conviction that the aëronautic problem will most probably admit of a satisfactory solution only by means of dynamic flying machines. Prof. Wellner is of the opinion that, manifold as are the difficulties besetting the road to this end, it is likely to be attained before the close of our century. The inventor's starting point is the observation and analysis of the flight of insects and birds, which have of late been made possible by the graphic methods of chronometric observation and photography. It would, of course, be a mistake to attempt a close imitation of the organs of motion observed in birds or insects, as these would lose their utility through the unavoidable clumsiness of man's appliances. What must be aimed at is the most advantageous shape and construction of wings, productive of the greatest propelling power with the expenditure of the smallest possible sum of energy; the application of a light but powerful motor; a contrivance for easy and efficient steering, available alike at the time of the ascent, while flying, and in alighting; and arrangements for the prevention of accidents.

It may be regarded as an established fact that gently curved or arched surfaces, pointed toward their ends, make the fittest wings for flying machines; they must be carried against the atmosphere at small angles. The lifting power of the wings arises from the carrying quality of the air compressed and forming, we might say, an air-cushion under the aëroplanes. The air pressure increases in a duplicate ratio to the velocity of the latter; consequently very small wings are capable of great lifting power when vigorously and swiftly plied. In order to advance the air-ship, a power imparting horizontal motion is needed; this has to be secured by a retrograde movement, thrusting the air backward and thus causing it to propel the air-ship. The shape, position, and direction of the aëroplanes will have to be such as to combine the vertical lifting with the horizontal propulsion. The two great distinct groups of air-ships attempting to secure this end are those propelled by screws and those working on the principle of a kite.

The models constructed by Ponton d'Amécourt, Achenbach, Dieuaide, Forlanini, Philipps Popper, Jarolimik, and some others are based on the screw principle. They employ propeller screws moving horizontally on vertical axes and connected with aëroplane surfaces which are capable of inclination between the horizontal and vertical positions like those of a windmill. These aëroplanes pressing down the air act very much like the propeller screw in a ship, which drives the water backward so as to make it move the ship forward. The difficulty inherent to this construction arises from a considerable loss of motive power, caused by the difference in revolving speed of the screw at various points nearer to or remoter from the axis. This difference of speed in the turning of the screw combined with the inevitably small angles at which its slanting surfaces are presented to the wind make it incapable of developing, by the help of any of the dynamo machines now in use, a power adequate to the weight of the machine itself, its accessories, and the aëronauts.

The laws that come into play in the flying of a kite are involved in the flight of birds independent of the movement of their wings. In calm weather the kite is moved forward by the boy, who runs along, drawing the string with him. This movement, creating a wind under the kite, causes the air to gather under its slanting surface, and thus calls into play the lifting power of the atmosphere. The flying machines propelled from the rear by a motor with sufficient velocity, on rising into the air are enabled to soar on the same principle. The stronger the wind, the better the kite will rise; the quicker the horizontal motion of the flying machine, the better its aëroplanes will develop the supporting

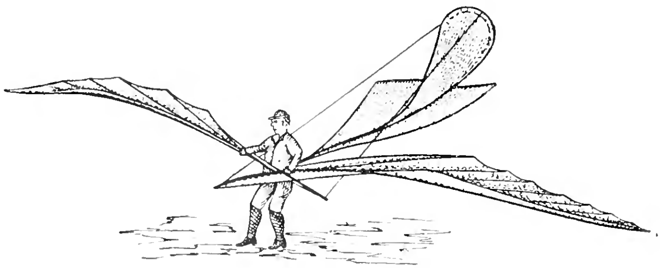

Fig. 2.—Lilienthal's Flying Apparatus. The start.

power of the air. The exertion made by a bird on traveling a long distance is smaller, and its sailing power greater, the faster it flies.

The fastest fliers have the smallest wing surface. Some birds even reduce the area of their supporting surfaces when they increase their speed by drawing in their wings and closing their tails. Consequently, in order to keep the aëroplanes of the flying machine within a moderate size, considerable velocity has to be developed. This at the same time serves to overcome the resistance of the wind and of air currents. The air-ship is not capable of maintaining the direction pursued unless its velocity is so much greater than that of the strongest wind that it can overcome the latter and yet have velocity to spare.

While the construction of the kite machines seems to insure success through the high velocity of movement that must be attained, a new obstacle arises from the difficulty of ascent. The speed of motion being the condition of their rising power, they can not be made to ascend slowly. Once progressing on their road with the tremendous speed adequate to their weight and wing surface, the kite machines can not be stopped or propelled at a lesser rate without at once descending from the level attained. The contrivances applied to counteract these disadvantages have not proved efficient to overcome them. Nevertheless, the experiments and constructions made by Stringfellow, Moy, Tatin, by Kress in Vienna, Lilienthal in Berlin, Koch in Munich, Philipps, Langley, Edison in America, Maxim in England, and by Hargrave in Australia, all represent so many stages of constant progress. Mr. O. Lilienthal has just succeeded in floating down at a moderate rate from a height of two hundred metres; his personal skill in the handling of the apparatus adds considerably to the advantages derived from its judicious construction (Figs. 2, 3, and 4). Some of the most remarkable experiments in the field of aërodynamics are those devised and carried out by Prof. Langley.

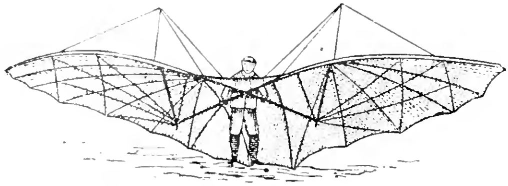

Fig. 3.—Lilienthal's Flying Apparatus. The landing.

The essence of Prof. Wellner's innovation is his invention of the sail-wheel (Fig. 5). It consists of a horizontally placed axis with spokes and arched aëroplanes attached to them in a cylindrical form. While revolving round the axis the latter take a slightly slanting position, which causes the forward edges of these surfaces to be inclined, and consequently to compress the air in the way of a sail or a kite, calling into play the vertical force. Three ribs running across each lifting surface and made in the form of a screw at the same time serve to strengthen the aëroplanes and to add to the horizontal force.

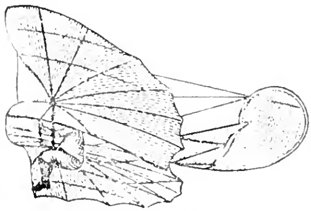

Fig. 4.—Lilienthal's Flying Apparatus. In flight.

These sail-wheels set in pairs can be placed, according to the size of airship aimed at, in one or more groups of two wheels, revolving in opposite directions, behind or beside each other. The cigar-shaped car, furnished with a motor and carrying the aëronauts, is attached horizontally under the center of the wheels, so that the whole construction will resemble a colossal bird, propelled, instead of by wings, by revolving wheels, the lifting surfaces of which are consecutively and constantly developing vertical and horizontal power. The bird's movements in flying and the speedy headway motion necessary to the kite-flying machines for their support in the air are in Prof. Wellner's invention changed to a rotary motion. This construction, while permitting of an easy, slow ascent, assures the horizontal position and constant stability of the air-ship, at the same time permitting of a high velocity. The more the latter is increased, the stronger is the lifting power developed. The direction is given by a rudder at the end of the ship or by increasing the velocity of the sail-wheels on one side only. It is the peculiar quality of these wheels that they do not, as might be supposed, disperse the air around them; they rather attract it toward their rapidly moving surfaces, condensing it to a powerful stream, which passes down obliquely through their cylinders. Their velocity can be made to surpass by far that of railway trains, thus enabling them to conquer contrary winds and air currents. This flying machine

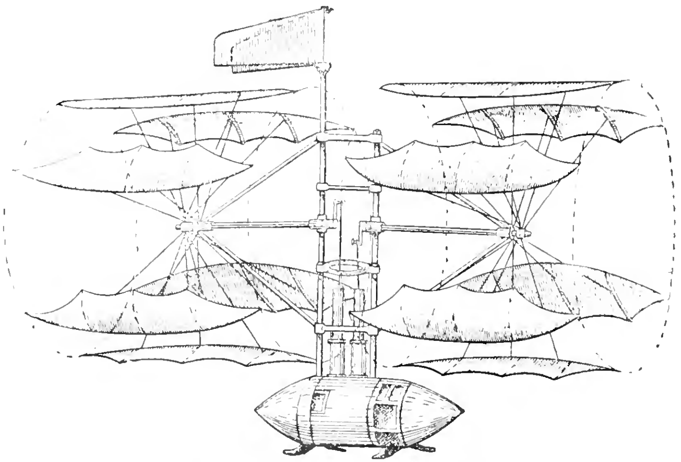

Fig. 5.—Wellner's Sail-wheel Flying Machine for Two Persons.

will hardly be called upon to rise above the cloud region; it will be most efficient to reach its goal on the shortest air line at a moderate height above the earth.

Fig. 5 shows a small sail-wheel air-ship for two aëronauts. Each of the two wheels has a diameter of 4·77 metres and six planes five metres wide. Two steam engines of twenty horse power each are said to produce during one hundred and eighty rotations per minute a velocity of forty-five metres, a soaring speed of fifteen metres per second, and a carrying power of fifteen hundred kilogrammes.

A larger machine (Fig. 6), comprising six sail-wheels of 6·4 metres diameter and a steam motor representing eighty horse power, will, at one hundred and thirty-five rotations, carry sixty-four hundred kilogrammes and accommodate eight persons.

The latest experiments with Prof. Wellner's flying machine do not seem to favor the construction of those air-ships which are intended to rise by the strength of their lifting power only, this power sufficiently outbalancing their weight. Some eminent European aëronauts—Profs. Pistio, Miller, Hauenfels, and Wellner himself—now favor the principle of partial disburdening by the application of some gas or other, which will add to the lifting power of the machine.

Important and very animated discussions of the present aspect of aëronautics have recently taken place in London and in Vienna. In the Aëronautic Section of the British Association Prof. H. Maxim laid before his colleagues a detailed report of the

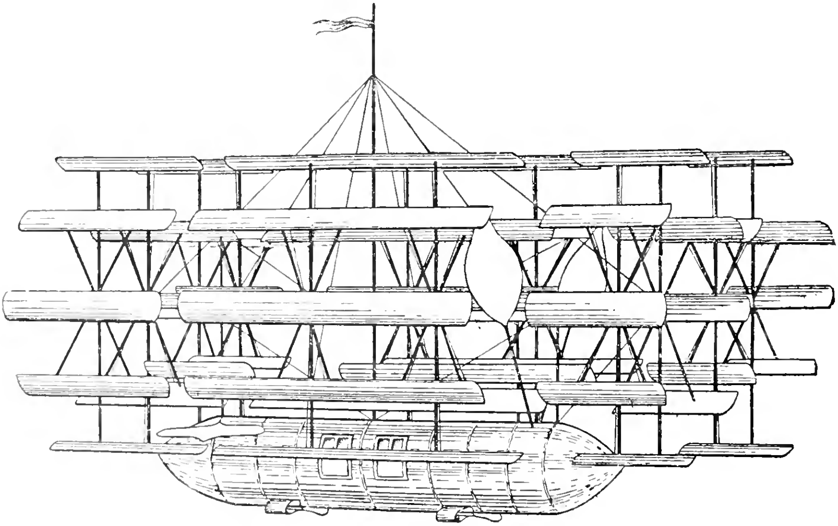

Fig. 6.—Wellner's Sail-wheel Flying Machine for Four Persons.

experiments made with the model which he has had constructed for the purpose, and which, though it has met with an accident and has not led to a definite result so far, has certainly brought the vital question nearer to its solution. Prof. Maxim's apparatus is a wonder of ingenuity. It carries its provision of fuel in the form of naphtha in a small, exceedingly light boiler, so constructed as to cause a constant, unvarying pressure. The machine proved able to rise and fly for thirteen hours at a velocity of more than fifty English miles per hour. Its two large screw-propellers are set in motion by two compound engines, the strongest in proportion to their size that have ever been made. Their construction allows of the power being raised within one minute from two hundred to three hundred and twenty-five pounds per square inch. The screws are capable of more than five hundred rotations per minute. The entire weight of this flying machine and crew is eight thousand pounds and its lifting power ten thousand. Unfortunately, the surplus power of two thousand pounds during the experiment lifted the machine off the rails on which it was running, and broke the rear axletrees that were holding it down, thus wrecking the apparatus. The prominent English physicists, Lord Kelvin, Lord Rayleigh, etc., speak of Maxim's air-ship with the greatest enthusiasm; they expect him actually to solve the problem in a near future. The German scientists, however, at the Sixty-sixth Congress of German Naturalists, which was held in Vienna in September, stated that while Maxim's experiment has certainly brought the problem nearer its solution, it has cost one hundred and fifty thousand dollars, and left the question of steering the air-ship, which is at present the greatest impediment to ultimate success, altogether unimproved. They expressed their hope of seeing the real invention made by a German, after all, although their nation does not command pecuniary means which permit of such costly experimenting as that done by Mr. Maxim, whose apparatus, they say, is in its main traits merely the application of Mr. Kress the German inventor's model, executed in colossal dimensions. Mr. Kress demonstrated before the assembly the capacities of his model, which he constructed some years ago, and was loudly applauded as his machine rose with great speed and landed at the appointed place on one of the galleries. Prof. Ludwig Boltzmann, of the Vienna University, gave a general survey of the latest inventions. He considered as a very important step the work done by the engineer, Mr. Otto Lilienthal, in Berlin. This gentleman, while using a flying machine of the smallest possible dimensions, has made great progress in the art of steering it, partly by the application of a rudder that takes the place of a bird's tail, partly by well-calculated motion of his own body and feet. An extensive practice is likely to produce absolute mastery of this part of the problem. "The aëronaut," said Prof. Maxim in his report before the British Association, "has to excel not as an expert in technique only, but also as an acrobat." This implies the same conception of the task to which Prof. Boltzmann gave utterance when speaking of Mr. Lilienthal's work and its prospects. He added that Mr. Kress has recently constructed an apparatus for steering which is based on new principles and gives fair promise of good results.

Montenegro enjoys a paternal government. Mr. W. H. Cozens-Hardy tells of an officer who, when asked why he had put five men in prison, replied that they had seen after dark a figure dressed in white, sitting on a grave. Ghost stories, he said, were bad for public morals.

BIOLOGICAL WORK IN SECONDARY SCHOOLS.

By ALFRED JAMES McCLATCHIE, A. B.
DEPARTMENT OF BIOLOGY, THROOP POLYTECHNIC, PASADENA.

I SHALL not attempt to go over all the ground covered by the above topic, but shall simple lay special stress upon a few points. I shall put in a plea for genuine, systematic laboratory work upon plants and animals; shall insist that, in studying both, students become familiar with the general structure, physiology, and classification of members of all the main groups from the lowest to the highest; shall urge the necessity of teachers especially trained for the work; and I shall then attempt to point out the training that should result from such a course of study.

It should not be necessary to spend much time in urging the importance of laboratory work in the study of biological subjects. It seems strange that any teacher should ever think of having a pupil spend the precious hours of his school life in studying plants and animals in any other way. But the fact that only a small per cent of our teachers are pursuing the laboratory method makes it imperative that somebody plead in behalf of the students of our public schools. By laboratory work I mean the dissection of plants and animals for the purpose of discovering the facts concerning them, not the verifying of statements made by text-book or teacher. It is a very common mistake on the part of teachers to think they are doing the best they can for their pupils when they themselves bring in or require the pupils to obtain specimens that will illustrate their own or text-book statements. Students should be original investigators, and should be deprived of none of the pleasures connected with original investigation. Only laboratory guides and reference books should be put into their hands. The teacher and laboratory manual should aid pupils in the discovery of truth, but should never rob them of the pleasure of discovering it for themselves when practicable. As F. Mühlberg says: * "Of course, one gets on faster with a child by carrying it, but it is for the child's interest to teach it to run and swim for itself. In the same way it is better not to give young scholars scientific knowledge ready made, but to teach them the way to it. By imparting to them results obtained by others the ideal purpose of instruction is seriously prejudiced, the sense of scientifically accurate thinking is destroyed, the belief in authority is increased instead of checked, and the mind becomes surfeited, instead of finding

* Natural Science in Secondary Schools. Bureau of Education, Washington, D. C., 1882, p. 3.

pleasure in the exercise of its powers." Laboratory work upon any given object should always precede, never follow, the class discussion of it. If it is impossible for the teacher to supervise laboratory work previous to each recitation, then at least three recitation periods of each week should be thus spent, with drawing as a regular part of the work.

In the study of neither plants nor animals should the work be confined to the highest groups. After trying various methods, I am fully satisfied that the plan in general should be to study the simpler forms of life first, and proceed from these to more complex ones, until the highest forms are reached. I find that even young pupils enjoy following Nature's order in the study of living things. To do this to good advantage it is necessary to have the use of at least one good compound microscope; but I take it that most teachers of science are now agreed that to attempt to do biological work without this instrument is not using time to the best advantage. If it is impossible to equip the school for doing biological work in the right way, it is far better that pupils should spend their time upon something from which they can get good discipline. But a properly trained science teacher will not let a school be long in such a condition.

As botany is more generally studied in our secondary schools than zoölogy, and as the method of presenting it is ordinarily so poor, I shall speak of plant study the more fully. It is well known what the usual method is. It is about the same as that which was in vogue when even the oldest of us studied what was called botany. We began in the spring, and learned the names of the different shapes of leaves, stems, roots, and flower parts, with as much seriousness as if this knowledge were really important; then we "analyzed" (as it was called) a few plants, probably pressed and mounted them, heaving a sigh of relief as the name of each was determined and the plant properly ticketed. There was little discipline in such work. The principal aim was to be able to find the scientific names of a few plants. The result to most of those who pursued such a method was a bundle of dried plants and a bundle of still drier facts. To be sure, the statements of the book are often verified or illustrated by specimens brought in by teacher or pupils; but it seems to occur to few instructors that the process ought to be reversed, and the pupils be directed in making a careful study of a plant, in drawing and describing its organs, and then be given the names for these organs.

The study of plants should extend through the year. There is little to prevent this in any State. Prof. Bessey, of the Nebraska State University, says:* "Remember that plants are

* Elementary Botanical Exercises. Lincoln, Neb., 1892, p. 3.

with us all the year. The prevalent custom of assigning the spring term only to botany is a relic of scientific ignorance which should long since have been discarded. All Nature studies should extend through the year." President, Coulter, of Lake Forest University, writes: * "How many who teach botany are laboring under the impression that botany can be taught only while flowers are blooming? Plants are always with us, and are always fit subjects for study; and is not a moss, or a toadstool, or a seaweed as truly a plant as a buttercup? The only difference is that a buttercup is far more difficult to understand than the others, and is not so fit a subject for elementary study. It is ignorance that makes the toadstool seem difficult and the buttercup easy. From my own experience, and from the testimony of others, I know that children make no such distinctions and find no such difficulties, and in this way they follow Nature."

Unless pupils study the lower plants they get no conception of the great scope of the vegetable kingdom and of the development of one group from another. Fortunately, most colleges and universities are abandoning the old, irrational method, and are adopting the more rational one of giving instruction in the lower plants, instead of spending so much time in learning, for example, the different forms of leaves that seem to be able to perform their functions just as well whether they are "elliptico-oblanceolate" or "palmately-plurifoliate." They have been giving instruction in bacteria, the group of plants that is probably of more importance to man than all the rest combined; they have been having their pupils study the rusts, smuts, and mildews that destroy crops, as well as the more beautiful forms that frequent water and are considered offensive by those unacquainted with them. But the secondary schools, not having properly trained teachers, and not being properly equipped with instruments, have in most cases followed the old method. In fact, most teachers of botany suppose the lower forms too difficult for beginners in secondary schools; but in a few the experiment of beginning with these forms has been tried and the practicability of it verified.

Further, unless pupils learn something of the lower forms of plants they always have an erroneous idea of what a plant really is, and how it differs from an animal. I have found, by testing pupils that have studied in the old way, that they always define a plant as something stationary, as composed of roots, stems, and leaves, and as reproducing by seeds—all of which applies to the higher plants only. In short, they have no real knowledge of the science of botany. It is impossible to understand the structure and the reproductive system of the flowering plants unless the

* School Review, March, 1893, p. 143.

lower ones have been previously studied. On this point B. Fink, writing in Science, says: * "I wish to enter a protest against the method of teaching botany still in vogue in certain colleges and high schools; . . . the old plan of a spring term in botany confined to a study of phanerogams, followed by the analysis of from fifty to one hundred plants. This way of studying botany came into use when the microscope was scarcely known among the masses, and when the economic interest of the lower orders of vegetable life was not well understood. . . . Instead of the old plan, I would have all schools during the first term take up the orders, proceeding from the lowest to the highest, and close the work with the leading facts of vegetable physiology. I would divide the time equally between cryptogams, phanerogams, and physiology. This both gives the best foundation on which to build, and is the most essential knowledge for the student who can not give more time to the subject." President Coulter gives as his opinion the following: † "It is more satisfactory and scientific to begin with the study of the simplest forms, not merely because they are far easier to understand, but also because this order of study will give some notion of the evolution of the plant kingdom. The many advantages of this order of study—advantages which have been seen in much experience—should outweigh any supposed advantage in beginning with the study of the most complex plants. In my own experience both methods have been tried, and in beginning with flowering plants and then afterward approaching them from the lower forms, I have invariably found that previous wrong conceptions of the higher forms had to be corrected. I thoroughly believe that no proper notion of higher groups can be obtained without previous study of the lower ones." Prof. Campbell, of Stanford University, advocates strongly following Nature's order in plant study, of which fact his excellent text-book is the best evidence. In response to inquiry on this point, he writes: "I have never had any serious trouble, even with quite young students, in beginning with the protophytes. One advantage in beginning with microscopic work is that it requires an amount of concentration upon a single object that is very valuable in forcing the student to observe accurately, especially when he is obliged to draw carefully what he has seen."

Plant physiology ought to receive more attention than it now does. To study the structure of an organ without considering its use is of little value. In fact, the chief object of morphological work should be to furnish a basis for physiological and systematic work. Enough time should be spent upon classification to

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* Science, October 20, 1893, p. 217.

† School Review, March, 1893, p. 148.

enable students to become familiar with the limits and characteristics of the main vegetable groups. To know how to determine the scientific name of a plant is also useful, but is of secondary importance.

It may be objected that the teachers now in our secondary schools are not sufficiently trained to carry on this work properly. Better give no instruction in it at all, then. But this need not be the condition. If all our boards of education fully realized the need of special training in this line, and were not, in many cases, so lamentably corrupt; and if vacancies were always filled by the deserving, instead of those who have a "pull," we would have plenty of teachers in our secondary schools in sympathy with and abundantly prepared for this work. Our universities and other higher institutions are sending out plenty of well-trained science teachers, who stand ready to supply any demand for their services. As to the training that science teachers should have, F. Mühlberg * expresses the opinion that "the teacher of natural science ought to have the necessary special scientific schooling for that purpose. In no department of instruction is it less permissible to teach authoritatively than in this, and to make it a subordinate branch for a teacher not specially prepared for it is often worse than to provide no scientific instruction whatever; the teacher must not only be master of the material he teaches, but ought also to be a model of the intellectual training he tries to impart; he should have the capacity to observe, describe, and reason accurately about the material of study. In order to give his instruction in such a way as to incite his pupils to an interested activity in their studies, it is indispensable for him constantly to try to develop his own intellectual powers further, and continually refresh them by special studies."

But the most important point is yet to be considered, viz., the development that ought to result from pursuing such a course of study.

The first thing that all beginners must learn is to see a thing just as it is. None of us have this power fully developed. We go through life with our eyes only partially open. We do not see things as they really are. The first power that a proper study of plants and animals develops is that of observing accurately. None do this when they begin the work. Usually they see at first only vague generalities. But the best stimulus to seeing accurately comes through expressing what has been seen. This expression should be required of the pupils in three forms: drawing, notes, and oral discussions. This is a very valuable part of

* Natural Science in Secondary Schools. Bureau of Education, Washington, D. C., 1882, p. 6.

the exercise. To be able to express accurately with a pencil point what is observed is a power of inestimable value. However, the power to observe accurately is not necessarily accompanied by the power to express accurately, but the former must precede the latter. No one can draw accurately what he has not seen accurately. And along with this mental development must also go a moral development. Seeing accurately is only seeing the thing as it actually is—that is, seeing the truth; and drawing and describing are only stating the facts, or telling the truth. Here is where the temptations lie. An indolent or careless pupil finds telling the exact truth with his pencil point to be arduous, and is tempted to distort or only partially represent the truth. But accuracy of expression must be a constant drill in truthfulness.

But, along with the seeing and expressing, pupils must be led to think, if the work is to be of much value. What is the relation between this observed fact and that observed fact? What must be the use of this organ? Why is it so constructed? Why why? why? These are questions that should be continually brought before them. This is the shore upon which many are at first stranded. They may see fairly well, they may draw and describe fairly well; but to answer such "whys" is something to which they are not accustomed. However, they launch out little by little, and eventually become bold explorers on the ocean of truth. But besides being able to answer "whys," they should learn to deduce laws from observed facts, and to make predictions as to future processes. Here the power of imagination, that is so important in all school work, must be exercised. Without this power few "whys" can be answered, few deductions made, and no processes predicted. If a pupil can build up in his mind a plant or animal, with or without this or that organ or set of organs, and can then imagine what functions could or could not be performed by his creation, he has a power that will aid him in any work to which the duties of life may call him.

But as yet I have said little concerning the value of the facts learned in pursuing such a course of study. The value of the information gained was formerly the chief reason for studying natural history, as it was called. But now the best educators know that the power to discover truth, to acquire knowledge, is of far greater value than simple possession of knowledge. However, the information obtained from the study is of great value to any one. For example, in studying progressively the structure and use of the organs of the animals below man, they get accurate ideas concerning their own bodies. I make a special effort to have them get correct ideas concerning sexual organs and processes, that subject concerning which there is such a wide spread ignorance and such a lamentable amount of false modesty and reticence on the part of both those who should receive and those who should impart this instruction. The study of the sexual processes in the lower plants furnishes an excellent opportunity to get correct ideas concerning sex. The sum total of the information gained can be greatly increased by the reading that pupils should do after making a thorough study of the object. They can appreciate and remember the illustrations and opinions of others after they have made drawings, written descriptions, and expressed opinions of their own. This is a part of the work that is too frequently omitted. Biological work is often merely a study of types, without sufficient reading to get the connecting facts.

What this work ought to do for its students, then, is to train their powers of observation; to teach them how to discover truth for themselves; to train them in expressing discovered truths in the form of drawings and in written and oral language; to train them in the power of getting thoughts from the writings of other investigators; to lead them to see the beauties and harmonies in Nature, and incidentally to give them information concerning life and life problems that will be ever useful to them in any occupation they may choose.

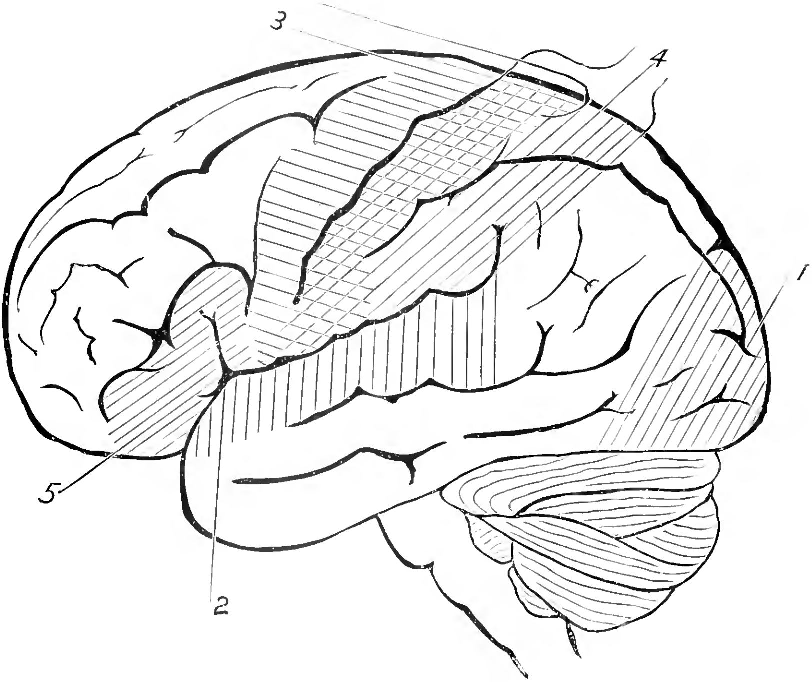
THE "MUTUAL AID SOCIETY" OF THE SENSES.

By Dr. S. MILLINGTON MILLER.

NUMEROUS images have been felicitously employed to illustrate the significance of the human brain. Drummond, in his book on The Ascent of Man, likens it to a great table-land, traversed by many broad highways, studded with mighty cities, broken up into an endless maze of cross-roads and paths, with some mere faint trails. The cities are the originating centers of gray matter; the highways the constantly traversed paths of ordinary thought; the cross-roads and bypaths its correlations; and the trails, the solitary, unfrequented channels of new and original ideas.

A better simile, perhaps, would be to typify the human brain by some rich mine, with numberless operating centers, connected by subterranean, well-worn passages and alleyways. The number and complexity of these is constantly increasing, as new lodes of ore are opened up, and still newer short cuts are daily blasted out for the economical conveniences of transportation and discovery.

"Suppose I want to buy a dynamo, as power for an electric light, or for the movement of machinery," said Dr. Walter E. Fernald (I am clothing his idea with my words), the Superintendent of the Massachusetts State Asylum for Feeble-minded Children, at Waverly, Mass. "Here is one which is cheap, but limited in its possibilities. It can only feed so many lights, or will only give me so much horse power. Here is one larger, perhaps, but not noticeably so, which is warranted to support ten times the circuit, and to develop ten times the gauge of physical motive energy. I examine them closely, and I find the difference of the two to consist in the complexity of their coils of wire. The lesser power dynamo, with fewer volts, has coarser coils and fewer of them; whereas the more powerful developer of energy consists



OUTLINE OF HUMAN BRAIN, SIDE VIEW. (After Ecker.)

1. Area of sight and its memories.
2. Area of hearing and its memories.
3. Area of motion and its memories. } upper one third, leg. middle one third, arm.
4. Area of touch and its memories. } lower one third, face.
5. Area of motor speech-memories

The areas of motion and general sensation coincide to some extent.

of endless and delicate windings and layers of wire." The difference between the normal and idiotic brain is entirely one of complexity.

The central nervous system consists practically of ingoing fibers from the various organs of sense, and of nerve cells for receiving and retaining impressions conveyed by these fibers. By some as yet unexplained power of co-ordination these cells combine these impressions and evolve new combinations of them, which are rendered manifest externally by impulses sent through a set of outgoing fibers to the various organs of motion.

A diagram is here reproduced showing the localized areas of sight, hearing, touch, etc., in the human brain, and their relation to the motor centers. It should be stated, in passing, that these centers are in duplicate, or pairs—one of each on each side of the brain.

The purpose of this article is to show by numerous facts that, when one of the senses is lost by accident, or when it is congenitally absent, the other senses, in persons otherwise normally constituted, become preternaturally keen, and this in a way to compensate in some degree for the loss of power in the disabled or absent sense. It is this that I have ventured to call the "Mutual Aid Society of the Senses."

The historian William H. Prescott, of Boston, who was himself blind, used to say that "the blind man saw little outside of the circle drawn by his extended arms, but that within that circle he saw more than those whose eyes were sound."

In considering my subject I will first narrate a very curious illustration of the strangely wayward, atavistic recurrence of blindness, deafness, and idiocy in collateral branches of an originally tainted stock.

I am indebted to Dr. A. Graham Bell for a very interesting story about a little hamlet in a certain isolated portion of New England. He happened accidentally at one time to come across a gentleman resident in that section who had an immense mass of genealogical statistics (made out on little slips of paper which he kept stuffed in different small bags) covering the family trees not only of his own neighbors, but also of descendants of the old stock now scattered all over New England.

From this unique material, which Dr. Bell has helped to put in usable shape, he became acquainted with the fact that this hamlet was a very peculiar little town, and had been so for twelve generations—ever since its original settlement. Its peculiarity consisted in the fact that one out of every twenty-five of its inhabitants was deaf. Two of the family who were its original settlers had been deaf; and this original leaven of affliction, like the veritable yeast plant itself, had gone on budding and sprouting and ramifying, until at the present day the whole town has a flavor of affliction; and, strange as it may seem, it is not only deafness (and dumbness) from which its quaint inhabitants suffer: some of them are blind, and some are idiotic. Dr. Bell has so many data in his possession that he has not had time as yet to thoroughly digest them all, but they strike him somewhat in this wise. All the way down and through one branch of an originally tainted stock deafness occurs, and disappears and recurs, generation after generation; and in another *collateral* branch blindness pursues the same wayward and yet persistent course; and strangest of all, idiocy itself creeps out here and there. Blindness and deafness are not the children of idiocy, but blindness goes on intensifying its peculiar brain cell and fiber lesion until the whole central shrine of the mind is vitiated and an idiot is born; and deafness grows and grows into a similar vice of the whole nervous system.

All this means that blindness and deafness are ill weeds which thrive apace if left uneradicated by proper specific education, and that, like the fly in the potter's ointment, they in time impeach the entire mental integrity.

The percentage in this town is, therefore, greater than anywhere else as regards its ratio of afflicted persons. They are like Darwin's cats with white fur and blue eyes, who are always deaf.

Miss Camilla E. Teisen, who was formerly employed in Johan Keller's Institution for Feeble-minded Children in Copenhagen, Denmark, and who is now settled down as chief instructress in the Pennsylvania Institute for Feeble-minded Children at Elwyn, Pa., has very kindly answered a number of pertinent questions which I asked her regarding the relative physical condition of the senses in idiots.

Miss Teisen regards the sight and hearing of feeble-minded children as the senses most frequently defective. She thinks sight the most important sense to develop, and that most easily developed. She feels assured of development in other directions as soon as the idea of color dawns upon the child's mind. According to her experience, the development of one sense is accompanied by improvement of the other senses. And yet exceptional cases have presented themselves to her notice where the development of one sense has seemed to leave the other stationary. Miss Teisen has found it impossible to reach the moral sense without a fair development of the physical senses. Improvement of the physical senses has been usually shown to improve the habits and manners. A child that distinguishes sound and appreciates music will not be so likely to howl and scream, and a child that feels the influence of color is far less inclined to tear its clothes.

Miss Teisen makes one statement of unusual interest. She says that many of the children of lowest grade have perfect sight, which their minds can not use. This very striking announcement opens the way to the question as to whether the structure of the image-field of sight, together with both that of afferent and efferent nervous fibers (the carriers to and from the brain) may not in many cases be approximately perfect, and the great and perhaps only desideratum exist in the original centers of apprehension and action—the gray tissue cells of the brain itself.

As a commentary upon Miss Teisen's views, I may add the very interesting statement of Dr. Fernald, that the reason why sound and color give so much pleasure to the feeble-minded is that the simplicity of their brain and nerve fiber requires a greater blow of sense, so to speak, to affect it pleasurably. The idiotic child has the peculiarity (shared with it by Alexander III and the composer Bach) that he is most affected by loud music. In the same way fullness and force of color give the greatest pleasure to his eyes, such as the gorgeous crimson rose, or the serried stalks of full-petaled sunflowers, or huge beds of brilliant feathery chrysanthemums.

Instructors of the blind have always regarded the sense of touch as increased by the loss of sight. The fuller opportunities for close aural attention and thought—concentration, due also to their blindness—have been noted. There is no question but that the blind derive unusual enjoyment from music, and that their chief pleasure is found in listening to it.

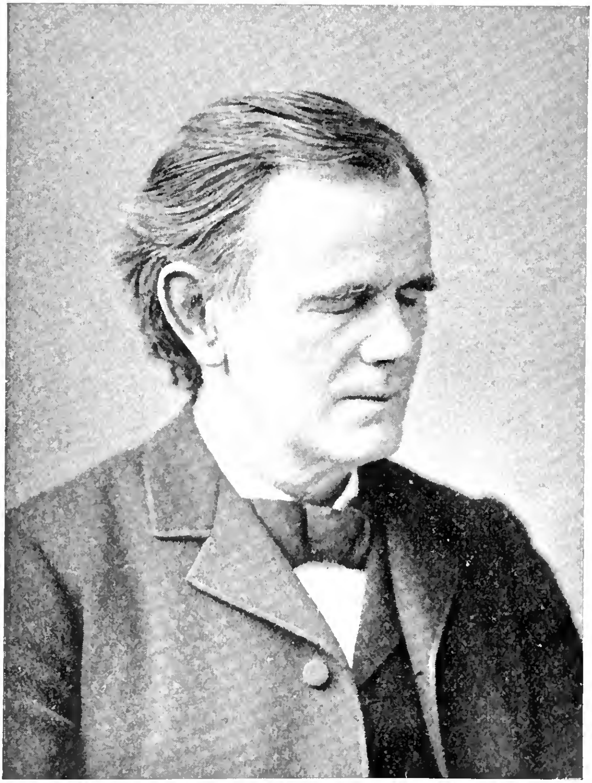
There is an absolutely infinite field open for the improvement of the blind in clay modeling, which is already a main feature of their education. But no school has as yet *pushed* pupils of great promise in this respect with the intent of developing them into Karl Bitters in this wide field.

Given damp clay and a specific object to imitate, blind pupils are enabled by constant digital comparison (and their subtle sense of touch is no mean guide) to turn out in clay a very fair reproduction of their stuffed models. Afterward they model from memory, and without opportunities of comparison.

Henry Tschudi, a boy of seventeen, blind from birth, and educated in the American College of Music, passed his examination in June, 1891, in harmony, counterpoint, the history of music, musical form, terminology, acoustics, and the theory and practice of the organ. It was necessary for candidates to play at command compositions of Bach, Handel, Mendelssohn, and other composers, in polyphonic sonata and free forms; also to transpose, to harmonize a figured bass, improvise upon a given theme, and determine pitch tones by ear. The demonstrative examination at the organ was conducted by three experts, and Mr. Tschudi received 92·80 per cent, being the first blind person to pass the examination.

Another pupil, of whom the New York Institution for the Blind is justly proud, is Mr. Lewis B. Carll, also born blind, who was prepared for Columbia College within its walls. He was graduated from Columbia College in 1870, being a classmate of the now president, Mr. Seth Low, and took second place in a class of thirty. He delivered the class oration. Mr. Carll now lectures at Columbia College twice a week on the Calculus of Variations, and supports himself by giving lessons in mathematics. He lives in New Jersey, and comes to New York every day alone, sometimes going as far as Harlem.

The list which is kept of the occupations followed by pupils after graduation from the New York Institution for the Blind is curious reading. One of the tuners in Steinway's warerooms is



PROF. DAVID D. WOODS.

a graduate, and another graduate was for years organist in Dr. Crosby's church. An insurance broker, a prosperous news vender with three stands, a horse dealer, a tax collector, a real estate agent, a florist, are duly registered. But the most astonishing of all entries are those of a lumberman, a sailor and a cook, and finally a switch-tender.

The Pennsylvania Institute for the Blind, in Philadelphia, points with pride to two very distinguished graduates in the field of music—Mr. David D. Woods (a very excellent likeness of whom is herewith reproduced), the famous blind organist of

St. Stephen's Church in Philadelphia, and Mr. Adam Geibel, composer and organist of the Baptist Temple at Broad and Berks Streets, Philadelphia, and of the John B. Stetson Chapel, at Fourth and Columbia Avenues in the same city.

Prescott the historian and Huber the naturalist were both blind.

The following remarkable instances of deaf persons, many of them congenitally so, who are practicing professions, and depending entirely upon lip-reading for their understanding of conversation, was prepared by a gentleman connected with an institution for the deaf, whose name I am not at liberty to give.

A Columbus paper has published some accounts of the stone-deaf Ohio lawyer, in full practice, who depends absolutely upon lip-reading, and who has tried cases in Columbus courts. For twelve years now, Mr. N. B. Lutes, of Tiffin, Ohio, has depended entirely upon lip-reading to do all that any lawyer does for his clients in court and in every phase of the practice of the law.

The latest issue of the Missouri Deaf-Mute Record gives an account of a lady who reads the lips of ministers and public speakers. Mr. Alexander Hunter, of the United States Land Office, in Washington, D. C., is "deaf as an adder." Though far from perfect in lip-reading, he has read one hundred and fifty words "given out" from the dictionary without making a mistake. He has read the lips of Beecher and Booth almost faultlessly, and has greatly enjoyed pulpit and platform orators and some of the great actors, the chief drawback in reading their lips being the shifting of their positions on the stage, so that their lips were at times invisible.

Mitchell, the chemist, an examiner in the United States Patent Office, graduated from the Clarke Institute, Northampton, Mass., and, though a poor lip-reader, graduated from the Worcester (Mass.) Polytechnic School as an analytical chemist.

For many years a totally deaf man has occupied a place in the United States Civil Service, receiving his first appointment on the strength of admirable papers in the civil-service examination. Notwithstanding his infirmity, thanks to his lip-reading, he took the regular course at a great university, recited with his classmates, attended lectures, and secured his degree. I doubt if president or professors knew that he was a deaf man. Certainly some of his classmates did not know it. For business reasons his deafness is kept secret, and a keen newspaper man went through the office in which he was employed a few years ago in search of a deaf clerk, and failed to find such a man or any one who knew of the existence of such a case in that department.

This, of course, is an extraordinary case, but probably none more so than that of Miss Salter (see Annals of Volta Institute, Volume XXIII, pages 181–185), so far as proficiency in lip-reading is concerned, or, for that matter, for many other reasons. Then there is the case of the English barrister Lowe, the most learned congenital deaf-mute on record. He was a pupil of the first Watson (who taught by the oral method without recourse to signs, but used the two-handed alphabet). The North British Review said of Lowe, "A stranger might exchange several sentences with him before discovering that he is deaf." Dr.

HELEN KELLER AND HER TEACHER.

H. P. Peet said of him (after an interview), "He certainly uses the English language with an exceptional degree of correctness." The Annals gives a glowing account of Lowe's attainments, in Volume XXII, pages 36–40, abridged from an article in Smith's Magazine, but is silent as to his attainments in speech and lip-reading. Dr. H. P. Peet, in his Tour, says his voice was guttural, and single words were intelligible, though his connected speech was hard to understand. Lowe, in addition to being a great and successful barrister at law (studying under the learned chief justice), was a master of many languages—French (modern and old), Latin, Greek (ancient and modern), German, Italian, Spanish, Portuguese, Dutch, Danish, with some knowledge of Gaelic, Irish, Welsh, Swedish, Polish, Russian, Bohemian, Finnish, and had not neglected Hindostani and Sanskrit. He commenced Hebrew in his thirty-fifth year, and afterward constantly read the Old Testament in that language. He was also familiar with various branches of science, architecture, etc. The McLellan brothers, both deaf, are successful Canadian lawyers.

The results of competent oral instruction are simply marvelous, students being shown at the Penn Institute for the Deaf, at Mount Airy, Philadelphia, who can understand and repeat, in a fairly modulated voice, long sentences uttered away from them—i. e., when they are only able to perceive the movements of that corner of the speaker's mouth which is toward them—who can also read fluently from the shadow of speaking lips thrown upon the wall. These visual organs of the deaf are made to do the work of two senses, and attain in time the most extraordinary power and even subtlety of vision. It has with propriety been suggested that such highly developed eyes would be of service in the most delicate astronomical and physical experiments, where instruments of precision are commonly employed. A likeness of Helen Keller and one of her teachers accompanies this article. This girl was congenitally deaf and blind, and has been taught to use articulate speech by the oral system of education now so successfully practiced.

By oral instruction I mean that system which teaches the deaf to communicate with the world at large by means of articulate speech, in contradistinction to the inferior and largely discarded manual-alphabet system, which entirely isolates them as a class from society in general, which does not understand their signs and can not spare time to use the writing pad.

The theory of probability and uniform experience, said Dr. William Harkness, at the American Association, alike show that the limit of accuracy attainable with any instrument is soon reached; and yet we all know the fascination which continually lures us on in our efforts to get better results out of the familiar telescopes and circles which have constituted the standard equipment of observatories for nearly a century. Possibly these instruments may be capable of indicating somewhat smaller quantities than we have hitherto succeeded in measuring with them, but their limit can not be far off, because they already show the disturbing effects of slight inequalities of temperature and other uncontrollable causes. So far as these effects are accidental they eliminate themselves from every long series of observations, but there always remains a residuum of constant error, perhaps quite unsuspected, which gives us no end of trouble.

AN OLD INDUSTRY.

By MARY H. LEONARD.

IN the rich lands along the river banks of South Carolina, particularly in the Peedee section, there could be seen a few years ago an occasional vat or tank, made of the durable cypress timber, and raised high above the ground on wooden posts. Perhaps before the present time the last of these vats has disappeared; yet these recent traces of an old industry tell of a time when the making of indigo was the most important source of wealth of a prosperous colony. For fifty years, extending from a little before the middle of the eighteenth century to its last decade, when the invention of the cotton gin changed the direction of southern enterprise, indigo-making in South Carolina exceeded all other industries in importance.

To-day not an ounce of indigo is prepared for market purposes within the State. The cypress boards of the "beaters" and "steepers" have been converted into other structures. The records of the methods and profits of the industry have been shelved in the archives of the once flourishing Winyaw Indigo Society, whose old hall in Georgetown has been given over to the use of a modern graded school. The wild indigo still grows abundantly in the woods, but its associations are foreign to the thoughts of the present industrial generation.

There are two species of plants native to South Carolina from which indigo for market purposes has sometimes been prepared. The most familiar of these is the *Baptisia tinctoria*, of the order *Leguminosæ*, commonly called "wild indigo," a branching herb with insignificant yellow blossoms and small, bluish-green leaves which blacken in drying. It grows in dry, sandy soil in all the eastern States, and is abundant along the woody roadsides of New England, where it is often picked to put over the heads of horses on the road as a protection against worrying flies.

The other indigo-bearing plant was known as "false indigo" or "bastard indigo." It is the *Amorpha fruticosa*, a shrubby plant, also of the order *Leguminosæ*, but bearing bluish-purple blossoms. A coarse kind of dye was formerly prepared from its young shoots.

In the palmy days of indigo-making the dye generally thought to be of finest quality was obtained from a cultivated plant similar to the "wild indigo"—a native of Hindostan, but introduced into South Carolina from the West Indies. A writer* of the

* This quotation is taken from A Description of South Carolina prepared by Order of Governor Glen, and containing Curious and Interesting Particulars relating to the Civil, Natural, and Commercial History of the Colony within Forty Years (1710-1750).

eighteenth century tells us: "Indigo is of several Sorts. What we have gone mostly upon is the Sort generally cultivated in the Sugar Islands, which requires a high loose Soil, tolerably rich, and is our annual Plant, but the Nilco (i. e., wild) sort which is common in this Country is much more hardy and is perennial. The Stalk dies every year, but it shoots up again next Spring. The Indigo made from it is of as good quality as the other, and it will grow on very indifferent Land, provided it be dry and loose."

Experiments with indigo are noted as early as 1670. The earliest records of the colony contain allusions to "indico" as one of the sources of wealth. After a few years the making of indigo languished for a time. A London writer * of 1682 says: "Indigo they have made, and that good. The reason why they have desisted I can not learn." The industry was revived to some extent in Governor Thomas Smith's administration—the landgrave and wealthy planter who is said to have introduced the rice culture by planting in his garden at Charles-Town a bag of seed rice from Madagascar.

Edisto Island was early given to indigo culture, and the quality of its product became noted. The better soil for the production of indigo led many of the Huguenot immigrants to leave their first home at St. James on the Santee, and settle in St. Stephen's Parish. Yet these early efforts in indigo culture were not a marked success. We are told by an old writer that "all creatures about an indigo plantation are starved, whereas about a rice one, which abounds with provisions for man and beast, they thrive and flourish."

The honor of raising indigo-making to a profitable industry belongs to an enterprising young lady named Eliza Lucas. The story of her efforts is told in Ramsay's History of South Carolina.† George Lucas, the father of Eliza, was Governor of Antigua, in the West Indies, and also the owner of a plantation in South Carolina at Wappoo Cut.

In 1739 the daughter, who had become familiar with the crop and its methods in the West Indies, came to live in South Carolina. Her father often sent to her tropical seeds to be planted for her amusement on the plantation. The fact that a plant similar to the indigo of the West Indies grew spontaneously in the province suggested the adaptedness of the crop to this climate. Accordingly, some seed was sent, which Eliza planted in March,

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* Quotation from A Compleat Discovery of the State of South Carolina, prepared by T. A., Gent, clerk in his Majestic's Ship Richmond, which was sent out in the year 1680 to inquire into the State of that Country by his Majestic's Special Command. To be sold by Mrs. Grover in Pelican Court, Little Britain, 1682.

† See Ramsay's History, vol. ii, p. 138, etc.

1741. It was destroyed by a frost; but in April the experiment was repeated, the second crop being also cut down by a worm. Nothing daunted, the persevering young lady planted for the third time, and the effort proved successful.

When Governor Lucas heard that the plant had seeded and ripened, he sent from Montserrat, at high wages, an indigo-maker, named Cromwell, to show Eliza the process. He built vats on the Wappoo, and made some indigo of indifferent quality. Having repented of his engagement as likely to injure the industry in his own country, he also made a mystery of the process, and tried to deceive by throwing in too much lime. But Eliza, who was watching carefully, detected the deception, and at once engaged a Mr. Deveaux to superintend further attempts at indigo-making.

Not long after these experiments Eliza Lucas married Charles Pinckney, afterward Chief Justice of South Carolina. A generation later, their son—Charles Cotesworth Pinckney—was an illustrious figure in the affairs of the State and nation.

Eliza Lucas brought to her husband as part of her dowry the fruit of her own industry, in the form of all the indigo raised on the plantation. It was saved for seed, and a part was planted the next year on Mr. Pinckney's plantation at Ashepoo. The rest was given to friends, who began making experiments in indigo. Most of these proved successful, and the manufactured product soon became an important article of export.

Miss Lucas, though best known as the introducer of indigo, and the mother of Charles Cotesworth Pinckney, is said to have possessed literary talent as well as executive power. Her letters were afterward privately printed, and one of them, under the title A Love Letter of the Last Century, has been included in Stedman and Hutchinson's Library of American Literature.

The success attending the experiments with imported indigo turned the minds of the people again to the native plants. A Mr. Cattell brought to Mr. Pinckney some of the wild indigo from the woods. Experiments were made, and it was found capable of yielding good indigo, but was less productive than the other. From this time, indigo for home use and for exportation was extensively made from both kinds of plants. Of the women of the Revolution we are told, " Indigo either tame or wild enables them to give a beautiful blue to their homespun."

In 1747 a considerable quantity of indigo was sent to England, which induced the merchants trading to Carolina to petition Parliament for a bounty on Carolina indigo. This petition of the English merchants was followed by another from the planters. Parliament examined the matter, and found that indigo was one of the most beneficial articles of French commerce; that the

West India Islands supplied all the markets of Europe; and that Great Britain alone consumed annually six hundred thousand pounds weight of French indigo, which at five shillings a pound cost England the enormous sum of a hundred and fifty thousand pounds sterling. It was also found that the English West Indies were generally raising sugar cane instead of indigo. Accordingly, in 1748, a bounty was given "of sixpence sterling on all indigo raised in the British-American plantations and imported directly into Great Britain from the place of its growth."

Some years elapsed before the colonists learned the art of making it as well as the French. The planters were blamed by the English merchants for paying too much attention to the quantity and too little to the quality of their indigo, and the West Indian indigo brought a higher price in the market. But each year the skill of the colonists increased, and in process of time they brought indigo-making to such a degree of perfection as not only to supply the mother country but also to undersell the French in several European markets.

In 1748 the amount of indigo exported from South Carolina was 138,118 pounds, which was sold at 2*s.* 6*d.* sterling; in 1754 the export was 216,924 pounds; and shortly before the Revolution it had risen to 1,107,660 pounds.

Various statements regarding the price of indigo are given in the old records. The value varied greatly during the half century of its production. A recent writer * says, "The finest quality of the dye at one time sold in the market for as much as four or five dollars a pound, and fortunes were made rapidly by its cultivation." It is certain that between the years 1763 and 1775, when indigo was at the height of its importance, South Carolina had a most unexampled period of prosperity. Ramsay tells us that "indigo proved more profitable to South Carolina than the mines of Mexico or Peru to Old or New Spain." Wealth poured in upon the people, many of the planters doubling their capital every three or four years. During the years preceding the Revolution † it is said that "a larger number of children were sent to England for education from South Carolina than from any of the colonies, and this on account of the greater wealth of the colony, owing to the superiority of her products—rice and indigo—which gave abundant means."

But the Revolution brought a change in industrial and commercial conditions. During the war more rice was raised than indigo, as was natural. After peace was declared, indigo culture increased again for a little time. But the conditions of trade were different. The English bounty was no longer available.

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* Scott's Random Recollections, etc., 1876.

† See Ramsay's History.

Large importations of indigo soon came to England from the East Indies, which lowered the price, and the palmy days of indigo for South Carolina were gone forever.

As its value declined, other crops took its place. Rice superseded indigo in the coast districts. In North Carolina, where indigo had been extensively raised also, tobacco became the principal export, and was used as a medium of exchange, as indigo had formerly been. But the climax of decline was reached in 1794, when a certain Yankee schoolmaster of Georgia, named Eli Whitney, brought to perfection the saw gin, which relieved the necessity of tedious manual operations in the cleaning of cotton. The value of cotton and of negro labor to cultivate it became suddenly very great. So the reign of indigo passed away; cotton became king, and a new industrial era dawned, leading to tremendous historical consequences in the State and nation.

But although indigo was no longer a staple or article of export, yet during the early part of the nineteenth century it was still produced in small amounts for domestic use. In his Random Recollections of a Long Life, published in 1876, Mr. Edwin J. Scott tells us of the process as he saw it carried on in his boyhood. The plants were immersed in water and the coloring matter extracted. This was allowed to sink by its own weight to the bottom of the vat, when the water was drawn off and the sediment left to harden. He continues: "When broken, the cleavage in good indigo was smooth, and showed a copper-colored tinge. The recipe of a traditional old lady of South Carolina for judging of the quality of indigo is said to have been as follows: 'Take a clean new cedar or cypress piggin; fill it three thirds full with clean spring water; put into it a lump of indigo as big as an egg and if good it will sink or swim, I have forgotten which!'"

But simple as the process sounds in the descriptions of Mr. Scott, the indigo industry was one which involved much risk, and required great skill and untiring attention day and night. Through the whole of the "making season" a periodical change of hands was kept up, except in the case of the "indigo-maker," who, we are told, "could no more leave his post than the captain of a ship on a lee shore."

In his Reminiscences of St. Stephen's Parish,* Mr. Du Bose says: "I have often heard it said that during the manufacturing season Mr. Peter Sinkler [Mr. Du Bose's grandfather, who was an indigo-maker of high reputation] would be three weeks without seeing his wife, though he slept at home every night. He would come home late, when she was asleep, and return to his professional labors before she awoke in the morning."

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* Du Bose's Reminiscences of St. Stephen's Parish, printed in 1852.

The want of success with indigo in the early days was probably owing far more to the imperfect knowledge of the methods of preparation than to the want of the imported seed. It seems to have been usually attempted at first to carry on indigo-making in alternation with other labors.

In an early Description of South Carolina* we read: "One Slave may manage two acres and upwards [of indigo] and raise provisions beside; and have all the Winter Months to saw Lumber and be otherwise employed in."

And again: "I cannot leave this Subject without observing how conveniently and profitably as to the change of Labour both Indigo and Rice may be managed by the same persons: for the Labour attending Indigo being over in the Summer Months, those who are employed in it may afterwards manufacture Rice in the ensuing Part of the Year, when it becomes most laborious; and after doing all this they will have some Time to spare for Sawing Lumber and making Hogshead and other Staves to supply the Sugar Colonies."

In its best days indigo-making was a profession absorbing all the thought of an entire plantation.

An extended list of "Rules and Directions as practiced by an ingenious Person who practiced them with much Success" is given in Dr. Hewit's Historical Account of South Carolina and Georgia.† Another even more explicit description of the processes used is given by Du Bose in his Reminiscences. From these and other sources the following details of methods in vogue among professionals have been compiled:

The ground to be planted was plowed or turned up with hoes some time in December, that the frost might render it rich and mellow. Afterward it was harrowed, cleaned from all roots, grass, etc., well drained, and thoroughly pulverized. After all danger of frost was over—in South Carolina about the beginning of April—the fields were laid off in drills about an inch deep and twelve to fifteen inches apart. In these drills the seeds, mixed with lime and ashes, were sown.

Mr. Hewit tells us: "The next thing to be considered is the choice of seed, in which the planters should be very nice. There is great variety of it, and from every one good indigo may be made, but none answers so well in this colony as the true Gautimala, which if good is a small, oblong black seed, very bright and full, and when rubbed in the hand will appear as if highly polished. A bushel of seed will sow four English acres."

If the season was a fair one, the seeds came up in ten days or

* Same book referred to in the first note of this article.

† Included in Carroll's Historical Collections.

a fortnight, and grew rapidly, requiring nice and frequent hoeing and weeding. The plants were usually cut three or four times in the season. Whenever the plant was in full bloom it required to be cut down without regard to height, as the leaves were then thick and full of juice.

The plants were cut with a reaping hook and carried to the macerating vat, also called the "steeper." This, as well as a second vat called the "beater," was "made of the best cypress or yellow-pine planks, well fastened to the joints and studs by spikes and then calked."

When the steeper was furnished with a sufficient quantity of weed, clean water was poured in, and the weeds were left to steep or macerate until all the coloring matter was extracted. The weed was laid regularly in the steeper with the stalk upward, and upon it long rods were fastened lengthwise in the vat to prevent its buoying up when the water was pumped in. Soft water was needed for the purpose, and the quantity must be just enough to cover all the weed. This process of "steeping" or fermentation usually took from twelve to fifteen hours.

The fluid was then drawn off into the beater, where it was agitated violently until all the coloring matter was united in a body. The usual contrivance for this purpose consisted of an axle, to which were attached long arms, each furnished with a small bucket at the end. The laborer would place himself upon the vat, and work the axle with a handle or crank, causing the buckets to rise and fall rapidly in the liquid. This process of "beating" required great nicety, for if not continued long enough a part of the tingeing matter remained in the water; if continued too long, a part of that which had separated was dissolved afresh.

Du Bose tells us: "I can well remember how often in the process the liquor was taken up in a plate and anxiously examined in the rays of the sun to ascertain whether all the particles of dye were separated; for if not, the result would be a failure; the bright true-blue color would not be obtained, and the value of the drug would be impaired."

Lime was then applied, which assisted in the separation of the water from the indigo. The whole was allowed to rest eight or ten hours, until the blue matter had thoroughly settled. The clean water was then drawn off by cocks in the sides, at different heights, and the blue part was discharged by a cock in the bottom into another vat. It was strained through a horsehair sieve, and afterward put into bags "made of osnaburgs, eighteen inches long and twelve inches wide," and suspended for six hours to drain. After this, the mouths of the bags being well fastened, they were put into a press to complete the removal of the water.

The indigo had now become a fine stiff paste which was cut into pieces about two inches square and laid out to dry. The drying house was made of logs so arranged as to allow free access of air without exposure to the sun, "which was very pernicious to the dye"; as indigo, if placed in the sun, "in a few hours would be burnt up to a perfect cinder." While in the drying house the indigo was carefully turned three or four times a day to prevent it from "rotting." Care was also taken to keep away flies, since "at this season of the year they are hatched in millions and infect an indigo plantation like a plague." Care was also necessary that the indigo should be sufficiently dry before being packed, lest after it was headed up in barrels it should "sweat" and so become spoiled for the market. In packing the indigo the lumps were brushed to make them look as bright as possible.

While the indigo was curing it had an offensive smell, and we read that "as the dregs of the weed are full of salts and make excellent manure they should be immediately buried underground when brought out of the 'steeper.'"

The season for making indigo in Carolina ended with the beginning of frosty weather, and the planters brought their indigo to market about the end of the year. The merchants judged of its quality by breaking it and observing the closeness of the grain and the brilliant copper or violet-blue color. The weight also showed the quality, for heavy indigo of every color was always bad. Fire afforded another test, as good indigo was almost entirely consumed, but the bad would leave a quantity of ashes.

Probably these numerous details in the process were abbreviated by many of the indigo-makers. But there were many grades of professional reputation among indigo planters, dependent on the nicety of their work.

In addition to the risks attending the manufacture of indigo, there were others connected with the growth of the crop. Du Bose writes: "The great enemy of the crop was the grasshopper, which would sometimes destroy the crop in a few days. The best remedy against this enemy was chickens. I recollect that my father was in the habit every year of sending into the swamp fields several hundred chickens. Movable coops were furnished for their accommodation by night, but no food. Nor did they require any so long as the grasshopper infested the fields. Those who could not use chickens suffered the margins of their fields to grow up to grass. The grasshoppers, driven from the fields with whipping brushes, would alight in the grass, which was then fired."

The indigo for exportation was brought into Charles-Town in wagons, and the owners received the proceeds in the form of Spanish silver coin, which composed almost the entire currency before the Bank of the State was established in 1812. It was a clumsy and inconvenient medium of exchange for large amounts. We read that "the merchants of North Carolina and other distant points used to carry the money in boxes fitting under the seats of the 'sulkies' in which they traveled, so as to be taken out at night and put back in the morning."

The indigo itself was often used directly as a medium of purchase for other commodities. General Harrington at one time sent three four-horse wagonloads of indigo to Virginia, buying in exchange from fifteen to twenty negroes.

An interesting illustration of this use of indigo is connected with General Francis Marion. The incident occurred in 1783, just after the battle of Hobkirk Hill. A nephew of General Marion was to be sent to school in Philadelphia, and was accordingly fitted out with a wagonload of indigo which was to pay for his tuition and other school expenses. As the British then held possession, General Marion wrote * to Lord Balfour in command in Charles-Town, asking a permit for the boy to pass through the British lines. General Marion's letter was sent by Balfour to Rawdon and was afterward countersigned by Cornwallis. The youth with his wagonload of indigo was allowed to proceed by the Charlotte route toward Philadelphia, but unfortunately he died before reaching his destination.

The history of the indigo industry would not be complete without a description of the old Winyaw Indigo Society of Georgetown. This society, named from the tribe of Indians who once occupied this part of the State, was originally a social club formed in 1740 by the planters of the Georgetown district. It met once a month to discuss the latest news from London, and also certain agricultural questions. The society was not incorporated until some years later, and then took the name "Winyaw Indigo Society," having in view the improvement of the indigo industry, and also certain educational aims.

The annual fees of the members were paid in indigo, and, as the expenses were light there had accumulated in 1753 a sum which seemed to require some special application. The president proposed that the surplus fund should be devoted to the establishment of a charity school for the poor. Ramsay tells us, nearly fifty years later: "The object of this society is now wholly confined to the education of orphan children. Since its commencement there have been educated and supported by its bounty between one hundred and two hundred children. From the continual accession of new members the funds are in a flourishing condition and enable the society to educate twenty children annually." The

* This interesting letter of General Marion's is now in the possession of Mr. Richardson, of Sumter, S. C.

school had a growing reputation, and afterward enlarged the sphere of its benefits. It was for many years one of the chief schools in the eastern part of the State, and was resorted to by all classes.

The society * also accumulated a valuable library, which was added to and maintained until destroyed by the Federal troops on the occupation of Georgetown during the civil war. Also during the war the school itself was discontinued.

The Winyaw Indigo Society still exists in Georgetown as a social club, but has no connection with indigo except in name. The old hall of the society is now occupied by the public graded schools of Georgetown.

Thus a new social and industrial order has established itself upon the old. The children of these schools to-day know nothing of indigo. The process of its manufacture, once so important, is now forgotten. But to the traveler through the country the branching herbs of the wayside with their bluish-green leaves are eloquent with the memories of an era long past, and of a forgotten industry whose records are hidden away within the pages of a few obscure old volumes.

THE SCIENTIFIC WORK OF TYNDALL.

By the Right Hon. LORD RAYLEIGH, F. R. S., etc.,
PROFESSOR OF NATURAL PHILOSOPHY, ROYAL INSTITUTION OF GREAT BRITAIN.

IT is fitting that the present season should not pass without a reference on these evenings to the work of him whose tragic death a few months since was felt as a personal grief and loss by every member of the Royal Institution. With much diffidence I have undertaken the task to-night, wishing that it had fallen to one better qualified by long and intimate acquaintance to do justice to the theme. For Tyndall was a personality of exceeding interest. He exercised an often magical charm upon those with whom he was closely associated, but when his opposition was aroused he showed himself a keen controversialist. My subject of to-night is but half the story.

Even the strictest devotion of the time at my disposal to a survey of the scientific work of Tyndall will not allow of more than a very imperfect and fragmentary treatment. During his thirty

* An account of the Winyaw Indigo Society, and the school established by it, is given in a Paper on Colonial Education in South Carolina, read before the South Carolina Historical Society, August 6, 1883, by Edward McCrady, Jr., and afterward published in vol. iv of the Collections of the Historical Society of South Carolina.

years of labor within these walls he ranged over a vast field, and accumulated results of a very varied character, important not only to the cultivators of the physical sciences, but also to the biologist. All that I can hope to do is to bring back to your recollection the more salient points of his work, and to illustrate them where possible by experiments of his own devising.

In looking through the catalogue of scientific papers issued by the Royal Society, one of the first entries under the name of Tyndall relates to a matter comparatively simple, but still of some interest. It has been noticed that when a jet of liquid is allowed to play into a receiving vessel, a good deal of air is sometimes carried down with it, while at other times this does not happen. The matter was examined experimentally by Tyndall, and he found that it was closely connected with the peculiar transformation undergone by a jet of liquid which had been previously investigated by Savart. A jet as it issues from the nozzle is at first cylindrical, but after a time it becomes what the physiologists call *varicose;* it swells in some places and contracts in others. This effect becomes more exaggerated as the jet descends, until the swellings separate into distinct drops, which follow one another in single file. Savart showed that under the influence of vibration the resolution into drops takes place more rapidly, so that the place of resolution travels up closer to the nozzle.

Tyndall's observation was that the carrying down of air required a jet already resolved into drops when it strikes the liquid. I hope to be able to show you the experiment by projection upon the screen. At the present moment the jet is striking the water in the tank previons to resolution into drops, and is therefore carrying down no air. If I operate on the nozzle with a vibrating tuning fork, the resolution occurs earlier, and the drops now carry down with them a considerable quantity of air.

Among the earlier of Tyndall's papers are some relating to ice, a subject which attracted him much, probably from his mountaineering experiences. About the time of which I am speaking Faraday made interesting observations upon a peculiar behavior of ice, afterward called by the name of regelation. He found that if two pieces of ice were brought into contact they stuck or froze together. The pressure required to produce this effect need not be more than exceedingly small. Tyndall found that if fragments of ice are squeezed they pack themselves into a continuous mass. We have here some small ice in a mold, where it can be subjected to a powerful squeeze. The ice under this operation will be regelated, and a mass obtained which may appear almost transparent, and as if it had never been fractured at all. The flow of glaciers has been attributed to this action, the fractures which the stresses produce being mended again by regelation. I should say, perhaps, that the question of glacier motion presents difficulties not yet wholly explained. There can be no doubt, however, that regelation plays an important part.

Another question treated by Tyndall is the manner in which ice first begins to melt under the action of a beam of light passing into it from an electric lamp. Ice usually melts by conducted heat, which reaches first the outside layers. But if we employ a beam from an electric lamp, the heat will reach the ice not only outside but internally, and the melting will begin at certain points in the interior. Here we have a slab of ice which we project upon the screen. We see that the melting begins at certain points, which develop a crystallized appearance resembling flowers. They are points in the interior of the ice, not upon the surface. Tyndall found that when the ice gives way at these internal points there is a formation of apparently empty space. He carefully melted under water such a piece of ice, and found that when the cavity was melted out there was no escape of air, proving that the cavity was really vacuous.

Various speculations have been made as to the cause of this internal melting at definite points, but here again I am not sure if the difficulty has been altogether removed. One point of importance brought out by Tyndall relates to the plane of the flowers. It is parallel to the direction in which the ice originally froze—that is, parallel to the original surface of the water from which it was formed.

I must not dwell further upon isolated questions, however interesting, but will pass on at once to our main subject, which may be divided into three distinct parts, relating namely to heat, especially dark radiation, sound, and the behavior of small particles, such as compose dust, whether of living or dead matter.

The earlier publications of Tyndall on the subject of heat are for the most part embodied in his work entitled Heat as a Mode of Motion. This book has fascinated many readers. I could name more than one now distinguished physicist who drew his first scientific nutriment from it. At the time of its appearance the law of the equivalence of heat and work was quite recently established by the labors of Mayer and Joule, and had taken firm hold of the minds of scientific men; and a great part of Tyndall's book may be considered to be inspired by and founded upon this first law of thermodynamics. At the time of publication of Joule's labors, however, there seems to have been a considerable body of hostile opinion, favorable to the now obsolete notion that heat is a distinct entity called caloric. Looking back, it is a little difficult to find out who were responsible for this reception of the theory of caloric. Perhaps it was rather the popular writers of the time than the first scientific authorities. A scientific worker, especially if he devotes himself to original work, has not time to examine for himself all questions, even those relating to his own department, but must take something on trust from others whom he regards as authorities. One might say that a knowledge of science, like a knowledge of law, consists in knowing where to look for it. But even this kind of knowledge is not always easy to obtain. It is only by experience that one can find out who are most entitled to confidence. It is difficult now to understand the hesitation that was shown in fully accepting the doctrine that heat is a mode of motion, for all the great authorities, especially in England, seem to have favored it. Not to mention Newton and Cavendish, we have Rumford making almost conclusive experiments in its support, Davy accepting it, and Young, who was hardly ever wrong, speaking of the antagonistic theory almost with contempt. On the Continent perhaps, and especially among the French school of chemists and physicists, caloric had more influential support.

As has been said, a great part, though not the whole, of Tyndall's work was devoted to the new doctrine. Much relates to other matters, such as radiant heat. Objection has been taken to this phrase, not altogether without reason; for it may be said that when heat it is not radiant, and while radiant it is not heat. The term dark radiation, or dark radiance as Newcombe calls it, is preferable, and was often used by Tyndall. If we analyze, as Newton did, the components of light, we find that only certain parts are visible. The invisible parts produce, however, as great, or greater, effects in other ways than do the visible parts. The heating effect, for example, is vastly greater in the invisible region than in the visible. One of the experiments that Tyndall devised in order to illustrate this fact I hope now to repeat. He found that it was possible by means of a solution of iodine in bisulphide of carbon to isolate the invisible rays. This solution is opaque to light; even the sun could not be seen through it; but it is very fairly transparent to the invisible ultra-red radiation. By means of a concave reflector I concentrate the rays from an arc lamp. In their path is inserted the opaque solution, but in the focus of invisible radiation the heat developed is sufficient to cause the inflammation of a piece of gun cotton.

Tyndall varied this beautiful experiment in many ways. By raising to incandescence a piece of platinum foil, he illustrated the transformatiom of invisible into visible radiation.

The most important work, however, that we owe to Tyndall in connection with heat is the investigation of the absorption by gaseous bodies of invisible radiation. Melloni had examined the behavior of solid and liquid bodies, but not of gaseous. He found that transparent bodies like glass might be very opaque to invisible radiation. Thus, as we all know, a glass screen will keep off the heat of a fire, while if we wish to protect ourselves from the sun, the glass screen will be useless. On the other hand, rock salt freely transmitted invisible radiation. But nothing had been done on the subject of gaseous absorption, when Tyndall attacked this very difficult problem. Some of his results are shown in the accompanying table. The absorption of the ordinary non-condensable, or rather not easily condensable, gases—for we must not talk of non-condensable gases now, least of all in this place—the absorption of these gases is very small; but when we pass to the more compound gases, such as nitric oxide, we find the absorption much greater, and in the case of olefiant gas we see that the absorbing power is as much as 6,000 times that of the ordinary gases.

	Relative Absorption at 1 inch Pressure.
Air	1
Oxygen	1
Nitrogen	1
Hydrogen	1
Carbonic acid	972
Nitric oxide	1,090
Ammonia	5,460
Olefiant gas	6,030

There is one substance as to which there has been a great diversity of opinion—aqueous vapor. Tyndall found that aqueous vapor exercises a strong power of absorption—strong relatively to that of the air in which it is contained. This is of course a question of great importance, especially in relation to meteorology. Tyndall's conclusions were vehemently contested by many of the authorities of the time, among whom was Magnus, the celebrated physicist of Berlin. With a view to this lecture I have gone somewhat carefully into this question, and I have been greatly impressed by the care and skill showed by Tyndall, even in his earlier experiments upon this subject. He was at once sanguine and skeptical—a combination necessary for success in any branch of science. The experimentalist who is not skeptical will be led away on a false tack and accept conclusions which he would find it necessary to reject were he to pursue the matter further; if not sanguine, he will be discouraged altogether by the difficulties encountered in his earlier efforts, and so arrive at no conclusion at all. One criticism, however, may be made. Tyndall did not at first describe with sufficient detail the method and the precautions which he used. There was a want of that precise information necessary to allow another to follow in his steps. Perhaps this may have been due to his literary instinct, which made him averse from overloading his pages with technical experimental details.

The controversy above referred to I think we may now consider to be closed. Nobody now doubts the absorbing power of aqueous vapor. Indeed, the question seems to have entered upon a new phase; for in a recent number of Wiedemann's Annalen, Paschen investigates the precise position in the spectrum of the rays which are absorbed by aqueous vapor.

I can not attempt to show you here any of the early experiments on the absorption of vapors. But some years later Tyndall contrived an experiment, which will allow of reproduction. It is founded on some observations of Graham Bell, who discovered that various bodies became sonorous when exposed to intermittent radiation.

The radiation is supplied from incandescent lime, and is focused by a concave reflector. In the path of the rays is a revolving wheel provided with projecting teeth. When a tooth intervenes, the radiation is stopped; but in the interval between the teeth the radiation passes through, and falls upon any object held at the focus. The object in this case is a small glass bulb containing a few drops of ether, and communicating with the ear by a rubber tube. Under the operation of the intermittent radiation the ether vapor expands and contracts; in other words, a vibration is established, and a sound is heard by the observer. But if the vapor were absolutely diathermanous, no sound would be heard.

I have repeated the experiment of Tyndall which allowed him to distinguish between the behavior of ordinary air and dry air. If, dispensing with ether, we fill the bulb with air in the ordinary moist state, a sound is heard with perfect distinctness, but if we drop in a little sulphuric acid, so as to dry the air, the sound disappears.

According to the law of exchanges, absorption is connected with radiation; so that while hydrogen and oxygen do not radiate, from ammonia we might expect to get considerable radiation. In the following experiment I aim at showing that the radiation of hot coal gas exceeds the radiation of equally hot air.

The face of the thermopile, protected by screens from the ball itself, is exposed to the radiation from the heated air which rises from a hot copper ball. The effect is manifested by the light reflected from a galvanometer mirror. When we replace the air by a stream of coal gas, the galvanometer indicates an augmentation of heat, so that we have before us a demonstration that coal gas when heated does radiate more than equally hot air, from which we conclude that it would exercise more absorption than air.

I come now to the second division of my subject, that relating to sound. Tyndall, as you know, wrote a book on sound, founded on lectures delivered in this place. Many interesting and original discoveries are there embodied. One, that I have been especially interested in myself, is on the subject of sensitive flames. Prof. Le Conte in America made the first observations at an amateur concert, but it was Tyndall who introduced the remarkable high-pressure flame now before you. It issues from a pinhole burner, and the sensitiveness is entirely a question of the pressure at which the gas is supplied. Tyndall describes the phenomenon by saying that the flame under the influence of a high pressure is like something on the edge of a precipice. If left alone, it will maintain itself; but under the slightest touch it will be pushed over. The gas at high pressure will, if undisturbed, burn steadily and erect, but if a hiss is made in its neighborhood it becomes at once unsteady, and ducks down. A very high sound is necessary. Even a whistle, as you see, does not act. Smooth, pure sounds are practically without effect unless of very high pitch.

I will illustrate the importance of the flame as a means of investigation by an experiment in the diffraction of sound. I have here a source of sound, but of pitch so high as to be inaudible. The waves impinge perpendicularly upon a circular disk of plate glass. Behind the disk there is a sound shadow, and you might expect that the shadow would be most complete at the center. But this is not so. When the burner occupies this position the flame flares; but when by a slight motion of the disk the position of the flame is made eccentric, the existence of the shadow is manifested by the recovery of the flame. At the center the intensity of sound is the same as if no obstacle were interposed.

The optical analogue of the above experiment was made at the suggestion of Poisson, who had deduced the result theoretically, but considered it so unlikely that he regarded it as an objection to the undulatory theory of light. Now, I need hardly say, it is regarded as a beautiful confirmation.

It is of importance to prove that the flame is not of the essence of the matter, that there is no need to have a flame, or to ignite it at the burner. Thus, it is quite possible to have a jet of gas so arranged that ignition does not occur until the jet has lost its sensitiveness. The sensitive part is that quite close to the nozzle, and the flame is only an indicator. But it is not necessary to have any kind of flame at all. Tyndall made observations on smoke jets, showing that a jet of air can be made sensitive to sound. The difficulty is to see it, and to operate successfully upon it; because, as Tyndall soon found, a smoke jet is much more difficult to deal with than flames, and is sensitive to much graver sounds. I doubt whether I am wise in trying to exhibit smoke jets to an audience, but I have a special means of projection by which I ought at least to succeed in making them visible. It consists in a device by which the main part of the light from the lamp is stopped at the image of the arc, so that the only light which can reach the screen is light which by diffusion has been diverted out of its course. Thus we shall get an exhibition of a jet of smoke upon the screen, showing bright on a dark ground. The jet issues near the mouth of a resonator of pitch 256. When undisturbed, it pursues a straight course and remains cylindrical. But if a fork of suitable pitch be sounded in the neighborhood, the jet spreads out into a sort of fan, or even bifurcates, as you see upon the screen. The real motion of the jet can not, of course, be ascertained by mere inspection. It consists in a continuously increasing *sinuosity*, leading after a while to complete disruption. If two forks slightly out of unison are sounded together, the jet expands and re-collects itself, synchronously with the audible beats. I should say that my jet is a very coarse imitation of Tyndall's. The nozzle that I am using is much too large. With a proper nozzle, and in a perfectly undisturbed atmosphere—undisturbed not only by sounds, but free from all draughts—the sensitiveness is wonderful. The slightest noise is seen to act instantly and to bring the jet down to a fraction of its former height.

Another important part of Tyndall's work on sound was carried out as adviser of the Trinity House. When in thick weather the ordinary lights fail, an attempt was made to replace them with sound signals. These are found to vary much in their action, sometimes being heard to a very great distance, and at other times failing to make themselves audible even at a moderate distance. Two explanations have been suggested, depending upon acoustic refraction and acoustic reflection.

Under the influence of variations of temperature refraction occurs in the atmosphere. For example, sound travels more quickly in warm than in cold air. If, as often happens, it is colder above, the upper part of the sound wave tends to lag behind, and the wave is liable to be tilted upward and so to be carried over the head of the would-be observer on the surface of the ground. This explanation of acoustic refraction by variation of temperature was given by Prof. Osborne Reynolds. As Sir G. Stokes showed, refraction is also caused by wind. The difference between refraction by wind and by temperature variations is that in one case everything turns upon the direction in which the sound is going, while in the second case this consideration is immaterial. The sound is heard by an observer down wind, and not so well by an observer up wind. The explanation by refraction of the frequent failure of sound signals was that adopted by Prof. Henry in America, a distinguished worker upon this subject. Tyndall's investigations, however, led him to favor another explanation. His view was that sound was actually reflected by atmospheric irregularities. He observed, what appears to be amply sufficient to establish his case, that prolonged signals from fog sirens give rise to echoes audible after the signal has stopped. This echo was heard from the air over the sea, and lasted in many cases a long time, up to fifteen seconds. There seems here no alternative but to suppose that reflection must have occurred internally in the atmosphere. In some cases the explanation of the occasional diminished penetration of sound seems to be rather by refraction, and in others by reflection.

Tyndall proved that a single layer of hot air is sufficient to cause reflection, and I propose to repeat his experiment. The source of sound, a toy reed, is placed at one end of one metallic tube, and a sensitive flame at one end of a second. The opposite ends of these tubes are placed near each other, but in a position which does not permit the sound waves issuing from the one to enter the other directly. Accordingly, the flame shows no response. If, however, a pane of glass be held suitably, the waves are reflected back and the flame is excited. Tyndall's experiment consists in the demonstration that a flat gas flame is competent to act the part of a reflector. When I hold the gas flame in the proper position, the percipient flame flares; when the flat flame is removed or held at an unsuitable angle, there is almost complete recovery.

It is true that in the atmosphere no such violent transitions of density can occur as are met with in a flame; but, on the other hand, the interruptions may be very numerous, as is indeed rendered probable by the phenomena of stellar scintillation.

The third portion of my subject must be treated very briefly. The guiding idea of much of Tyndall's work on atmospheric particles was the application of an intense illumination to render them evident. Fine particles of mastic, precipitated on admixture of varnish with a large quantity of water, had already been examined by Brücke. Chemically precipitated sulphur is convenient, and allows the influence of size to be watched as the particles grow. But the most interesting observations of Tyndall relate to precipitates in gases caused by the chemical action of the light itself. This may be illustrated by causing the concentrated rays of the electric lamp to pass through a flask containing vapor of peroxide of chlorine. Within a few seconds dense clouds are produced.

When the particles are very small in comparison with the wave length, the laws governing the dispersion of the light are simple. Tyndall pursued the investigation to the case where the particles have grown beyond the limit above indicated, and found that the polarization of the dispersed light was effected in a peculiar and interesting manner.

Atmospheric dust, especially in London, is largely organic. If, following Tyndall, we hold a spirit lamp under the track of the light from the electric lamp, the dark spaces, resulting from the combustion of the dust, have all the appearance of smoke.

In confined and undisturbed spaces the dust settles out. I have here a large flask which has been closed for some days. If I hold it to the lamp, the track of the light, plainly visible before entering and after leaving the flask, is there interrupted. This, it will be evident, is a matter of considerable importance in connection with organic germs.

The question of the spontaneous generation of life occupied Tyndall for several years. He brought to bear upon it untiring perseverance and refined experimental skill, and his results are those now generally accepted. Guarding himself from too absolute statements as to other times and other conditions, he concluded that under the circumstances of our experiments life is always founded upon life. The putrefaction of vegetable and animal infusions, even when initially sterilized, is to be attributed to the intrusion of organic germs from the atmosphere.

The universal presence of such germs is often regarded as a hypothesis difficult of acceptance. It may be illustrated by an experiment from the inorganic world. I have here, and can project upon the screen, glass pots, each containing a shallow layer of a supersaturated solution of sulphate of soda. Protected by glass covers, they have stood without crystallizing for forty-eight hours. But if I remove the cover, a few seconds or minutes will see the crystallization commence. It has begun, and long needles are invading the field of view. Here it must be understood that with a few exceptions, the crystalline germ required to start the action must be of the same nature as the dissolved salt; and the conclusion is that small crystals of sulphate of soda are universally present in the atmosphere.

I have now completed my task. With more or less success I have laid before you the substance of some of Tyndall's contributions to knowledge. What I could not hope to recall was the brilliant and often poetic exposition by which his vivid imagination illumined the dry facts of science. Some reminiscences of this may still be recovered by the reader of his treatises and memoirs; but much survives only as an influence exerted upon the minds of his contemporaries, and manifested in subsequent advances due to his inspiration.

THE HIGHEST MOUNTAIN ASCENT AND THE EFFECTS OF RAREFIED AIR.

By EDWIN SWIFT BALCH.

IN 1855 the brothers Adolph and Robert Schlagintweit reached an altitude that for many years was unapproached. This was in a partial ascent of the Ibi Gamin or Kamet Mountain on the southern frontier of Tibet. They traveled up a long glacier by easy stages and encamped at gradually increasing elevations. Their highest camp was 19,360 feet above the sea, and the greatest height they reached on their final effort, 22,250 feet.

Between the years 1860 and 1865 Mr. W. H. Johnson, of the Indian Survey, reached some very great altitudes in Cashmere, for which he has never had due justice done him. Colonel Montgomarie, in receiving from the Royal Geographical Society a reward for Mr. Johnson, made the following statement: "The occasion of Mr. Johnson's (1864) ascending to 22,300 feet was owing to his inability to get at a valley in any other way except by crossing a ridge which reached this altitude. He actually forced his way over, and was obliged to spend the night at nearly 22,000 feet above the sea, darkness having come on before he got any lower." In 1865 Mr. Johnson climbed three peaks of the Kuen Lun, one of which, according to the measurement of the Indian Survey—by a single observation, however—is put down at 23,890 feet. Mr. Johnson seems never to have written any account of his ascents, and in the opinion of the Indian Department it was considered as probable that the single unverified determination of height was erroneous rather than that Mr. Johnson should have ascended to nearly 24,000 feet without special difficulty, and the determination was therefore omitted in compiling the synopsis of final data for publication.

In the year 1884 the little world of Alpine climbers was startled by the narrative read before the Royal Geographical Society by Mr. W. W. Graham, describing a journey to the Sikhim Himalaya, in which with Emil Boss, proprietor of the Hotel Bär at Grindelwald, and the well-known guide, Ulrich Kaufmann, he claimed to have reached in the preceding October the height of 24,000 feet on Mount Kabru. The whole Anglo-Indian press and Himalayan Survey, prompted by jealousy at an English climber with two Swiss guides leaving their efforts so far behind, with great unanimity attacked Mr. Graham's assertions most bitterly. Their arguments are very curious. One of them was that the Bhooteas, natives of the neighboring valleys, stated that they would not attempt the ascent under any circumstances; and yet it was argued that if any one could make the ascent it would certainly be the Bhooteas, for one of the women once carried a grand piano on her back forty-six miles in three days. This is equivalent to saying that a hotel porter would be the best guide on a mountain side. One of the Indian surveyors, Mr. Roberts, said it would be impossible to ascend Kabru, "as no one can avoid the almost certain consequences of an attempt to clamber over sharp ledges of rock and of the yielding of the snow coating that covers over a concealed crevasse." What almost certain consequences clambering over sharp ledges of rock should entail, except, perhaps, barking the climber's shins or tearing his knickerbockers, is a still unsolved riddle, and evidently the Indian Survey has never even heard of using a rope on a glacier.

Then, again, Mr. Graham was attacked about Pandim, a mountain 22,018 feet in height, which the Anglo-Indian press said the natives denied he had ascended. His character for veracity was called in question. The beauty of this attack lay in the fact that he never claimed to have ascended Pandim; on the contrary, he said in his report: "I do not know of any more formidable peak. On the west side it drops sheer, while the other three are guarded by the most extraordinary overhanging glaciers which quite forbid any attempt." Mr. Graham also announced his discovery of two peaks from Kabru, the one a rock peak, the other a snow peak, which seemed higher than Gaurisankar. The Indian Survey taxed this as being no discovery on his part, because the following February a survey party saw peaks which are assumed to be identical with those of Mr. Graham, and which the surveyors thought would prove higher than any mountain yet measured.

Mr. Douglas W. Freshfield, the present secretary of the Royal Geographical Society, aroused by the general foolishness of the Indian Survey, took up the cudgels in behalf of Mr. Graham, and a war on paper resulted in the pretty general acceptance of the reality of his ascent.

Since Mr. W. M. Conway's exploration in the Karakorums, however, the whole question has been reopened, Mr. Edward Whymper, the first climber of the Matterhorn, coming forward especially on account of his disbelief that any one could reach 24,000 feet without extreme suffering from rarefied air. Mr. Graham in his narrative states that neither he nor his Swiss companions "suffered any inconvenience from breathing other than the panting inseparable from any great muscular exertion. Headaches, nausea, bleeding at the nose, temporary loss of sight and hearing, were conspicuous only by their absence; and the only organ perceptibly affected was the heart, whose beatings became very perceptible, quite audible, while the pace was decidedly increased." Mr. Conway, on the contrary, states that "when 18,000 feet had been passed, we found that it was well to look to our breathing. A long stride had to be taken, and one went at it as usual with a momentary holding of the breath. The penalty was instantly exacted—a giddiness supervened, and had to be puffed and pumped away." Mr. Conway's greatest altitude on the Pioneer Peak was 22,500 feet, which is believed to be the greatest altitude from which an observation on the spot was ever taken. The difficulty in reconciling Mr. Graham's and Mr. Conway's narrative lies especially in the fact that all of Mr. Conway's party suffered—Englishmen, Swiss guide, and Ghoorkas—while none of Mr. Graham's party were affected.

This question of loss of breath at great altitudes can not, however, be taken as a sure test of the height reached. The state of health of the climbers, and whether they are in proper training or not, whether they have had a sufficiency of food, and the different states of the weather are very large factors in the comforts or discomforts of an ascent. Count Henry Russell, one of the most experienced of mountaineers, suffered severely on Mont Blanc (15,800 feet), while Mr. Henry Gale Gotch, after an easy ascent of the same mountain, tried the experiment of jumping a number of times over an alpenstock, which he did without any inconvenience whatever—his guide, Henri Dévouassoud, however, confiding to him after a few days his abiding astonishment at so peculiar a mode of resting after an ascent. Mr. Whymper and the Carrels suffered severely on Chimborazo (21,424 feet), while on the other hand Dr. Güssfeldt on Aconcagua reached 21,000 feet without suffering any inconvenience; and Mr. Freshfield's party of six did not suffer in any way from the air, though they almost ran up the last rocks of Elbruz (18,526 feet).

As the question now stands, we can not be certain which is the highest mountain ascent. There are certainly mistakes in the measurements of the Indian Survey. Peak K 2, Mr. Conway's "Watch Tower," will have to come down from its 28,200 feet to something nearer 27,700 feet; and it is quite possible that too high a measurement may have been given to Kabru, which has not been measured either by mountain barometer or boiling-point thermometer. It is not impossible that Mr. Graham may have been mistaken in his peak, and gone up some other mountain instead. If Mr. Johnson had been a less reticent man than he is described as being, and if more were known of his ascents, he might be a possible claimant for the record. The careful notes on breathing made by Mr. Conway, however, prove pretty conclusively that beyond 21,000 feet every one will, at any rate at certain times, suffer more or less from want of air, and the general feeling in the Alpine Club at present is that Mr. Conway has the highest established record.

BOOKBINDING: ITS PROCESSES AND IDEAL.*

By T. J. COBDEN-SANDERSON.

BOOKBINDING is in itself a comparatively simple matter and is easily described: but it is associated with great and interesting conditions of society, and at its highest rises into disinterested admiration by such means of expression as are within its reach of what is most beautiful and wonderful in human achievement, the written and printed speech of man. Binding, moreover, like every other handicraft, is on its ideal side a discipline and a type of life. I propose, therefore, to explain indeed how a book is bound, and how, when bound, it may be tooled. But I propose also throughout to set the craft into imaginative sympathy with the thought it would perpetuate; to touch upon its origin, its history, and its patrons; to characterize the styles of the great periods of tooled decoration; to insist upon the need of some new departure in the invention and development of pattern; and finally, leaving the special objects of the binder's craft, to find in the intuition of the harmony of the universe an outline of the ideal of the craftsman and of the artist.

Speaking generally, binding has its origin in the desire to perpetuate thought. Before the discovery or invention of pliable portable material suitable for writing upon, "binding" was sought for and found in imperishable natural objects, stones, tablets, columns, ready to hand, upon which the thought was permanently incised. In this case the binding may be said to have preceded the writing. It was only when writing was made upon separate pieces or sheets of a pliable and perishable material that binding proper was invented to hold the pieces or sheets together and to give strength to them, and protection and beauty.

But here again a distinction must be made. The pliable written sheet may be either *rolled* or *folded*, each giving rise to a form of binding peculiar to itself. The rolled sheet is bound by fastening each sheet to the other *sideways*, and rolling the whole laterally from end to end, the last sheet serving as a cover to all the rest. The folded sheet, on the other hand, is bound by simply sewing or otherwise fastening the parts of the sheet to one another at the back crease or fold. And a number of folded sheets or of sections, as they are called, are bound by fastening each of them at the back to some common support, so that when all are sewn or otherwise fastened *at the back*, they may yet be free to open and shut *at the front*, or fore-edge.

The invention of the folded sheet thus gave rise to the invention-

* Address delivered at the Royal Institution of Great Britain, February 2, 1894.

tion of modern binding, which in its essence is the union at the back of the folded sheets, which together constitute the folded book, or, as I might say, despite the latent contradiction, the folded volume.

Throughout the long period which has elapsed since the invention of the folded sheet—it is said to have been invented in the third century before Christ—binding must have undergone many and important changes. But of these changes few records remain. Speaking generally of the binding of the middle and later ages, we may say that at each successive epoch the form of the binding adapted itself to the state of literature at the time. When books were few and large and stationary, the binding was correspondingly large and bossy and heavy; and when books became numerous and lighter and portable, the binding adapted itself to the new conditions, and, dropping the oak boards, the brass fittings, clasps, bosses, and chains, became itself light and portable and beautiful. And thus wood and silk, and velvet and leather, iron and brass, and silver and gold, and precious stones, were all used by the artificers of the middle and earlier ages in the protection and embellishment of the world's written wealth. The invention of printing, however, and the multiplication of books, gave the victory to leather and to gold tooling, and with the invention of printing, binding passed into its modern phase, and became ultimately a craft apart, the craft of the bookbinder.

To the renown of bookbinding many countries and cities and patrons have contributed, as well as the artists and craftsmen whose work it has been. Singularly enough, the names of very few bookbinders are known, but it is well known that to Grolier and to France is mainly due the gold tooling which is still the chief means of making the bound book beautiful. This tooling, of obscure origin, was practiced first in Europe in Italy, but was soon after introduced into France by Grolier, and the French schools of the sixteenth and seventeenth centuries are still the great schools of design in that decorative method.

Deserving of mention or of allusion in this connection, even in the shortest account of bookbinding, are the innumerable crafts—crafts for the production of materials and crafts for the production of tools—upon which the binder's own craft depends. For this collaboration of crafts is a fact of capital importance and should always be borne in mind, that the solidarity of all industries may be understood and the dignity of each be appreciated.

It is to be regretted, however, that at this moment the craftsmen immediately concerned in making a book, the paper-maker, the printer, and the binder, are not in possession of ideas bearing and operative upon the book as a whole, and controlling their several crafts to the one common end of the book beautiful, and the binder is in the unfortunate position of coming last, to inherit all, and be helpless under, the mistakes of his predecessors the paper-maker, printer, and publisher.

Modern binding may be divided into two main divisions: 1. Bindings for use. 2. Bindings for beauty's sake. I do not say that the divisions can be precisely defined or that the useful may not be beautiful, or that the beautiful may not be useful. I mean only that of a certain class the utility of the binding is the main characteristic, and that of a certain other class not the utility of the binding but the beauty of the decoration is the prominent and delightful feature. All bindings may be, and most bindings are, decorated in some form or other, but I would deprecate the decoration in gold of cloth or paper bindings; the material is too poor and the kind of binding is unsuitable for elaborate invention. Decoration should be reserved for cases in which a permanent pleasure is aimed at, and decoration in all its affluence exclusively for bindings of the best kind, and for books that are in themselves, apart from their apparel, beautiful and worthy of conspicuous honor.

The binding of a book, to come closer to our subject, is a series of processes too numerous to be entered upon in detail, in so short an account of bookbinding as the present, but the main operations are as follows:

1. The sheets are folded so that the headlines of each page shall, if possible, be at a uniform height throughout the book.

2. The sections are then sewn to cords, set and held at equal distances from one another in a frame, and at right angles to the sections.

3. The ends of the cords are frayed out and laced into and fastened to rectangular pieces of millboard (called boards), cut to the size of the sides of the book, which they protect.

4. The boards and back are then covered with leather or other suitable material, and the last and first sheets of the book (added to the book proper for the purpose) are pasted down upon the inside of the boards.

The book so treated is completely "forwarded," as it is called, and ready to pass into the hands of the "finisher" to be tooled or decorated, or "finished." The decoration in gold on the surface of a bound book is wrought out bit by bit by means of small engraved brass stamps called "tools." The steps of the process are shortly as follows:

1. The pattern is first worked out with the tools blackened in the smoke of a candle or lamp, upon a piece of paper cut to the exact size of the portion of the book to be decorated.

2. The piece of paper with the pattern upon it is then applied

to the surface to be decorated, and the pattern is reimpressed on the paper, and so through on to the surface of the book.

3. The paper is now removed, and the pattern on the book is reimpressed with hot tools to make the impression crisp and distinct.

4. At this stage a different process begins. The surface of the cover, with the pattern impressed upon it as described, is taken bit by bit and treated as follows:

1. First it is moistened with water or vinegar.

2. Then the pattern is penciled over with "glaire," which is a liquid composed of the white of an egg beaten up and drained off.

3. Then, when the glaire is dry, the surface is lightly touched with oil or grease to give a hold to the gold leaf next to be applied.

4. Then the gold leaf, cut to the size and shape of the portion of the cover to be operated on, is applied by a flat brush called a "tip," and pressed down by a pad of cotton-wool to reveal the pattern underneath.

5. Then, and finally, the pattern with the gold upon it is gone over again with the hot tools, and the gold is impressed into it. The rest of the gold is rubbed away with an oiled rag, and the pattern is now displayed permanently in gold and "finished."

The description is easy—how easy!—but the craft is difficult. Gold can not be persuaded to stick as a friend may be persuaded to stay; it must be *made* to stick—i. e., all the conditions upon which successful gold tooling depends must *in all cases* be observed, and there is the rub! What in each case—and the circumstances are never quite the same—*are* the conditions? How divine them? A little more or a little less makes so much difference. How dry may the leather be, or how damp must it be? How much glaire? How hot must the tools be? When is the moment to begin? Then how difficult it is correctly to manipulate the tools, to keep them even upon the leather! How difficult, finally, to keep the leather, throughout all the long and difficult operation, perfectly clean and the gold brilliant! What patience, what natural aptitude, what acquired skill, what fortitude! "The city sparkles like a grain of salt." "Shall I ever succeed?" the apprentice may well ask himself. "Shall I ever attain to such skill, to such consciousness of power, that I shall not even know *how* to fail?" In this difficulty, too, and in the effort and ambition to overcome it, lies a further difficulty, the snare of the art, the temptation of the finisher. He becomes engrossed in it—the finisher in mere finishing. He pursues it positively, and not in subordination to design. And he achieves victory at last, only to find that what he should have achieved, the thing beautiful, has escaped him. He can tool but he can not design; and he has so magnified execution that when completely successful, when completely triumphant, he is then most conspicuously a failure. The tremulous outline of design—and design appeals to the imagination, to the inner eye of the soul as well as to the outer eye of sense—the tremulous outline of design has perished in the too great exactitude of his acomplished execution. Wholly to achieve victory, indeed, in the binder's craft, to forget no end in the prosecution of the means, to exaggerate no feature from long practice and perfect skill, to permit no craft of hand to overcome the judgment of the head, is, in bookbinding, as in all crafts, an exceedingly difficult task, and we have in the very development of a craft the cause of its ultimate decay. But what an education the prosecution of a craft is for the soul of a man! The silent matter, which is the craftsman's material, is wholly in his hands, it hears and makes no reproaches, but it never forgives and it has no mercy. Sunrise after sunrise lights the craftsman to his task, sunset after sunset leaves him to his regret. Shall the sun ever rise upon victory or set upon contentment? It is a great struggle. He only knows how great the struggle is, who knows what the aim of craft rising into the ideal is, and who tolerates, between him and it, no cloud of self-illusion, no splendor of popular praise to blind or to darken his gaze. And so through the work of his hand man may rise indeed to his soul's height. But the victory itself is withdrawn behind the veil. The world may not know it when it is achieved, and the artist himself may sometimes see it achieved, as he thinks, when to reach it he has yet to traverse the entire way of truth.

> "Sown in a wrinkle of the monstrous hill,
> The city—sparkles still, a grain of salt."

The great schools of design for the decoration of bound books are the great schools of France of the sixteenth and seventeenth centuries.

The first great school—the school of Grolier as it may be called—is characterized mainly by the simple motives of straightness and curvature. Straight and curved bands or straps and straight or curved lines are interwoven one with the other and distributed on a more or less simple or intricate but always symmetrical plan over the sides and back and sometimes the edges of a book.

The second great school—the school of the Eves—is characterized by the symmetrical distribution over the side of the cover of symmetrically drawn compartments or panels, and the union of them all into one organic whole by the intermediation of twisted or interwoven bands. This is its main and for its earlier years almost its only characteristic. But the school attained its maturity by the combination with it of an independent contemporary style, which consisted in the use of a number of branches, spreading from each corner of the cover toward the center, the unity of the whole being enhanced by a semis, simple or alternate, of some simple tools over the whole of the side. The combination was effected under the direction, if not by the hands, of the great binders Nicholas and Clovis Eve, and consisted in the enrichment of the interspaces of the first style by means of the sprays and branches of the second. When mature the school was characterized by compartments symmetrically distributed and connected, filled with dainty devices or with the severer tools of the Grolier pattern, and supported and enriched in the interspaces by foliated branches and sprays.

The third great school—the school of Le Gascon—and perhaps the last, was characterized by the combination with the geometrical framework of the preceding school of a new motive, borrowed, I think, from the contemporary lace, or perhaps filigree work, and used, ultimately, to fill in both the compartments or panels and the space between them. The motive is an exceedingly simple one, a small spiral of dots, but the close repetition of it has a singularly rich if somewhat bewildering effect. The school, however, in what specially characterized it, has dropped the tradition of form and is content with the glitter of gold. The repetition of the spiral is not always organic in its construction. The spirals are placed side by side, they do not grow the one out of the other. And I submit that all patterns, to be good, must be organic in the relation of their details and organic in the method of their development.

The great schools of design which I have thus attempted to characterize are historical, and they are closed. The future, as I have elsewhere had occasion to remark, is not, in my opinion, with them or their developments or repetition, however much the present may occupy itself with their corrected iteration.

Design is invention and development, and when development has reached a certain point the invention is exhausted and some new departure must be taken. No new departure, however, of any importance has taken place since the close of the great schools of France of the sixteenth and seventeenth centuries, and the decoration of bound books is still an open problem awaiting solution at the hands of genius.

But though the problem awaits solution the conditions of the problem may, I think, be stated shortly in general terms. In the first place, then, there must be in any design a scheme or framework of distribution. The area to be covered must be covered according to some symmetrical plan. In the second place, the scheme or framework of distribution must itself be covered by the orderly repetition and, if need be, modification and development of some primary element of decoration. In the great French schools which I have attempted to describe, the *motifs* were primarily curved or straight bands or lines, and compartments composed of the same, the whole pattern of the first school becoming, in principle, the *motifs* of the second and third.

Before leaving this subject of design I may be permitted to prophesy that in the infinite inventions of Nature herself will, in the future as in the past, be found the suggestions of design, and that in seeking them there the craftsman artist will enter again into that vital communion with her which is the condition at once of his own happiness and of his own imaginative growth. But the prophecy must be accompanied by this caution—design can not, in my opinion, be taught. It is as distinctly a gift of imaginative genius as the power of poetical vision and expression. To the conditions of the problem, then, must be added the genius suitable for its solution.

I have now, in conclusion, to say what, in my opinion, the craft of the binder is, and in what relation it stands to the supreme art and craft of life itself.

All this universe of light and shade and sound, which at all moments surrounds us, and constitutes the supreme object of man's thoughts, his intranscendent inner and outer self, may be looked upon as itself a work of art in progress, and man's life through the ages as an attempt, ever renewed, to apprehend it in its entirety, and to reduce it to something appreciable by his imagination and his affections. This is not the moment to dwell at length upon this attempt, or to show how, with increasing knowledge of his environment, his previous conceptions of it have perished to give birth to higher and wider appreciations; but I may allege that, in my opinion, all the religions which have figured upon the stage of history, as well as all philosophical and scientific systems, are attempts at this reduction of the universe, and of man as a part of it, to an entirety harmonious within itself, and fit to be the dwelling place of the imaginative soul of mankind. They are attempts, and for some of us they have ceased to be adequate. For myself, I see only unbounded space and infinite time, and within those illimitables, a finite world obedient to law, unfolding to unknown ends; and though I can not grasp that world in its entirety, yet I can divine the amplitude of its rhythm, be sensitive to its adaptations and to the balance of its parts, and, in the spirit of the infinitely great, work at the infinitely little, and feel the two akin in their adjustments, balance, and rhythm.

It is in this intuition of the harmony of the universe that the ideal of the work of the hand resides. It is itself an adjustment, at once beautiful and serviceable. It is a dedication of man's powers to an end not beyond man's reach; it develops invention and the imaginative faculties; it distracts the mind from the vexed question, never wholly to be put aside, of man's own ultimate destiny; it gives him rest; it gives him hope that, even as from the work of his own hands here there arise things of beauty and of use, so from his whole life's work there may arise in the "hereafter," which in some sense may be only another form of the "present," a something of even greater use and greater beauty still.

It is in this wise that I commend to you all the life of the workman, of the workman working in little in the spirit of the whole.

THE BEGINNINGS OF AGRICULTURE.

By M. LOUIS BOURDEAU.*

THE appropriation of the riches of the vegetable world is accomplished in two ways, according as our principal effort is to make use of the spontaneous products of wild plants or to multiply them by cultivation. The former, which constitutes the system of selection, reduces itself to mere taking possession, and, as it is executed by the most simple means, it can be practiced by all animals. The second method, which is applied to the production of resources that are needed, alone achieves a conquest and a durable empire. But it requires superior capacity and a degree of intelligence and reflection to which no other animal than man has risen. Cultivation might therefore serve, as does the use of fire, to mark the precise boundary where reason is separated from instinct and passes beyond it.

During an initial period of very long duration, man, destitute of knowledge and without power to act upon Nature, had to satisfy himself with utilizing the spontaneous products of plants, while he was incapable of adding to them by his industry. Like all plant-eating animals he subsisted on the resources of a hazardous collection. This sort of life demanded nothing more than an attentive search and the instinct to profit by happy finds. Existence was passed in wandering in quest of nutritious plants and gathering their fruits. The numerous families of monkeys and even some human tribes still live in this way.

So simple a method of exploitation is necessarily very restricted. Man did not in the beginning know the value of all the productions that abounded around him. First of all, he had to

* From his book, *Conquête du Monde Végétal* (Conquest of the Vegetable World). Félix Alcan, Paris, publisher.

learn to distinguish the useful plants among those which were not useful. It is not an easy task to pick out, in the three or four hundred thousand species of which the existing flora is composed, those most suitable for satisfying various wants—especially when we recollect that most of the uses we make of them, instead of being naturally indicated, are suggested by previous discoveries, and that there is no motive to impel one to seek in things a utility which is not suspected.

Primitive man was doubtless put in the way of making such discoveries by pressing necessities and the suggestion of chance. The terrible famines to which savages are exposed, which force them to eat the most insignificant berries, grasses, roots, and even the leaves of trees, caused them to learn by repeated trials the productions which could best afford them nourishment. Attention was fixed upon the most advantageous and least repulsive of them. Such experimentation, marked by disgusting and perilous features—for many poisonous plants proffer baits to greedy appetites by which they are sometimes caught—was accomplished at the instigation of hunger, with the assistance of instincts then more formal or better minded than now, comparable to those which guide animals so surely in the choice of their food. At a later date, nascent reason discovered various useful qualities in plants. Fortunate observations and trials followed by success showed what profit could be derived from products long neglected. The uses of wood assigned an increasing importance to it, first as a combustible, beginning with the discovery of fire, then as a substance that could be made serviceable in infinite ways. In time, men learned to separate, twist, spin, and weave bark and fibers, to color them in various shades, and to extract oil, wine, and sugar. Casual cures revealed the medicinal properties of simples. Every age saw an increase in the number of useful products which one could draw from plants. Even now, after the many investigations that have been pursued through thousands of ages, we are far from having made available all the resources which the vegetable world might furnish us; and its fertility holds in reserve for us many treasures of which we are still ignorant.

All the plants that have come into cultivation among us were first used wild, for their value had to be recognized before the thought of multiplying them could take shape. As long as they were naturally abundant enough to suffice for the necessities of sparse populations, no pains would be taken to propagate them. This phase of absolute uncultivation, the longest that the human species has traversed, appears to have continued from the origin of the race to the present geological period. Nothing, in fact, in the vestiges that have come down to us of that age reveals any signs of cultivated plants or of modes of cultivation; and such are not found till the period of the station at Robenhausen, the most recent of the prehistoric ages. A similar condition has persisted among many peoples, not only savages reduced to the sorry resources of the animal searching, like the Hottentots, Bushmen, Fuegians, etc., but hunters, like a number of American tribes, Indians and Eskimos, and even pastoral people like the populations in Asia and Africa which live solely on the products of their flocks. Several peoples of Europe were found in a similar condition at no very ancient date. Tradition preserved among the Greeks and Romans the memory of a time when their ancestors, given over solely to pastoral industry, could neither till nor plant.* At the age represented by the kitchen middens and the oldest lake stations, the aborigines of Denmark and those of Switzerland were not aquainted with any sort of cultivation. A large part of England was, not less than twenty centuries ago, plunged in the same state of savagery. "The two most numerous peoples of Great Britain," says the abridger of Dio Cassius, "the Caledonians and the Meati, to whom all the others are related, live on uncultivated mountains or in desert plains, where they have neither cities nor cultivated lands. They subsist on milk, game, and wild fruits." † The narrative of the circumnavigation achieved by Other in the ninth century, on the shores of the Baltic, describes populations which lived by fishing, and makes no mention of agricultural products. ‡ Even with peoples who have given agriculture its widest developments, a notable part of the resources is always borrowed from the products of the wild flora. We need only cite forest, woods, and pasture lands. Half of the territory of France has not yet been put under regular cultivation, and it is estimated that in the whole world the plants propagated by man do not occupy the tenth part of the surfaces which they might fructify.

Thus man has by the system of gathering become acquainted with and taken possession of the resources of which Nature offers him the gratuitous enjoyment. Although this mode of exploitation is anterior and appears strange to agricultural civilization, we should not fail to appreciate how necessary it was to the establishment of that condition. It has furnished valuable suggestions as to what the vegetable kingdom contained that was useful or capable of being made useful—that is, has indicated all the species which it was profitable to cultivate.

While the appropriation of the products of wild flora presented few other difficulties than those of trying and searching, it can

* Varro, *De Re Rustica*, i, 2.

† Xiphilin, Abridgment of the Roman History of Dio Cassius.

‡ Periplus of Other, inserted in the introduction to Paul Orose's version by Alfred Le Grand.

procure only an extremely limited subsistence, because plants adapted to the wants of man were rare and scattered. Like the animals whose kind of life he continued, he first limited his demands to asking life and shelter from plants. A commensal of all the phytophagous species, he took his place as a parasite, not as a master, at the banquet of creation served without distinction to the multitude of the hungry. If he managed to subsist, it was with great difficulty, constantly a prey to hunger and in a perpetual uncertainty as to the future even in the midst of a temporary abundance, which was dissipated in his hands without his being able to make permanent provision.

To the phase of absolute uncultivation that occupied the first age of the human race succeeded a period of trials which was prolonged through the ages of savage hunting and pastoral barbarity. On rising from the state of Nature, men in quest of food would give more attention and care to the exploitation of the resources of the hunt, always available, than to that of vegetable production, which was limited to a short season. Wherever, as in North America, game was abundant over vast territories, the preying system could maintain itself independently. Where, on the other hand, game was rare and the extent of the territory small, as in Polynesia, the populations had early recourse to agricultural operations. Peoples who from being hunters became shepherds, obliged to wander from pasture to pasture with their flocks, were hardly able to devote themselves to agricultural experiments, which demanded sedentary customs. But when hunters, for lack of game, and shepherds, after droughts and epizoötics, became deprived of their customary resources, they were forced to call upon plants to supplement their subsistence. The getting of wild food was manifestly insufficient for populations which had multiplied in a relative abundance, and people were obliged, under pressure of necessity, to apply their ingenuity to the artificial propagation of useful plants to fill the measure of their wants. In fact, the more earnestly these plants were sought, the rarer they became. A certain number of species of great merit have thus disappeared from wild Nature, and are preserved only in cultivated varieties. The advantage of saving and increasing so precious types was understood at an early period, and man, exercising an intelligence of which no other animal had shown itself capable, learned to take good care of the plants which had proved most valuable to him. Doubtless fortunate accidents showed the way and were a revelation. Some seeds of fruits thrown down carelessly and springing up around the house suggested the thought of intentional plantings. The savage, who saw these young plants spring up and grow, watched over them, tried other experiments of reproduction and plantation—and the garden was formed, the beginning of agriculture. Success was not difficult in regions where propitious conditions of soil and climate favored the propagation of plants of great productiveness. Observation and experiment next fixed the elements of a theory, limited at first to a few species, then extended and perfected by degrees. To reach these feeble beginnings by the rational methods of agriculture, a long series of attempts marked by more failures than successes had to be gone through. Gradually, however, the processes were improved; the resources increased, and the profits of vegetable production, so long surpassed by those of the hunt and of cattle-raising, at last prevailed over them; and this determined the adoption of a special kind of life, the consequences of which were destined to transform the condition of man.

Regarded as a whole, the cultivation of plants was a more complex and more arduous problem than the domestication of animals. To subject animals, it was enough to capture and hold them. They were then tamed as they became familiar, and afterward required nothing more than watching or protection. They could themselves provide for their wants, or make them known in a language easy to understand. They spontaneously sought their food and fled from danger. The mothers suckled and defended their little ones. Animal instinct thus saved the master of the herd much trouble. Plants, on the other hand, although their passive nature is apparently less rebellious to subjection than the undocile character and self-will of animals, really opposed more obstacles by the very fact of their lack of activity, on account of which they could not help and be sufficient for themselves. Constant watchfulness had to be exercised to see that their growth was accomplished regularly, for their needs never became evident till they were dying, and intelligent cares are necessary to prevent this or remedy it. Taking the propagation of plants under his charge, man had to choose a favorable soil for them, to break it up by toilsome labor, to put the seed in at the proper time, to stimulate their growth with manures, to furnish them water, warmth, and light, according to their needs. Their reproduction, in the wild state, was accomplished in the midst of innumerable risks, under the laws of the struggle for existence, and multiplicity of seeds could alone, in the face of a fearful loss, make sure the duration of species. In the hard and incessant struggle to which plants were given in the contest for ground and a place in the sun, the most precious, which were also usually weak and delicate, were liable to be smothered. To cause them to increase, man had to interfere in the conflict, to extirpate useless, vigorous, and aggressive species, and procure for those under his protection conditions of development. It was necessary, therefore, to clear, plow, and weed; to study the phenomena of vegetable physiology, the qualities of different soils, the influence of exposure and climate, the course of the seasons, and the accidents of meteorology; to sow and to harvest at the most favorable moment, and then to store the products in such a way as to prolong the enjoyment of them. The establishment of agricultural industry thus exacted much more investigation, observation, and knowledge than that of pastoral industry; and further, instead of being limited, as in the domestication of animals, to a small number of selected species, agriculture had to extend its empire over thousands. This sort of life demanded, besides, more foresight, for it was necessary to work for results the profit of which was not gathered till after a long waiting. Finally, the profession of agriculture was much more toilsome than that of herdsman, and man, averse to hard work, recoiled long before the fatigue of so rude a task. He could not undertake it resolutely except during a phase of progress in which he had become more capable of reasoning, persistence, and effort. Agricultural civilization is therefore superior in every aspect to pastoral civilization by the extent of knowledge and foresight it implies, by the amount of labor it imposes, and by the quantity of wealth it creates. And when the two functions are in exercise at the same time, while the care of the herds is left to the most ignorant and weakest of the population—children, women, and old men—the agriculturists compose the most active, the most intelligent, and the most experienced part.

A progressive era of agricultural operations did not arrive till after both the hunting and the pastoral phases. On the one side, in fact, the destruction of wild animals must be sufficiently advanced to permit the cultivator to enjoy the reward of his labors, which too many spoilers would render of no avail. Agriculture would be hard to establish in a country where a pillaging and devastating fauna flourishes. In South Africa, for example, the plantations, exposed to the ravages of deer, birds, and insects, give little return. On the other hand, the co-operation of domestic animals was necessary, in order to plow large surfaces expeditiously as well as to fertilize by their manure the ground which repeated croppings would exhaust. This is the reason why, while we find among many peoples just issued from the savage state and destitute of cattle—Polynesians, Mexicans, Peruvians, etc.—interesting attempts at agriculture, they have not been able, in the absence of that resource, to arise themselves above a limited scale of gardening. The real agricultural system comes after the pastoral system.

But, this given, the other should arise from it in time, when the multiplication of herds in the natural pastures has reached a limit which can not be well exceeded. The least accident tending to diminish that wealth will force the herdsmen to seek a supplement to their subsistence in temporary cultivations. Compelled to periodical migrations, they would adopt, in preference to fruit trees propagated from the wild state by sedentary hunters, a few plants of rapid vegetation, like the cereals, and particularly barley, which matures in a short time. Fields are thus occasionally sown around provisional encampments, an intermittent kind of agriculture, consistent with the care of the herds, as appears among Arabs of the Tell in Algeria. In especially favorable regions agriculture gained the preponderance, and the richness of the harvests, accruing more rapidly than that of the herds, attaching man at last to the ground, caused him to change his method of life.

Still, the first men who gave themselves up to regular consecutive work in the fields did not take their place without difficulty in a barbarous world. Antagonism and war would not fail to break out between the pastoral populations, jealous of their rights of way and of pasturage, and the agricultural populations, which, appropriating the ground put under cultivation by them, assumed to reserve the fruits to themselves. The contest between these rival interests and opposing customs occupied a period in the history of the ancient peoples. In the long run the agriculturists, more civilized, more numerous, and better united, at last carried the day, took possession of the most fertile lands, and drove the herdsmen into the steppes and the deserts, the only regions where their system could be perpetuated in its primitive purity. So, when pasturage and agriculture were developed in concert, a marked classification was worked out between the two professions; and while, in the beginning, such gods as Apollo, Mercury, and Pan, or such kings as those of the Vedic age in India and of the Homeric cycle in Greece, were not degraded by keeping herds, the shepherds lost in consideration as the agricultural system became more prevalent, and the business of attending to the cattle fell more and more to the farm servants.

The moment when man sought the chief support of his life in agriculture is one of the most important dates of history, and opened the decisive era of civilization. Till then, hunter or fisherman, he lived chiefly upon his catches, free or domesticated, and, superior to carnivorous species, he differed from them only in having a more intelligent method of hunting. When he became an agriculturist, he rose above all the animals by a manner of living without analogy among them. He made the land his domain, cut down the forests, plowed the ground, and propagated by industry the plants useful for his wants. From that time he had at his disposal incomparably vaster resources than he could draw from animals. His comfort, henceforth assured, depended on himself only, and populations increased rapidly. Under the influence of these new conditions all the elements of civilization were developed and advanced. Varied industries were constituted to give value to the productions of the earth, habits were regulated, and milder religions substituted for the bloody sacrifices of the pastoral phase peaceful offerings of wheat, meal, oil, and wine.

This memorable event of the adoption of the agricultural system by the first pioneer groups probably dated from the later prehistoric times, and could in no case have been anterior to the subjection of the auxiliary animals during the pastoral stage. The dawn of history shows us large empires, already flourishing, from three to four thousand years before the Christian era—Chaldea, Egypt, and China—enriched and civilized by agriculture. The point of beginning should undoubtedly be thrown some thousands of years still further back. Probably also the mythological traditions relative to the origin of husbandry, in which honor is rendered to deified personages, such as Ceres, Triptolemus, Minerva, Bacchus, Osiris, Noah, etc., refer not to the primary institution, which was probably effected by degrees and slowly, but to the extension of the processes, which may sometimes have been made in a very short time and would all the more strike the imagination of the peoples. The agricultural system once fixed, the initiative of a leading innovator might introduce it by imitation into a country still barbarous, rapidly change the aspect of a district still uncultivated, and bring it, in less than a generation, to the point where territories that had already been transformed by cultivation had arrived after centuries of efforts. Those were undoubtedly benefits of this kind of which myths have transmitted the reminiscence to us. During these ages of ancient barbarity the fertility of the soils, suddenly revealed by practical sages, would appear miraculous to tribes that were acquainted only with the aridity of the steppes. The prodigy of making wheat and the vine grow where only grass and rushes had been would seem to partake of the divine, and it is conceivable that altars should have been erected to those who accomplished it. In the Oriental mythologies the conquest and distribution of domestic animals did not give rise to such legends; whence we may suppose that those achievements dated from an anterior cycle when religious conceptions, more closely related to primitive fetichism, induced the adoration of the animals themselves instead of those who subdued or introduced them, and of whom no recollection survived.

It is easier to indicate the countries in which the evolution occurred in which the pastoral system was supplanted by the agricultural. As our most valuable plants originated in regions now well determined by botanical geography, we thus know the area in which their cultivation was established as the center whence it radiated to different quarters. By this induction we are authorized to affirm that agriculture was first established in that part of the ancient world which also furnished the most useful species of animals for domestication. Asia has, in fact, contributed most of our fruit trees, cereals, and economical and industrial plants. The fertile valleys of the Euphrates, the Nile, the Ganges, and the Yang-tse-kiang were acquired to agricultural civilization very early. While we are not able to say which is entitled to priority, we can distinguish two principal centers of cultivation in the ancient continent—one in the southwest of Asia (Mesopotamia and Egypt), and the other in the east (China, India, and Indo-China). The former, which seems to have been the more important, propagated barley, wheat, the vine, flax, etc. The second acquired rice, tea, sugar cane, the mulberry, cotton, etc. A third center, more tardily constituted in intertropical America, gave us Indian corn, the potato, tobacco, etc. The north of Asia, Europe, South America, the United States, and Australia have furnished very little.

Without regarding the negroes and the American populations, which, continuing nearly in their original savagery, and having not even risen to the pastoral system, could give only an extremely limited aid to the establishment of agriculture, the credit of having introduced high cultivation can be disputed only by the three races which shared the dominion of the ancient continent. The claims of the Mongolian race are distinct enough in consequence of its long isolation. Some of its peoples have preserved their nomadic customs. Only China and its annexes adopted the new method of living. Yet, although agriculture has been long honored there, its general advance has been less evident than elsewhere, and the Middle Kingdom has hardly got beyond the practice of a highly perfected gardening. The claim of the Semitic race is based upon the record of the two ancient empires, Chaldea and Egypt, which were truly initiators. Yet, although it seems to have given the first example, it had not the honor of making the most decisive advances. Both pastors and cultivators, the Semites perhaps made the most material contribution to the passage from the former kind of life to the other. The pre-eminent agricultural race was that of the Aryans, which only exceptionally ever led a pure pastoral existence, and the name of which is associated with a root from which is derived also the word *arare*, to plow—as if the Aryans, to distinguish themselves from the nomads who surrounded them, desired to give themselves the characteristic appellation of *plowmen*.* In Europe, and under

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* Max Müller, Science of Language.

less favorable conditions of fertility, their descendants have carried agricultural industry to its most advanced point, have constituted the theory of rational cultivation, and have most largely developed the system of civilization which is the consequence of it.

The first people who adopted the agricultural system possessed only a few species of plants borrowed from the local or neighboring flora. Each region, apart from the others, was poor; only the world was rich. To compose the treasure of our agriculture, it was therefore necessary to collect in each country the best products of all the others. Such sharing in common was for a long time impracticable for want of relations between the ethnic groups, which were separated by geographical obstacles or impassable distances. Gradually profitable exchanges distributed the plants from their native regions into the zones which were suited to receive them. From the time when special centers of cultivation were established, the richness of this fund has gone on increasing. The migrations of peoples, their military expeditions, their conquests, the foundations of distant colonies, commercial and political relations, and often the intelligent curiosity of travelers gave opportunities for inestimable gains. The Egyptians sought for new plants. Queen Hatasu sent a squadron of five ships to the ports of the country of Punt, to bring from there fragrant trees, which she planted in her gardens at Thebes. Thothmes III had represented in one of the chapels of the Temple of Amun at Karnak the various species of plants he had collected during his campaigns in Syria and on the Upper Nile. We may also cite the case of the embassy of Chang-Kien, who, sent in the second century by the Emperar Won Ti into Bactriana, brought back a number of plants with which he enriched the agriculture of the Celestial Empire.* At successive dates, all the agricultural peoples have made their contributions to the common stock and have drawn largely from a constantly increasing patrimony.

The Indo-European race, with its taste for travel and its ambition for expansion, has especially contributed to the dissemination of useful plants. Originating in the center of Asia, it in the very beginning borrowed from its elder sisters the resources, acquired by them, of an agriculture which was destined to become cosmopolitan. The most ancient Aryan migrations carried into India and into Europe the precious seeds which the race had collected near its cradle. The Phœnicians, Greeks, and the Romans afterward propagated on the shores of the Mediterranean a choice of fruit trees, vegetables, and industrial plants selected from three continents: the vine, the olive, the almond, the walnut, the chest-

* The Pen-ts-'ao mentions the bean, the pea, lucerne, sesame, saffron, and the walnut.

nut, the plum, the apricot, the peach, the cherry, etc. In extending their domination from one extremity of the ancient world to the other, the Arabs still found something to glean, and the Crusaders took numerous loans from them. Europe then acquired rice, sugar cane, and the orange. Finally, since the great expeditions of the Renaissance, the flora of the entire world has been put under contribution. The Romans caused trees loaded with fruit to figure in their triumphs, in testimony, Pliny says, of a victory which had been gained over Nature not less than over men. Thus, wherever civilization established itself it sought, in order to make itself welcome and its presence a blessing, to lavish upon the new lands the gains which it had accumulated in its former cultivations. Like the gods of other days, when they descended among men, it appeared with its hands full of precious gifts. This propagation of useful plants is of itself so great a benefit that it compensates, and more, for all the evil that civilization has been accused of spreading.

During the course of the subjection of the vegetable world to our use, the conquest has followed an order upon which the documents of the past do not always cast a sufficient light, but of which it is possible to restore the stages by means of a logical induction, while bearing in mind the urgency of the needs, the difficulties of cultivation, and the complexity of the uses. The first plants which man interested himself in propagating were those which would assure his subsistence, for the demands of hunger are the most imperious. Then came economical and medicinal plants. The industrial species usually belong to a later stage. Ornamental and fanciful species were a late gain and the luxury of an already rich civilization.

Suess, in his book, The Face of the Earth, and Neumayr, accepting the Chaldean story of the flood as the original version of the Mosaic account, held that it was a local event in the plains of the Euphrates and Tigris, and that view has prevailed extensively. Richard Hennig, however, discussing the subject in the German Weekly Magazine of Science, argues in favor of the independent origins of the flood stories found among so many peoples, and associates it with some of the striking phenomena of the Ice age which indicate a general increase of rainfall and lowering of temperature during the Quaternary period. Isolated lands —Egypt, for instance—far from these influences, remained free from interruption. The accounts in the German Saga would apply well as descriptions of such a period.

Of the people of Montenegro, Mr. W. H. Cozens-Hardy says that every man, even the poorest, has the bearing and dignity of a gentleman. Education is universal and compulsory on all children over seven. Theft is unknown, and drunkenness unheard of. Women are universally respected; a woman goes in safety where no man dares.

SKETCH OF THOMAS NUTTALL.

IT has often happened that a young man who has begun life as a printer has afterward attained to distinction in some more intellectual pursuit. So it was with Benjamin Franklin and so with him whose story is to be told here. Whether this is due to the information which the young printer obtains from the matter constantly passing through his hands, or whether it is because the most intellectual of the young men who learn a mechanical trade take to printing, it would be difficult to say. The fact only need be noted here.

Thomas Nuttall was born in 1786, in the market town of Settle, in the West Riding of Yorkshire, England. His parents were probably in humble circumstances, for at an early age he was apprenticed to the printer's trade, either in his native town or in Liverpool, where he had an uncle engaged in this business. He worked as a journeyman for this uncle several years; then, having had a disagreement with him, young Nuttall went to seek employment in London. He was not fortunate in the metropolis, and sometimes went to bed without knowing where he would get his breakfast the next morning.

When twenty-two years of age he came to America, landing in Philadelphia. He must have devoted a large part of his spare moments to study during his early life, for he has been described on his arrival in this country as a well-informed young man, knowing the history of his country and somewhat familiar with some branches of natural history and even with Latin and Greek. A testimony to his early studious habits came to notice sixteen years later. It is thus recorded in the biographical notice of Nuttall, read by Elias Durand before the American Philosophical Society, which has been taken as the basis of this article:

"When, in 1824, Prof. Torrey was preparing for publication his Flora of the Northern and Middle States, which he dedicated to his friend Thomas Nuttall, with high compliments, the printer who was engaged upon it asked the professor who was that Nuttall so frequently referred to in his work, adding that he had once worked with a printer of that name, who spent the greatest part of his time in reading books, and he would not be surprised if he were the same man. Prof. Torrey rejoined that 'his surmise was correct; the printer of former times had proved a most arduous laborer in the field of science, and was now a distinguished botanist and an officer of one of the first scientific institutions of the country.'"

That Nuttall knew nothing of botany when he landed in the United States is shown by an anecdote that he used to tell of himself. Taking a walk in the outskirts of Philadelphia the morning after his arrival, he noticed a common greenbrier (*Smilax rotundifolia*). "Egad!" said he to himself, "there is a passion-flower"; and he plucked some branches of it, which he brought home for inquiry. His fellow-boarders could not satisfy him, but referred him to a certain Prof. Barton, a great botanist, whose residence was near. With his treasured branch in his hand, Nuttall called at once upon Prof. Benjamin S. Barton, who received him courteously and pointed out the difference between the genera *Smilax* and *Passiflora*. Then, perceiving the intelligence of the young man, Prof. Barton went on to tell him some of the general principles of botany and how much pleasure could be derived from its pursuit. This conversation made Nuttall a botanist, and Barton became his friend and patron. It was then early spring, and throughout the season of flowers he took frequent rambles over the neighboring fields, eagerly gathering specimens, which he brought to Barton, studying them with him and preparing them for the herbarium. Soon he began to extend his excursions, going first down into the lower part of the peninsula between the Delaware and Chesapeake Bays, and later to the coasts of Virginia and North Carolina. When occupied with his favorite pursuit, serious discomfort could not distract him. At one time, while collecting in the southern swamps, his face and hands became covered with mosquito bites, so that when he approached a human habitation the people of the house would not at first admit him, believing that he had the smallpox, and it was with great difficulty that he convinced them of the contrary.

Returning from this trip, he made the acquaintance of Mr. John Bradbury, a Scotch naturalist, who had come to America to collect objects of natural history in the interior. Nuttall eagerly offered to accompany Bradbury, and his proposition was accepted. Proceeding to St. Louis, they set out from that city on the last day of December, 1809, crossed the Kansas and Platte Rivers, passed through the Mandan villages, where Lewis and Clarke had spent the winter of 1804–'05, and ascended the Missouri River still higher, returning after an experience full of the greatest fatigues and dangers. They were pursued and robbed by the Indians, and Bradbury, who was captured by them, only saved himself from being killed by taking his watch to pieces and distributing the works among them. Nuttall, overcome by fatigue and hunger in the wilderness, laid himself down to die, but was found by a friendly Indian, who took him in his canoe down the Missouri to the first settlement of white men. In spite of these misadventures, he was able to bring with him on his return, in the beginning of 1811, ample treasures of seeds, plants, minerals, and other natural objects.

For the next eight years he remained in Philadelphia, during the winter months studying the collections made by him in summer excursions to various parts of the country east of the Mississippi, from the Great Lakes to Florida. Being absorbed in his studies and naturally reserved, Nuttall's social intercourse was limited. The families of the botanists and horticulturists of the time in Philadelphia—Prof. Barton, Zaccheus Collins, Reuben Haines, McMahon, from whom he named his genus *Mahonia*, William Bartram, and Colonel Carr—were almost his only acquaintances. To these he made visits, often of several days, from time to time. In Colonel Carr's house a room was expressly reserved for him. During this period he prepared also the description for his Genera of the North American Plants. Upon this work, which appeared in 1818, the reputation of Mr. Nuttall as a botanist principally rests. Prof. Torrey, in the preface to his Flora, declared that it had "contributed more than any other work to the advance of the accurate knowledge of the plants of this country." Nuttall turned his early trade to account by setting the type for the greater part of his book.

In 1817 Mr. Nuttall, already a Fellow of the Linnæan Society of London, was elected a member of the American Philosophical Society at the same meeting with Say and Schweinitz, and a corresponding member of the Academy of Natural Sciences of Philadelphia. He began to publish essays in the journal of the Academy, among the earliest being a description of *Collinsia*, a new genus of plants, named in honor of his friend and patron Z. Collins.

Nuttall had long desired to visit the Arkansas country, and soon after his American Plants was published Messrs. Correa de Serra, Z. Collins, William Maclure, and John Vaughan procured him the means of performing this long journey. Starting from Philadelphia on October 2, 1818, he reached the mouth of the Arkansas River about the middle of January and Fort Bellepoint on April 24th. Thence he made expeditions in several directions, returning with abundant collections. He was on one of these trips in the middle of August, when, exhausted by long and difficult marches, made under the rays of a burning sun and in constant dread of the Indians, having suffered much from thirst, insufficient food, and exposure to the night dews, he was seized with a violent fever among the Osage tribe. The Indians robbed him of his effects and even threatened his life, but he finally reached the garrison at Bellepoint, where he remained sick until the middle of October. He made one more trip and then set out for home, reaching New Orleans February 18, 1820. He had then in sixteen months made a journey of more than five thousand miles, mainly over a country never visited before by scientific explorers, and still in the undisputed possession of the Indians.

Getting back to Philadelphia early in the spring of 1820, he immediately set about arranging his Arkansas collections and preparing his Journey into the Interior of Arkansas in 1818 and 1819, which he published in the following year. In the course of the years 1820 to 1822 he contributed several memoirs to the Journal of the Academy of Natural Science, among them being one On the Serpentine Rocks of Hoboken and the Minerals which they Contain, for he was giving some attention to mineralogy at this time. He also lectured on botany to classes of young men. His lecturing was not remarkable for eloquence, but he always communicated to his pupils something of his own passion for his favorite science.

At the end of 1822 Mr. Nuttall was called to Harvard College. The fund of the college for a professorship of natural history not being sufficient to support a professor, he was appointed merely Curator of the Botanic Garden, and but light duties of instruction were assigned to him. In consequence the greater part of his time was devoted to the culture of rare plants and to his own studies, in which mineralogy and ornithology were included. In Cambridge, as in Philadelphia, he led a retired life.

In editing the Letters of Asa Gray Mrs. Gray remarks: "The garden was laid out by Dr. Peck in 1808, and the house built for him was finished in 1810. Mr. Nuttall, the botanist and ornithologist, who boarded in it while giving instruction in botany, left some curious traces behind him. He was very shy of intercourse with his fellows, and having for his study the southeast room, and the one above for his bedroom, put in a trapdoor in the floor of an upper connecting closet, and so by a ladder could pass between his rooms without the chance of being met in the passage or on the stairs. A flap hinged and buttoned in the door between the lower closet and the kitchen allowed his meals to be set in on a tray without the chance of his being seen. A window he cut down into an outer door, and with a small gate in the board fence surrounding the garden, of which he alone had the key, he could pass in and out safe from encountering any human being."

Aware that he was doing little for science, Mr. Nuttall became dissatisfied with his position at Cambridge; he used to say that he was only vegetating, like his own plants. Congenial occupation was furnished him for a time by the suggestion of Mr. James Brown, who was probably his only intimate friend in Cambridge, that he write a book on ornithology. He had given more or less attention to this science during almost the whole of his residence in America, and readily adopted the suggestion. He set to work with great zeal, and in 1832 produced his Manual of the Ornithology of the United States and Canada. It was published in two volumes of about six hundred pages each and illustrated with excellent woodcuts. In the course of his residence at Cambridge he contributed papers to the various scientific periodicals of the time, and issued a little book entitled An Introduction to Systematic and Physiological Botany.

About the beginning of 1833 Mr. Nuttall went to Philadelphia with a collection of plants gathered by Captain Wyeth during a journey overland to the Pacific Ocean. Captain Wyeth was soon to start on a second expedition, to establish posts for the Columbia Fishing and Trading Company, and Nuttall wished to accompany him. Not being able to obtain a sufficiently long leave of absence from Cambridge, he resigned his position at the college and spent the interval before the departure of the expedition in Philadelphia studying the collection already referred to and his own Arkansas plants.

Mr. Nuttall and Mr. John K. Townsend, a young naturalist, sent out jointly by the American Philosophical Society and the Academy of Natural Sciences, joined Captain Wyeth's party at Independence, Mo., from which place the start was made April 28, 1834. The details of the journey are given in Townsend's Narrative of a Journey across the Rocky Mountains to the Columbia River, etc. On September 3d they came to the Columbia, and, descending it, reached Fort Vancouver. Here the two naturalists remained for the rest of the autumn to explore the surrounding region. Then desiring to pass the winter months where inclemency of the season would not interfere with their pursuits, they took passage on a Boston brig for the Sandwich Islands, where they arrived January 5, 1835.

Here for the first time Mr. Nuttall enjoyed the beauties of a tropical vegetation. He remained two months collecting plants and sea shells on the several islands, and then, separating from his companion, sailed for California. He spent a great part of the spring and summer on the Pacific coast, then returned to the Sandwich Islands, where he embarked on a Boston vessel to come home by way of Cape Horn. It happened to be the vessel on which Mr. Dana was serving his two years before the mast, and the latter relates in his book that when rounding Cape Horn Nuttall's passion for flowers was aroused by the near view of land. He entreated the captain to put him ashore, if only for a few hours, that he might become acquainted with the vegetation of this dreary spot, although the wind was blowing furiously and the ship was surrounded with icebergs. When his persistent requests were sternly refused he was much disappointed and displeased, being unable to comprehend such indifference to the cause of science.

He arrived in October, 1835, and again took up his abode in

Philadelphia to work up the rich treasures gathered on his long journey. For several years he and Dr. Pickering worked harmoniously together at the Academy of Natural Sciences—the former on his own collections, the latter on the Schweinitz herbarium. Two important memoirs based upon the fruits of the trip across the continent were published about 1840 in the Transactions of the American Philosophical Society. Conchology was a new subject of study to Nuttall, and he became much absorbed in it. He did not trouble himself much about his meals when at work, and Dr. Pickering would often return after an hour's absence from the Academy hall in the middle of the day and find him stooping over a case of shells in the same place and position as when he left him.

Nuttall was a remarkable-looking man. His head was very large, bald, and bore the signs of a vigorous intellect; his forehead was expansive, but his features small, and his gray eyes looked out from under fleshy brows. His complexion was fair, and sometimes very pale from close application to study and lack of exercise. He was above medium height, his person stout, with a slight stoop, and his walk peculiar and mincing, resembling that of an Indian.

He was naturally shy and reserved, but, if silent and perhaps morose in the presence of those toward whom he felt no attraction, yet with congenial companions he was communicative and agreeable. It will readily be surmised that his devotion to science frequently led him into actions that were strangely at variance with the circumstances of the moment. In one of his solitary digressions in the wilderness he got lost. The party he was with resumed its march, sending out some friendly Indians to find him and bring him to rejoin it. The Indians performed their duty faithfully. Looking upon him, however, as a great medicine man, they were afraid to come close to him, so they surrounded him, keeping at a respectful distance. Nuttall soon became aware that he was watched by savages, and, not knowing whether they were friends or foes, became intensely alarmed. From what he had already experienced at their hands he had the utmost horror of Indians. Therefore hiding himself, and taking advantage of every ravine, every tree and bush, he succeeded in regaining the track of the caravan, which he followed for three days without food or sleep, when, to his infinite delight, he overtook it and was relieved from his anxieties.

On another occasion he was rambling in the vicinity of the camp when a band of Indians, apparently hostile, made its appearance. The alarm was immediately given, with orders to prepare for an expected attack. Nuttall was nowhere to be seen, and a friend ran in search of him. It was not long before he perceived the naturalist at some distance, quietly examining a specimen. He hailed him with signs to return quickly. "We are going to have a brush with the Indians," said his friend; "is your gun in good order?" Alas! the gun had been freely used to uproot plants, and was filled with earth to the muzzle. Had Nuttall fired it in this condition it would inevitably have burst in his hands and killed or severely wounded him.

On his journey to the Pacific the caravan separated into two parties to cross the Rocky Mountains by different routes. One of the parties had the good fortune to meet with plenty of buffalo cows, upon whose meat they became fat. The other, to which Nuttall belonged, suffered much from fatigue, and found scarcely anything to eat except a few lean grizzly bears. When the parties reunited, Nuttall had lost so much flesh that his old companions could scarcely recognize him. Upon one of these expressing his surprise at the great change in his appearance, he heaved a sigh of inanition and retorted, "Yes, indeed, you would have been just as thin as myself if, like me, you had lived for two weeks upon old Ephraim (grizzly bear), and on short allowance of that too!"

At Christmas, 1841, Nuttall returned to England, where he resided for the remaining seventeen years of his life. An uncle who had prospered in business, having no family of his own, bequeathed to him an estate called Nutgrove, in the neighborhood of Liverpool. A condition attached to the bequest was that Nuttall should reside in England at least nine months of the year for the rest of his life. He had been thirty-four years in the United States and become much attached to this country, so that, although he had visited England in 1811 and 1822, returning to reside permanently in the land of his birth seemed to him like going into exile. He therefore hesitated for some time to accept the inheritance, but consideration for his sisters and their families finally induced him to take it. Becoming a British landed proprietor did not make Mr. Nuttall wealthy. The Nutgrove estate was encumbered with annuities, besides which there was a heavy income tax to pay. Dr. Pickering and other American friends who visited him found him living in the fashion of a plain farmer, working and eating with his men like one of them. But his interest in botany was not allowed to die out. He made use of the opportunity which the possession of ample grounds afforded for the cultivation of rare plants, especially rhododendrons, which his nephew, Mr. Thomas J. Booth, brought him from the mountains of Assam and Butan. Various new species of these were described by him in British scientific journals.

Shortly before leaving the United States Nuttall was induced to write a supplement to Michaux's Sylva in three volumes. In the beautifully written preface to the work his own wanderings are vividly sketched. Owing to various delays the edition was not issued till 1846.

Nuttall returned only once to America. As he could not be absent more than three months in any one year, he took the last three months of 1847 and the first three of 1848—not a very desirable season for a botanist's outing. Nevertheless, he managed to do some congenial work. He studied at the Philadelphia Academy the plants brought by Dr. William Gamble from the Rocky Mountains and Upper California, and prepared a paper on them which was published in the journal of the Academy.

His death occurred on September 10, 1859. In his eagerness to open a case of plants received shortly before from Mr. Booth he overstrained himself, and from that time steadily declined until he died. Through his love of Nature, joined with untiring industry and great firmness of purpose, he had raised himself from the condition of an unknown artisan to the foremost rank of American men of science. No student begins upon the study of systematic botany without being struck by the frequency with which his name is met. His friends and colleagues, Profs. Torrey and Gray, have testified to their appreciation by attaching his name to a beautiful genus of the *Rosaceæ*. Elias Durand said of him immediately after his death: "No other explorer of the botany of North America has personally made more discoveries; no writer on American plants, except perhaps Prof. Asa Gray, has described more new genera and species."

Among the Kayans of Borneo, according to Mr. C. Hose, when a child is born, the father and mother sink their own identity and adopt the name of their offspring. Supposing a man named Jau becomes the parent of a son to whom he gives the name of Lahing, the former would no longer be called Jau, but Taman Lahing, father of Lahing. If his child were to die, he would be called Ozong Lahing, or Ozong Jau; if his wife dies, he adds the prefix Aban (widower) to his name; if a brother or sister, Boi, and he is called Boi Lahing. Should he attain the position of being a grandfather, he becomes Laki, adding thereto the name of his grandchild; so if the latter is given the name of Ngipa, the grandfather is no longer called Taman Lahing, or by any other name but Laki Ngipa. A widow is called Ballo.

In considering temperature as a factor in the distribution of marine animals, Dr. Otto Maas, of Munich, said, in the British Association, that the great ocean currents were primary elements in limiting the distribution of free-swimming forms, very few species being found both north and south of them. The influence which had been ascribed to pressure might often be more correctly attributed to change of temperature, as in the case of deep-sea animals which died on being brought to the surface in the Atlantic but not in the Mediterranean. In conclusion, attention was called to the corals and the geryonid jellyfish as illustrative of the principles laid down, both having a similar distribution, though the former are fixed, the latter free swimming.

CORRESPONDENCE.

SLEEP AND DREAMS.

Editor Popular Science Monthly:

In reading Dr. Wurtz's article on the Chemistry of Sleep, in the issue of December, I observe that he considers dreams to be an essential element of "normal sleep." "Sleep so deep as to be dreamless is probably not of the most natural kind. . . . No one would claim that natural dreams are symptomatic of morbid conditions," etc. And speaking of the sleep produced by the administration of nitrous oxide with oxygen, he says, "But the lethargy thus produced is dreamless, and *therefore not normal sleep*." The Italics are mine.

I think the experience of the larger number of people in average health is against this proposition; for dreaming is only occasional with them, and is usually considered in the light of a disturbance and as detracting to that extent from the rest and refreshment of the season. And the experience of people who frequently and even "regularly" dream is against it likewise; for it is certain that an ordinary dream occupies usually only a small portion of the time devoted to and spent in sleep, and that under ordinary circumstances the duration of dreamless sleep during the night, even with habitual dreamers, is many times greater than the duration of their dreams.

Then if, as all physiologists are agreed, sleep is in general terms a condition of rest and recuperation, especially of and to the "apparatus of relation"—the brain, the organs of sense, the voluntary muscles and their associated nervous system—it follows that *it ought to be* dreamless to be entirely effective (and normal). For observe that inasmuch as, so far as our experience teaches us, there is with us no consciousness without change of condition in *some* of the matter of our bodies, which means *metabolism*, which means destruction of tissue, therefore a given amount of consciousness in dreams (as in waking)—cerebral vision, audition, emotion, or what not—is at the cost of a certain amount of tissue change, and results in the accumulation in the blood of so much effete matter and gives to the excretory organs so much extra work to do. Both experience and theory are thus shown to be against his position.

I refrain from criticising in detail his "definition, or rather description, of the conditions we find in sleep," of which, however, it may be said that it will not bear the scrutiny either of logic or fact. Nevertheless, it does not follow that his article is uninstructive or valueless, for we often find that the errors in a conscientiously thought-out thesis lead to a more thorough understanding of the subject than would have been attained had all the propositions been demonstratively true.

George Pyburn, M. D.

Sacramento, Cal., *December* 20, 1894.

DO BIRDS CHANGE THEIR FOOD?

Editor Popular Science Monthly:

In a review of M. Frédéric Houssay's book on Thrifty Birds, occurring in your October number, page 856, it is said of the California woodpecker that, "though an insect-eater, it stores away for its winter supply food of an entirely different character, nor so subject to decay. It collects acorns for which it hollows small holes in a tree—a hole for an acorn—into which the acorn is exactly fitted, ready to be split by the strong beak of its owner," etc.

Now we have the same habit among various woodpeckers here, but the cause is not ascribed to the bird changing its diet, for examination of the acorns shows each one to be infested with a worm or larva which is rapidly fattening. It is this and not the meat of the nut which the woodpecker desires. It would seem, then, that M. Houssay is open to criticism in what he says about "change of diet." F. L. Washburn.

Corvallis, Ore., *September* 30, 1894.

STUDIES OF CHILDHOOD.

Editor Popular Science Monthly:

I was much interested in the article entitled Studies of Childhood, in the January number, but it seems to me that one, at least, of the writer's deductions is too serious. In discussing the child's idea of personal identity, he recalls instances in which the child's past self is remembered as of the opposite sex. I myself have noticed this peculiarity a number of times. Now, in each of my examples, as in those cited by the author, it is a boy who refers to himself as having been a little girl. Might not the simple fact that during infancy dresses are worn explain this delusion?

Harriet Heyl Cary.

Chicago, *December* 23, 1894.

EDITOR'S TABLE.

SOCIOLOGY IN THE UNIVERSITIES.

THERE was nothing commonplace about the title that first confronted the readers of the initial number of The Popular Science Monthly in May, 1872. The Study of Sociology: Our Need of It, had the flavor of that happy and legitimate audacity that makes things "go." For nobody knew what "sociology" was. Only a few curious readers of Comte, and subscribers to Mr. Spencer's Synthetic Philosophy, had ever met with the word. It is familiar enough now; and if the repetition of phrases meant always the assimilation of ideas, we might expect the coming generation to think of society as rationally as it will think of the solar system and the descent of man. "Sociology" confronts us in the morning newspaper; it is the favorite fad of philanthropic institutions; it is discussed in ministers' meetings, and it pleasantly stimulates the scientific ganglia of ladies' clubs.

The popular history of sociology in these twenty-three years has therefore been interesting and instructive. To Mr. Spencer and his followers the word has always meant a strictly scientific description and explanation of society as it is and as it has been. The business of the sociologist, as Mr. Spencer understands it, is to interpret the life and organization of society in terms of natural causation and evolution; not to abolish evil for dissatisfied people, nor to invent new moral worlds for gullible people, nor to fit out reformers with a brand-new set of rules of thumb. But it was inevitable that as soon as the serious scientific study of society was talked about the uninstructed and incompetent should try their hands at the task; and a curious mess they have made of it. They have seized upon the word sociology and made it do service in aid of every crazy enterprise and sentimental crusade that all the cranks in Christendom have ever thought of. To cap the climax, the theologians of the Christian socialist variety, and certain so-called "economists" who enjoy airing their disbelief in pretty much everything that used to be called political economy, have put their heads together and invented something that they call "Christian sociology," a last ridiculous manifesto in the warfare of obscurantism against science. Unable longer to sell text-books of six day geology, these estimable persons will see to it that the law of population and the formula of marginal utility are put on a safe Christian basis!

Meanwhile, however, a real and great progress has been made in the constructive development of scientific sociology, and, what is not less important, in teaching it. But it has been made so quietly that the general scientific public is scarcely aware of what has been accomplished. In European universities of the first class sociology is to-day firmly established as a recognized subject for degree work, and it is taught by extremely able men. De Greef at Brussels, Gumplowicz at Grāz, Letourneau at Paris, Durkheim at Bordeaux, and Simmel at Berlin are professors who combine scientific training with a philosophical grasp of their subject. In this country Prof. Sumner began using Spencer's Study of Sociology as a text-book at Yale soon after its publication. Since then courses in sociology have rapidly multiplied in our colleges. The new University of Chicago recognized the claims of such studies by putting Prof. Small, whose teaching has been based in a good degree on the views put forth in Ward's Dynamic Sociology, in charge of a well-equipped department of social science. Columbia College last year gave a new impetus to the movement by founding the first American university chair of sociology to be officially called by that name, and by calling to it Prof. Giddings, who holds that social ethics can never teach us what social relations ought to be until sociology has analyzed and classified them as they are; discovered how, through an evolutionary process, they came to be as they are; and explained in terms of natural causation why they are what they are, and not in all respects what we might wish them to be.

For university purposes it is obviously necessary to limit rather definitely the field of sociology, because a considerable part of the comprehensive and detailed study of society falls within the departments of political economy and public law. How the lines of demarcation ought to be drawn, with due regard to a logical classification, has been a question of practical interest to teachers, and the occasion of the recent annual meeting of the American Economic Association, in this city, was made the opportunity for a conference. The conclusion reached was that sociology is the master science that co-ordinates the special social sciences, and that, in teaching, the co-ordination must be shown not only by pointing out the interdependent relations of the different groups of social phenomena, a merely descriptive process, but by concentrating attention on those phenomena that are so elementary, or fundamental, that they are found in all groups, and are presupposed by all the special social sciences. Sociology is thus for university purposes the science of social elements and first principles, and therefore the fundamental and co-ordinating social science; a science of what is and has been, sharply distinguished from social ethics, but offering to social ethics legitimate data for a study of what ought to be.

With sociology as thus conceived more and more thoroughly taught in our universities, we may hope that the educated public will begin to entertain truer notions of what society is, and of the laws of its evolution.

MORE FACTS ABOUT DIPHTHERIA ANTITOXINE.

Since the writing of Dr. Armstrong's paper on the treatment of diphtheria by antitoxine serum, published in the Monthly for February, certain additional data have appeared that seem worth presenting to our readers.

Prof. Jaime Ferran, of Barcelona, has called attention to the fact that in April, 1890, he published a paper in which he described a safe and practical method of immunizing animals against fatal doses of the diphtheria poison, and thus he anticipated Prof. Karl Fraenkel's communication on the same subject by eight months. But, unfortunately for the Spanish bacteriologist, he did not carry his experiments to the ultimate point to which Behring carried Fraenkel's investigations, resulting in the antitoxine serum.

Recent investigations in relation to the duration of immunization have shown that the antitoxic properties of the serum of children who have had diphtheria do not appear until between the eighth and tenth days after recovery from the disease, but the property persists for several months. Antitoxic serum, however, immunizes more rapidly than the disease itself, but it does not produce a refractory state of equally long duration.

A further evidence of the value of the antitoxine serum is shown by a paper by Dr. Moizard, who administered it in two hundred and thirty-one cases of diphtheria in the Paris Trousseau Hospital, with a mortality of only 14·7 per cent. During the same months, October and November, in other years the mortality had never been less than fifty per cent. Prof. Widerhofer, of Vienna, treated one hundred patients with the serum, with a mortality of twenty-four per cent, while the mortality in fifty cases not treated with serum was forty-two per cent. In Trieste the adoption of the antitoxine treatment has reduced the mortality from 58·3 to sixteen per cent, four hundred and six cases of diphtheria being thus treated.

Occasionally some bad effects have followed the administration of the serum, such as high fever, pain in the muscles and the joints, enlargement of the lymph glands, skin eruptions, and occasionally it seems to produce or hasten kidney complications.

The celebrated Prof. Virchow has said that while he was not such a worshiper of antitoxine serum as many of its first discoverers, and, like others, he was in doubt about many things pertaining to it that further experience might correct, still he could not refrain from saying that it was the duty of every earnest physician to use the remedy. The possibility that it would do harm was so insignificant that it might be ignored.

"*SCIENCE.*"

We welcome with much satisfaction the reappearance, in an improved form, and apparently under the very best auspices, of our excellent contemporary, Science. The names upon its editorial committee are vouchers for the competence with which subjects falling into the several departments which these gentlemen supervise will be treated. The only important science which we fail to see on the list of those which our contemporary embraces in its programme is political and social science. It is true that the professors of this branch of science are not altogether at one even as regards the fundamentals of their subject; but all the more need is there for full discussion of that subject from every rational point of view. Psychology and paleontology, which *are* on the programme, are of interest chiefly as leading to wider and more intelligent views of man as a social and political animal; and we therefore trust, nay believe, that our revived contemporary, when it settles fully down to work, will have many a useful chapter to give us on the important topic to which we have called attention. Meantime we wish it, very heartily, all success.

LITERARY NOTICES.

Towards Utopia. Being Speculations in Social Evolution. By A Free Lance. New York: D. Appleton & Company. Pp. 252. Price, $1.

This is a book which we can cheerfully recommend to all who are interested in social questions. The author does not wear the badge of any school, and he writes in a style which is by no means academic. He believes in the duty of being as original as it is in one's power to be, and he therefore undertakes to apply some reforms, or what he considers such, to the accepted spelling of the English language and to some of its terms of expression. His theoretical convictions in regard to social principles are in general of the individualist order, but he is very far from being doctrinaire even on this ground. He is—to describe him briefly—a man of strong human sympathies and liberal tastes who has applied himself independently to consider the changes that will take place in society before it arrives at anything like its perfect development. The condition of perfect development he calls Utopia, and that he does not undertake to discuss or describe; he contents himself with the humbler task of describing in a discursive and very off-hand manner what he calls "semi-Utopia"—a condition of things intermediate between what we see now and the best and highest condition possible for humanity.

In the second chapter of the work occur the following excellent remarks: "Utopia can never be rightly seen otherwise than by the aid of science and a true philosophy that teach us to discriminate the possible and practicable from the impossible: the route can never be tracked by others than by pilots soundly trained in physical, psychological, and social science; and the march can never be performed by an army not disciplined and educated by the teachings of science, æsthetics, and ethics." The author is not one of those speculators who disparage the work of Herbert Spencer. In the opening of his third chapter we find the following: "It has been pointed out by Herbert Spencer—who seems to have pointed out pretty nearly everything—that ideal men are possible only in an ideal state; and conversely that a perfect social state is possible only when every unit has achieved perfection." He then proceeds to consider the great gain that would result if only all men were "decently honest." He shows how much labor is at present expended in guarding against dishonesty, and how seriously the general happiness is interfered with by these protective measures. The necessity of issuing railway tickets, he observes, arises from the fact that, as things now are, hundreds and thousands of persons would steal railway rides unless they were required to present tickets. Then the tickets have to be dated, punched, and carefully collected to prevent their being used again. "Taking any church," says our author, "probably nine tenths of the 'respectable worshipers' who perform their eminently respectable devotions there every Sunday and thank God that they are children of grace and neither Turks, Jews, Socinians, nor infidels, would have no scruple in cheating a railway company on their way home." There may be, and we trust there is, some exaggeration in this statement, but that there is a large element of truth in it no one who has any extensive knowledge of mankind would be disposed to question. This matter of railway tickets is, however, only one out of many illustrations which the author brings forward of the loss entailed upon society and the diminution of happiness through the defective morality of individuals. Before we can hope to reach or even to sight semi-Utopia there must be a radical change in this respect.

The author next proceeds to discuss the "Servant Question," quoting John Stuart Mill as saying that "there is hardly any part of the present constitution of society more essentially vicious and more morally injurious to both parties than the relations between masters and servants." The word "masters" is to be taken here as including mistresses. The condition of things to which the author particularly refers is that existing in England. Some of its features have been modified in this country, but whether upon the whole we have made any sensible advance toward semi-Utopia as regards the status of the servant class may be doubted. There is more independence on one side, but what is wanted is more humanity on both sides. It would be impossible in semi-Utopia to have one class of human beings whom another class regarded as the necessary instruments of their ease and pleasure, but as cut off from them in every social sense by an impassable barrier. In that happy state, when two human beings come together in any form of association, the thought of each will be how he or she can make the relation fruitful of good in the widest possible sense to the other. People will then no longer hoard their culture and their social advantages, as if to communicate them to others would be to diminish if not destroy their value; but whatever any one has that is good he or she will try to make common. The author's whole discussion of the servant question is full of useful suggestiveness. To those who can not rise in imagination above what is sanctioned by social usage, and to those who are dominated by a selfish passion to hold on to such class privileges as they possess, many of his ideas will appear absurd; but few liberal-minded or sympathetic persons will read these chapters without acknowledging the general force and truth of the author's positions.

Following the chapters on the Servant Question we have a trenchant discussion of Luxury and Waste. Here the author's indignation waxes hot, as well it may. He points out how utterly at war with the canons of true taste all useless and ostentatious luxury is, and to what extent the higher intellectual and moral interests of society are sacrificed to a mere love of display. Here there is much we should be glad to quote, but our limits forbid. The author again defines his position by remarking (page 195): "We can thus clearly perceive the feasibility of an approximation toward semi-Utopia—*if* only men would be moderately unselfish, unwasteful, and reasonable. *It is mainly human nature that has to be changed.*" We have only in part indicated the contents of this interesting volume, but we have perhaps said enough to show the main lines of the author's thought. The chief value of the work, in our opinion, lies in this—that it makes clear to every one of us what can be done *now*, without waiting for any of those magnificent feats of legislation which socialistic speculators promise us, to make a better society. With each one of us it rests to do something in this direction, by bringing his own life more into harmony with right reason and the dictates of pure humanity. We tiust that this little book by "A Free Lance" will set very many thinking, and not only thinking but acting.

We may perhaps be allowed to point out that the author is under a singular misapprehension as to the sense of the word "hypothecate." In half a dozen places in the book he uses it as though it were the verb corresponding to the noun hypothesis. It is unfortunate that there is no word of kindred etymology to hypothesis signifying to frame an hypothesis or assume as an hypothesis; but it does not do to lay violent hands on another word of wholly different signification.

The College Woman. By C. F. Thwing, LL. D., President of Adelbert College, Western Reserve University. New York: The Baker & Taylor Co. Pp. 169. Price, $1.

If there be a vantage ground from which to view the college woman and to map out her aptitudes and shortcomings, Dr. Thwing occupies such a one as president of a university for men and of a college for women. But, after a careful reading of his book, we are forced to conclude that, however fortunate his position, he is still restricted by a lens of limited power, if not by astigmatic vision.

As seen by him, the college woman may be said to sparkle with interrogation points. Four of the questions concerning her which have been answered in the past twenty-five years are: Whether women want a college education; whether they have the necessary intellect, the physical strength; and whether the process unsexes them. Among the problems yet surrounding her are: Should woman receive the same education as man? What should be the method of her training? Do her health and manners get sufficient attention? What may the community demand of her when college-bred? What will be the result of a large influx of her species?

The principle of her education is at first stated broadly as the development of a human being; but after a review of the differentiation of sexual power according to Ruskin and an analysis of womanly nature by Dr. Thwing, the conclusion is reached that "enriching studies"—literature, philosophy, and history—should be "peculiarly precious to woman." Inquiries addressed to the collegiate alumnæ bring out the fact that a majority sensibly judge physiology and hygiene to be of special value for woman; the next largest number designate social and political science. The author recommends the adoption of the group system in order to prevent the superficiality resulting from a careless election of studies.

In regard to environment, Dr. Thwing writes: "The question of room, board, clothes, exercise, sleep, is a pretty fundamental one." Elsewhere we learn "the question of clothes is a pretty large as well as serious one," and that many women enter the collegiate year "exhausted with dressmaking"! We think the author libels the average American family when he states it is considered "crankiness in a girl" to demand an evening for study. He believes the young woman has not been generally as well housed at college as the young man, and advocates the building of small and homelike dormitories.

An entire chapter is devoted to the question of woman's health at college. The collegiate alumnæ, being interrogated, furnish many replies, and the author finally lays stress upon hasty preparation, worry, and want of exercise.

In the discussion of the method of woman's education we are introduced to an unusual form, "the co-ordinate," as one which "promotes a very sane health and healthfulness"! In this system a college for men and a college for women are conducted under one administration as parts of a university. The classes are separate, the teachers often instruct in both colleges, and the library is shared in common. The inference from the context is that by this method there is less risk of love-making than in the coeducational system; but it is difficult to see how the classroom can prove as good a ground for this diversion as the library. The provincial note of the book is reached in the sixth chapter, Demands made by the Community upon Her. It seems obvious to us that if woman had done only what the community required of her, she would never have gone to college, and that, having gone, it is unlikely she will thereafter order her ways according to Mrs. Grundy. Such a standard is surely not an ethical goal for either man or woman, who needs to do right for right's sake, even in the face of the community.

Electricity One Hundred Years Ago and To-day. By Edwin J. Houston. New York: The W. J. Johnston Co., etc. Pp. 199. Price, $1.

The author aims in this volume to give credit to every one who has contributed even in the slightest degree to the development of thought in the field of electrical science and art. The great ideas and inventions by which progress is marked are arranged in three type groups: Immature or incomplete; untimely and therefore unfruitful; and fruitful, because mature and timely; of which the first class, though having but little visible influence, may at times be of value, because of their tendency to direct thought along certain channels, thereby they become forerunners of more important ideas. The second class have to wait for recognition and effect, but eventually contribute their force to the advancing impulse; while the third class are fruitful at once. The first enunciation of ideas concerning electricity is traced back to the Greek philosopher Thales, who experimented with the attraction of a piece of amber that had been rubbed. He was much before his time, for no advance was made on his experiment till near the close of the sixteenth century, when Dr. Gilbert showed that powers of attraction and repulsion are developed in several other bodies by rubbing them. Stephen Grey, in 1729, first pointed out the distinction between conductors and non-conductors of electricity. The power of wires to conduct the electrical force to a distance attracted attention and excited inquiry, in the course of which Watson, in 1747, erected conducting lines several miles in length, and used the earth as a return conductor. He was succeeded by Franklin, whose experiments are familiar, and were followed by the rapid development of electrical discovery which has not yet slackened. The invention of the electric telegraph, with the discoveries that made it possible and led up to it, and of the telephone, are reviewed in a very clear and comprehensive manner. The application of electricity as a motive power and light producer was first made commercially practicable after the invention of the Gramme dynamo. Since then it has been rapidly extended, and is likely to become general all over the earth, and as to all kinds of machinery. Still more wonderful expansions of electricity seem to be foreshadowed by the discoveries of Hertz, Tesla, and other workers of the day. As possible features of this future expansion, Mr. Houston dreams of a cheaper means for the production of electricity than is possible by the present method; perhaps producing it directly from the burning of coal; the entire replacement of the steam engine by the electric motor; the successful solution of the problem of aërial navigation, effected, possibly, by means of the electric motor, and being rendered possible as a result of improvements in the economical production of electricity; the replacing of the present electric light, with its preponderance of useless and injurious low heat rays, by some species of electrically produced light which shall possess a smaller proportion of the useless heat rays and a larger proportion of the desired light rays; a more intelligent means than are now adopted in the therapeutical applications of electricity to the curing of diseases; electrical transmission of pictures; electrical preparation of roadbeds by vitrifying the clay or soil *in situ*; and "an apparatus for the automatic registration of unwritten, unspoken thought, and its accurate repetition at any indefinite time afterward."

Science. A Weekly Journal devoted to the Advancement of Science. 41 East Forty-ninth Street, New York. Pp. 28. 15 cents a number; $5 a year.

We are glad to see the publication of Science resumed. There certainly is room, as Prof. Newcomb well observes in an editorial address to its readers, for a journal devoted to the promotion of intercourse among those interested in the study of Nature; and the wide separation of investigators in different centers of educational and civic life makes such a journal almost a necessity. Science, under its new auspices, will be conducted by an editorial committee of chosen students, each representing a field in which he is a specialist, and under the general editorial direction of Prof. J. McKeen Cattell. In the first number of the new Science, Prof. Newcomb explains the scope of the journal, and President Gilman invites communications from those who have matter suited to it. The leading place among the regular articles is given to a part of Dr. Brinton's American Association address on the Character and Aims of Scientific Investigation—a most appropriate subject with which to open the first number of the new journal; which is followed by the equally appropriate review of America's Relation to the Advance of Science, by G. Brown Goode. Prof. T. C. Mendenhall gives an account of the Legal Units of Electrical Measurement, now sanctioned by act of Congress. Major Powell discusses what in education are technically called the Humanities; Prof. C. Hart Merriam furnishes notes on Zoölogical Nomenclature; S. H. Scudder discusses the study of North American Orthoptera; several reviews of books appear; and notes are published on a variety of subjects.

Sea and Land. By N. S. Shaler, Professor of Geology in Harvard University. Illustrated. New York: Charles Scribner's Sons. Pp. 252. Price, $2.50.

Every thoughtful person who visits the seaside must have queried why there is in one place a gently sloping beach of sand, in another a stretch of loose stones, and elsewhere a ragged cliff rising abruptly from the water's edge, with a fringe of fragments at its foot. He who has voyaged upon the open sea has wondered how the fantastic icebergs that float by him were formed and what the dark depths of water beneath him may conceal. To answer these and similar questions Prof. Shaler's book has been prepared. He explains first what forces are at work carving the edge of the land and how different effects are produced under different conditions. Passing to the depths of the sea, he tells how our knowledge of the ocean floor has been obtained, and describes the processes going on upon it. The career of an iceberg is then sketched, after which the subject of harbors is discussed at some length. The different kinds of harbors are distinguished, and the ways in which they are formed or destroyed are described, the effects of tide and the work of animal and vegetable organisms finding place under the latter head. The book is handsomely printed and is embellished with many full-page illustrations as well as smaller pictures in the text.

An Elementary Chemistry. By George Rantoul White, A. M. Boston: Ginn & Co. Pp. 272. Price, $1.10.

The teacher who likes to roll along in a rut would be a good deal disturbed by this book; it is so different from other books. It is an experimental text-book, but it is different from others of this class. The various chemical properties and relations of matter are taken up in the order in which the author believes they can be learned most readily and profitably—not according to any logical or systematic arrangement. The first thing the student is told to do is to test the properties of iron, and cause it to combine with oxygen. The method of the book is to require the student to start from observations upon things and to arrive at general laws and principles by induction. Taking statements on authority is discouraged. In the words of the preface: "At first the student is told little or nothing. He is compelled to find out all things for himself. To assist him in finding the essential, and to make sure that he has succeeded in this, frequent questions are inserted in the text of the experimental part." Gradually proceeding to more complicated cases, the author finally puts before the student, under the head of A Chemical Investigation, such a problem as the chemist has who is working on the borderland of the science. After going through this experimental drill the student is led to trace the history of chemistry, "to note what observations lead to the establishment of certain theories, and the recognition of what facts lead to the overthrow of these same theories; to recognize the gradual unfolding of chemical law; and, finally, to inspect the foundations on which our present atomic theory rests, and have an opinion of his own as to its stability." Another feature of the book is that chemical symbols are not used until the need of them has been made apparent. Full and practical directions for manipulating apparatus, taking notes, etc., are given. The author is instructor in chemistry at Phillips Exeter Academy, and the book is adapted to the needs of academy students.

A Manual of Microchemical Analysis. By Prof. H. Behrens, of the Polytechnic School in Delft, Holland. With 84 illustrations. London and New York: Macmillan & Co. Pp. 246. Price, $1.50.

Seventeen years ago the Bohemian chemist Boricky published a memoir which gave rise to a new branch of chemistry. This is microchemical analysis. Other investigators have contributed to its advance, and now one of them gives us a view of its present condition. Devised for the examination of minute quantities of minerals, it has been applied also to alloys, and Prof. Behrens expects it to rival blowpipe analysis in convenience and value. The method consists in dissolving a particle of the substance to be examined, adding a minute drop of reagent to a drop of the solution, and observing the result through the microscope. Often the drop of solution is evaporated and the form and color of the crystals it deposits are observed microscopically. Something may be learned of the composition of alloys by heating polished surfaces or etching them with acid. The practical applications of all these and many other devices are described in the manual before us, and the forms of the crystals of many substances are shown in engravings.

The Egyptian Book of the Dead. The Most Ancient and the Most Important of the Extant Religious Texts of Ancient Egypt. Edited, etc., by Charles H. Davis. New York: G. P. Putnam's Sons. Pp. 186, followed by Ninety-nine Hieratic and Hieroglyphic Plates. Price, $5.

The Egyptian Book of the Dead is one of the most remarkable books in existence. Parts of it are among the oldest texts extant, some of its chapters having been inscribed in the tomb of the Queen of Mentuhotep, of the eleventh dynasty, and one of them being ascribed to the pen of the god Thoth. Very few of the Egyptian manuscripts are of earlier date. It is, further, most obscure as to its meaning. In a literal translation it is pure nonsense, and its real meaning has to be incorporated into it from the knowledge of the ancient mysteries possessed by the reader. Some of the old priests probably comprehended it; and the more advanced of the Egyptological students of the present are gradually getting glimpses of its significance. It is essentially mythological, Mr. Davis says, "and assumes the reader's thorough knowledge of the myths and legends. No one is capable of translating a single chapter of the Book of the Dead who has wrong ideas about the religion and mythology of Egypt, and is unable to understand the numerous technical and mystical expressions which everywhere occur. It is not always easy to discover what was the primitive concept attached to a particular word. The difficulty is not in literally translating the text, but in understanding the meaning which lies concealed beneath familiar words. However, the mystical nature of the text is gradually being unraveled, and, no doubt, will be ultimately understood. But we will have to make further researches into unwritten history, or perhaps have a fuller knowledge of Egyptian symbols or allegories." The text is further obscured by errors of copyists, and muddled by comments and attempts to explain the meaning which have been interpolated into it and made by subsequent copyists to run on as if they were part of the original. The purpose of the book—which is often called the Funereal Ritual—was to instruct the soul in that which would befall it after death, and to furnish prayers to protect it against dangers and assure it desired blessings. "It was given to the departed to carry with him to the grave as a passport and aid to the memory." Accordingly, more or less of it, according to the means of the deceased, was wrapped up with the mummy or inscribed on its coffin or on the walls of its tomb. About a thousand copies of it exist among the papyri of European museums, and some hundreds in Egyptian home collections. The longest copy known is the Turin hieroglyphic papyrus, containing one hundred and sixty-five chapters, which is reproduced in this volume. Yet it is not complete, for many chapters found in other copies are not contained in it. Of the translations, Dr. Samuel Birch's, made thirty years ago from the Turin papyrus, is literally correct, but nonsense. A more intelligible translation of it has been made by M. Pierret, and an exact and scholarly translation is in preparation by Dr. Le Page Renouf; while careful studies of it have been made by Lepsius, M. Edouard Naville, and M. Renouf. The translation of Mr. Davis is made, with that author's permission, from M. Pierret's version in French, and is purposely rather exact than graceful; and it has been revised in the light of the additional knowledge that has been gained since Pierret's work was published, in 1882. Excellent and valuable preliminary chapters are given on The Mythology and Religion of Primitive Peoples; The Egyptian Pantheon, with illustrations of some of the more important deities; The Mythology of the Ancient Eygptians; and a historical and critical introduction to the book.

A Text-Book of Inorganic Chemistry. By G. S. Newth, F. I. C., F. C. S. London and New York: Longmans, Green & Co. Pp. 667.

The periodic classification has been taken as the basis for the arrangement of the matter in this fully detailed treatise. Definitions and principles are placed in the fore part of the book, but the student without a teacher (suggestions to teachers being delicately withheld) is advised to study only four of the fifteen chapters of such material before taking up the descriptions of the four typical elements—hydrogen, oxygen, nitrogen, and carbon—and their compounds, which constitute the second division of the work. The other elements are taken up by subdivisions of the periodic system, beginning with "Group VII, family B," and ending with the "transitional elements of the second and fourth long period." The four elements first named are taken up out of their order so as to bring well forward such subjects as water, the atmosphere, and combustion, to which the student should be introduced at an early stage. Only general descriptions of the rare elements and their compounds are given, and technological details of metallurgical processes are dispensed with. While the performance of experiments by the student is strongly urged, another book by the same author is referred to for the necessary directions.

Radiant Suns. A Sequel to Sun, Moon, and Stars. By Agnes Giberne, with a Preface by Mrs. Huggins. New York: Macmillan & Co. Pp. 328. Price, $1.75.

In this work the author has tried to avoid treading in the same grooves, and to make a book entirely supplementary to Sun, Moon, and Stars, in which subjects which could there be merely glanced at should be entered more closely into, and difficulties explained which could not there be dealt with, and which should give a large amount of fresh information. The book falls into three divisions—a history of astronomy, in which short outlines are given of the lives of the greater astronomers of the past; a discussion of spectrum analysis, what it means and what it teaches; and a view of the stellar universe as it is now known, with references to some great theories which may in future gradually take their places as proved truths. Mrs. Huggins finds value in this book and its predecessor, not only in their describing well the facts of astronomy, but also in their appealing constantly and wisely to the imagination in a way that can not fail to give mental training to their readers. "Indeed," she says, "there are few pages in the present work in which, beyond the scientific information directly given, there is not also enforced indirectly some lesson of high practical value."

The Life of Richard Owen. By his Grandson, the Rev. Richard Owen, M. A. Also an Essay on Owen's Position in the History of Anatomical Science, by the Right Hon. T. H. Huxley, F. R. S. With Portraits and Illustrations. New York: D. Appleton & Co. Two Volumes. Price, $7.50.

A life extending over all but the first four and last eight years of the present century, and devoted to biology in connection with several of the leading scientific institutions of Great Britain, could not fail to have strong features of interest. When sixteen years of age Richard Owen was apprenticed to a "surgeon and apothecary." Later he attended lectures at Edinburgh, whence he went to London and studied under Abernethy. Soon after he had begun to practice his profession Abernethy, who had noticed the peculiar ability of his pupil as a dissector, obtained for him an appointment to arrange and catalogue the collections formed by John Hunter. Two years later he was appointed a lecturer at St. Bartholomew's Hospital, and after six years became Professor of Comparative Anatomy at the same institution. This was in 1834. In 1836 he was appointed Hunterian Professor at the Royal College of Surgeons, and the next year the professorship of anatomy and physiology was also assigned to him. As Hunterian Professor Owen delivered twenty-four lectures annually until 1855, making them illustrate Hunter's collections, and without ever repeating a subject. His time was now fully occupied with lecturing and scientific research. In the year 1831 he had published eight papers on the anatomy of various creatures that had died in the Zoölogical Gardens. His memoir on the Pearly Nautilus, published in 1832, "placed its author, at a bound, in the front rank of anatomical monographers." In his memoirs on the anthropoid apes, the monotremes, and the marsupials Owen gave the most complete accounts of the structure of these animals then extant. Memoirs of similar character on the apteryx, great auk, and dodo were produced by him. He discovered that terrible parasite the *Trichina*. His researches on fossil forms were also important. Says Huxley, "Unless it be in the *Ossemenes Fossiles*, I do not know where one is to look for contributions to paleontology more varied, more numerous, and on the whole more accurate than those which Owen poured forth in rapid succession between 1837 and 1888." His studies in philosophical anatomy were directed chiefly toward the "archetype" of the vertebrate skeleton and the problem of parthenogenesis.

The story of such a life, with its accompaniment of struggles, labor, recreation, domestic affairs, and honors, is told in the two volumes before us. The material for this biography was plentiful and highly satisfactory, consisting of twelve hundred letters from Owen to his wife and sisters, besides many to other persons, and fifteen thousand received by him in the course of his long life, also the diaries kept by him and his wife. The journal of his wife is a full record not only of the important facts but also of the trivial details of their joint lives, and large use has been made of it. By its aid we see Owen attending meetings of scientific societies and committees, with an occasional dinner, public or private, writing late into the night on his lectures or monographs, receiving leading naturalists at his house for consultation or study with the microscope, and now and then going with his wife to the zoölogical garden, or for an evening's recreation at the theater. Music and novels were other recreations that he greatly enjoyed. His visits to various parts of Great Britain and the Continent are described in very readable letters to some member of his family who did not accompany him. Many comical incidents and characteristic anecdotes of celebrated persons give a genial warmth to the recital.

Prof. Huxley's essay traces the progress of comparative anatomy before 1830, sets forth Owen's contributions to the science, and discusses his views on the "archetype" and "parthenogenesis." His conclusion in regard to Owen is that "his claims to a high place among those who have made great and permanently valuable contributions to knowledge remain unassailable." A bibliography of Owen's publications and a list of his honors close the record.

A History of Amherst College. By William S. Tyler, D. D., LL. D. With an Introductory Note by Richard Salter Storrs, D. D., LL. D. Published by subscription. Frederick H. Hitchcock, 55 West Forty-fifth Street, New York. Pp. 312. Price, $1.50.

A history of Amherst College, forming a substantial octavo volume, was written by Dr. Tyler soon after the fiftieth anniversary of the institution, in 1871. He has now told the story of the college in smaller compass and brought it down to the close of President Seelye's administration, in 1890. The labors of the founders of the college, the financial struggles of its early years, its period of depression and triumphant recovery, and its later years of increased usefulness through enlarged resources are set forth in a way to compel the respect of all friends of education. Although Amherst was founded for the education of preachers and missionaries, and "the gift of tongues" was deemed a prime need of its students, science was represented by chemistry and anatomy in its earliest course of study, and rapidly increasing facilities have since been accorded to it. Amos Eaton lectured on chemistry and botany in the early years of the college. Prof. Snell, with a wonderful Yankee handiness in constructing apparatus, had charge of the teaching of physics for many years. The instruction of these men, together with that of Shepard in mineralogy, of Adams in zoölogy, of President Hitchcock in geology, and the younger Hitchcock in physiology, has enabled the students of Amherst to go forth into the world with some understanding of Nature, of which man is no longer ashamed to confess himself a part. The volume is generously illustrated with portraits of the several presidents, and views of the buildings and grounds of the college. An appendix contains a list of donations to the college, the number of faculty and students year by year, etc., and there is a full index. The book will appeal strongly not only to the alumni of Amherst but also to every New-Englander who is proud of the educational institutions of his native section and to friends of learning everywhere. A limited *édition de luxe* at five dollars is announced.

Three reprints, from the Transactions of the Fifth Session of the International Congress of Geologists held in Washington in 1891, are geological, geographical, and topographical descriptions of the *Great Plains of the North* and of *the Yellowstone Park*, by Arnold Hague; and a paper in French by Lester F. Ward, on the *Principles and Methods of Study of Geological Correlation by Means of Fossil Plants.*

Science Progress is a new monthly review of Scientific Investigation, published by the Scientific Press, Cambridge, England, and edited by J. Bretland Farmer, with the co-operation of a number of investigators, masters in their several fields. Profs. Armstrong, Burdon-Sanderson, Dunstan, Fitzgerald, Goebel, Halliburton, Ray Lankester, Roy, etc., are named as among the contributors to the earlier numbers. The articles are of high character, about midway between the popular and the technical—that is, within the understanding of the general reader, but requiring thoughtful attention.

Dolls of the Tusayan Indians is the subject of an interesting paper published originally in the *Internationales Archiv für Ethnographie*, by *J. Walter Fewkes.* The dolls are illustrated in a series of striking pictures, colored like the originals, and described as examples of wood-carving and symbolism among the Hopis. This art, according to the priests, is very ancient; and many of the objects placed on the altars in subterranean chambers where secret rites were performed are said to have been brought up from the under-world when the ancients emerged from the *si-pa-pu*, or traditional opening in the earth out of which the races of man originally appeared. The images, often called idols, but in reality only dolls, are made in great numbers by the Tusayan Indians and present very instructive objects for the study of symbolic decoration. They are interesting as affording valuable information in regard to the Hopi conception of their mythological personages.

Recreation is a new monthly magazine "devoted to everything that the name implies," of which *G. O. Shields* is editor and manager, and which is published at 216 William Street, New York, for $1 a year. The first number contains a varied table of contents, of which the most striking articles are President D. S. Jordan's How the Trout came to California, and Captain H. H. Bellas's A Winter with the Cheyennes; and the illustrations are very attractive.

The second part of *Clarence B. Moore's* memoir on *Certain Sand Mounds of St. John's River, Florida*, represents the results of seven additional months' continuous work subsequent to the preparation of the first part, with a large body of assistants. The river has been covered practically from its source to its outlet, and the author believes that every mound of any importance bordering on the stream, except two on Murphy Island, has been examined. The descriptions are liberally illustrated with representations of the objects recovered from the mounds. A separate reprint is also published by Mr. Moore from the memoir, on the copper found in the mounds—*As to the Copper from the Mounds of the St. John's River, Florida.* In this paper are considered copper objects of European and of aboriginal design, the archæological aspects of the finds, and the results of chemical examinations. The conclusions as summarized are favorable to the aboriginal origin of the copper, and point to the Lake Superior region as the main source of supply.

The Progress and Trend of Scientific Investigation in Canada is the subject of the presidential address of 1894 of *George M. Dawson* as President of the Royal Society of Canada. The address presents the work of the Geological Survey, the Meteorological Service and Magnetic Observatory, the Dominion Lands Survey, experimental farms, the hydrographic surveys, the study of the fisheries, the Literary and Historical Society of Quebec, the Natural History Society of Montreal, the Canadian Institute at Toronto, the Entomological Society of Ontario, the Literary and Scientific Society of Ottawa, the Botanical Club of Canada, and the Royal Society of Canada.

A paper by *Edward A. Burt*, on a new species of fungus—*A North American Anthurus, its Structure and Development*—constitutes No. 14 of the third volume of the memoirs of the Boston Society of Natural History. This *Anthurus* was found growing in a sandy cornfield on a hillside near East Galway, N. Y., where it was represented by thirteen discovered mature individuals and several "eggs" in various stages of growth, and is the only species at present known in the northern continents. Two other species are known in South America and one in Australia, the differences from which of this species are pointed out. It is named *Anthurus borealis*. The paper is accompanied by two plates of illustrations of structure.

Around the World, an illustrated magazine of tours, travels, and natural history, devoted to a knowledge of the earth and of its inhabitants, of which Prof. *Angelo Heilprin* is editor, began its second year with the number for December, 1894. It has been received with a favor, the publishers represent, both by the general public and by specialists in scientific work, which emphasizes the need of a magazine covering its special field. Its general appearance and make-up go far to justify the claims its friends set up, that in its own field it stands alone in this country, and "in its pictorial features it surpasses all similar publications of the Old World." The December number contains articles on Wintering on the Riviera, The Pygmies of the Congo, Among the Thibetans, American Cave Dwellers, The Sargasso Sea, Notes on Mountains and Mountaineering, Hints to the Traveler and Notes on Appliances of Travel, and full-page illustrations of Popocatepetl, Bellagio, on Lake Como, Cliff Castle, and the Zebra. (Monthly: The Contemporary Publishing Company, New York and Philadelphia; 15 cents, $1.50 a year.)

The Mechanism of Weaving is designed by the author, *T. W. Fox*, to supply what seems to be a deficiency of books in which the mechanical side of the art is made prominent. Several admirable books have been written on weaving during recent years, but in them attention has been predominantly directed to designing, fabric and structure, and calculations relating thereto. The present work aims to put within the reach of the student, in as comprehensive a manner as possible, exact and practical information bearing upon the principles of weaving as exemplified in the various processes of the trade. Numerous topics of practice are treated, beginning with the description of the power loom, and continuing with chapters on healds, shedding or dividing the warp, over-and-under motions, the figuring harness, card cutting, picking, and other movements or elements of the art, described in detail. (Published by Macmillan & Co. Price, $2.50.)

A collection of *Lectures on Biology*, reprinted from the American Field, contains four lectures on that subject delivered by Dr. *R. W. Shufeldt*, on invitation, at the Catholic University of America, in January, 1892. The first lecture relates the history of biology and defines its present domain, and calls attention to the light it casts upon the unity of organization among plants and among animals, and upon the interdependence of the various natural divisions of science. The second lecture considers its relations to geology. The third treats of its value as a study to the medical man and to every student of Nature, as well as to the professional biologist. The fourth lecture forecasts its future growth and influence, showing how it has affected the trend of human thought, and now demands a prominent place in any scheme of education worthy of the name, and predicts that its beneficial influence is destined to be felt in every field of activity in which men engage.

PUBLICATIONS RECEIVED.

Agricultural Experiment Stations. Bulletins and Reports. New York (Geneva): No. 74. On the Application of Fungicides and Insecticides. Pp. 24, illustrated.—No. 76. Notes on Strawberries for 1894. Pp. 16.—No. 77. Dairy Cattle; and Milk Production. Pp. 32.—North Dakota Weather and Crop Service (Bismarck), November, 1894. Pp. 15.—Purdue University (Lafayette, Ind.): No. 53. Five Subjects. Pp. 16.—South Carolina, with Report of Clemson College. Pp. 79.

American Public Health Association Journal, January, 1895. Quarterly, Concord, N. H. Pp. 125. $1.25; $5 a year.

Anti-vivisection. Published Monthly, under the Auspices of the Illinois Antivivisection Society, by Mrs. Fairchild Allen, Aurora, Ill. Pp. 20. 50 cents a year.

Bardeen, C. W. Roderick Hume. The Story of a New York Teacher. Second edition, from new plates. Syracuse, N. Y.: C. W. Bardeen. Pp. 319. 50 cents.

Bhikshu Subhādrā. A Buddhist Catechism. New York: G. P. Putnam's Sons. Pp. 107.

Bryant, W. C. The American Scheme of State Education. St. Louis: W. B. Bell Book and Stationery Company. Pp. 66.

Call, Richard Ellsworth. The Life and Writings of Rafinesque. Louisville, Ky.: John P. Morton & Co., Printers to the Filson Club. Pp. 227. $2.50.

Carhart, H. S. Physics for University Students. Part I. Mechanics, Sound, and Light. Boston: Allyn & Bacon. Pp. 344.

Chittenden, F. H. Two New Species of Beetles. Pp 2.

Clemson Agricultural College, South Carolina. E. B. Craighead, President. Circular of Information, No. 2, 1894. Pp. 52.

Conn, Prof. H. W. The Biological Laboratory of the Brooklyn Institute, Cold Spring Harbor, L. I. Frederick Mather, Superintendent. Pp. 8.

Davies, T. A. Reading the Bible by Co-ordinates of Truth. Pp. 32. New York. Free.

Duluth, City of, Minn. Annual Report of the Board of Education, July 31, 1894. Pp. 108.

Farquhar. A Stable Monetary Standard. Salem, Mass.: G. A. Aylward, Printer. Pp. 32.

Fewkes, J. Walter. The Walpi Flute Observance. Pp. 24, with Plates.

Gowers, W. R. The Dynamics of Life. Philadelphia: P. Blakiston, Son & Co. Pp. 70. 75 cents.

Herdler, A. W. A Scientific French Reader. Boston: Ginn & Co Pp. 186.

Herrick, C. Judson, Boston University. The Cranial Nerves of Amblystoma Punctatum. Pp. 16, with Plate.

Heysinger, J. W. The Source and Mode of Solar Energy throughout the Universe. Philadelphia: J. B. Lippincott Co. Pp. 363.

Hibberd, James F., Richmond, Ind. The Relations of Matter and Mind. Pp. 12

Hodge, F. W. List of the Publications of the Bureau of Ethnology. Washington: Government Printing Office. Pp. 25.

Hollick, Arthur. Dislocations in Atlantic Coastal Plain Strata. Contributions from the Geological Department of Columbia College.

Holmes, W. H. An Ancient Quarry in Indian Territory. Washington: Bureau of Ethnology. Pp. 19, with Plates.

Jones, Richard. The Growth of the Idylls of the King. Philadelphia: J. B. Lippincott Co. Pp. 161.

Kemp, J. F. The Nickel Mine at Lancaster Gap, Pa.; and the Pyrrholite Deposit at Anthony's Nose on the Hudson. Contributions from the Geological Department of Columbia College. Pp. 14.

Kersey, John A. Ethics of Literature. Marion, Ind.: E L. Goldthwait & Co. Pp. 572.

Keyes, C. H., State Geologist. Missouri Geological Survey. Vols. IV and V. Paleontology. Jefferson City. Pp. 271 and 266, with 56 Plates.

Latch, Edward B. Mosaic Chronology and the Great Pyramid of Egypt. Philadelphia: J. B. Lippincott Co. Pp. 30.

Los Angeles Public Library. Annual Report of the Board of Directors, etc. Pp. 38.

Mach, Ernst. Popular Scientific Lectures. Translated by Thomas J. McCormack. Chicago: Open Court Publishing Co. Pp. 313. $1.

Martin, George H. The Evolution of the Massachusetts Public-School System. New York: D. Appleton & Co. Pp. 284.

Mateer, H. N. Evolution and Christianity. Wooster, Ohio. Pp. 20.

Means, James, Editor. The Aëronautical Annual, 1895. Boston: W. B. Clarke & Co. Pp. 171. $1.

Merriam, Dr. C. Hart. Laws of Temperature Control of the Geographic Distribution of Terrestrial Animals and Plants. Reprint from the Geographic Magazine. Pp. 10, with Maps.

Newton, Alfred, and Gadow, Hans. A Dictionary of Birds. Part III (Moa-Sheathbill). London: A. & C. Black. Pp. 260. $2.60.

Oels, Dr. Walter. Experimental Plant Physiology. Translated and edited by D. T. MacDougal, Minneapolis, Minn. Morris & Judson. Pp. 86.

Ormsby, F. E., Editor. Planets and People. Mysteries from the Sun. Monthly. Vol I, No. 1. Chicago: Ormsby & Sprague. 25 cents, $2 a year.

Our Animal Friends. An Illustrated Monthly Magazine. Vol. XXI. September, 1893, to August, 1894. New York: American Society for the Prevention of Cruelty to Animals. Pp. 288.

Parker, L. F. Higher Education in Iowa. Bureau of Education, Washington. Pp. 190.

Peckham, George W. and Elizabeth G. The Sense of Sight in Spiders; with Some Observations on the Color Sense. Wisconsin Academy of Sciences, Arts, and Letters. Pp. 32.

Pickering, Edward C. Forty-ninth Annual Report of the Director of the Astronomical Observatory of Harvard College, Cambridge, Mass. Pp. 14.

Powell, J. W., Director. Twelfth Annual Report of the Bureau of Ethnology. Washington: Government Printing Office.

Powell, Lyman F. The History of Education in Delaware. Washington: Bureau of Education. Pp. 186.

Publishers' Circular. Christmas Number, 1894. London. Pp. 272.

Riggs, Stephen R. Dakota Grammar, Texts, and Ethnography. Washington: Bureau of Ethnology. Pp. 239.

St. Nicholas, Vols. I to XXI, Index to. Cambridge, Mass.: W. M. Griswold. Pp. 20.

Seymour, Paul H. Bibliography of Aceto-Acetic Ester and its Derivatives. Smithsonian Institution. Pp. 148.

Shipping. A Monthly Review of Items of Interest to the Shipping Community. London: Wilkinson Bros.

Spencer, Herbert. Weismannism Once More New York: D. Appleton & Co. Pp. 24.

Spencer, J. W. Reconstruction of the Antillean Continent. Rochester, N. Y.: Geological Society of America. Pp. 36.

Stone, Witmer. The Birds of Eastern Pennsylvania and New Jersey. Philadelphia: Academy of Natural Sciences. Pp. 185.

Tariff Laws of 1890 and 1894. Comparison of Text. Washington: Government Printing Office. Pp. 241.

Thompson, Sylvanus P. Elementary Lessons in Electricity and Magnetism. New Edition, revised throughout, with Additions. New York: Macmillan & Co. Pp. 628. $1.40.

Tolman, William H. History of Higher Education in Rhode Island. Washington: United States Bureau of Education. Pp. 208, with Plates.

Ward, C. Osborne. The Equilibration of Human Aptitudes, and Powers of Adaptation. Washington: National Watchman Company. Pp. 333. $1.25.

Ward, Lester F. Natural Storage of Energy. Washington. Pp. 12.

White, Theodore G. The Geology of Essex and Willsboro' Townships, Essex County, N. Y. Contributions from the Geological Department of Columbia College. Pp. 14, with Plates.

POPULAR MISCELLANY.

Transportation of Dust in the Air.—In his studies of the atmospheric transportation of matter, Prof. J. A. Uddin finds that the velocities in the atmosphere being so much greater than those obtaining in rivers, lakes, and seas, the distances over which materials may be transported in it will be correspondingly greater, as was shown by the Krakatoa dust, of which the finer particles circled round the earth for months and even years. The greater depth of the aërial ocean renders it but little dependent in its movements on smaller elevations of the land. Few of our mountain ranges are so high as to stand materially in the way. "While the conditions requisite for much aërial erosion are limited to rather small areas of the land of the globe, there can be little doubt that deposition is much more general and widespread; for dust is carried everywhere, and if it be conceded that the atmosphere is never entirely free from dust, it follows that sedimentation occurs wherever and whenever there is a comparative calm. In places in the ocean where sedimentation is known to be very slow, atmospheric dust may be supposed to form an appreciable part of the deposits. The areas of deposition being much greater than the areas of erosion, it is evident that the accumulations of atmospheric sediments, as a rule, are insignificant, only exceptionally exceeding on the land the secular erosion by water, and therefore accumulating only in such exceptional cases. From a dynamical point of view the wind theory would appear to furnish an adequate explanation of the occurrence of the loess in the Mississippi Valley, at least as to most of its phases."

Habits of Polar Bears.—Appropriately to the recent mortal illness of the large polar bear in the London Zoölogical Gardens, a writer in the London Spectator remarks upon the mistake we make in supposing that the denizens of the frozen north necessarily suffer unduly in warmer climates, that "in all stories of arctic travel the extreme of cold appeals so strongly to the imagination that the heat of the nightless summer, in which the Eskimos strip themselves naked in their snow houses, is often forgotten. The good health and long life of the polar bears in this country [England] is less surprising than it at first appears when this extraordinary range of arctic temperature is remembered; moreover, the white bears are absolutely indifferent to fog and wet. Creatures that live and thrive on islands like Nova Zembla, where half their life is spent in fog and darkness, are little troubled by the London fog and damp of Regent's Park. . . . They will plunge and roll in the bath with as much pleasure in pouring rain or when the tank is full of clinking ice as on a hot summer day, and the only weather which seems to cause them discomfort is a hot August afternoon, when they pant and loll out their tongues like Newfoundland dogs." The size of these bears approaches that of the ox or the elephant, rather than that of the true carnivora. In some respects the bears' powers of movement exceed those of cats. They "can maintain a gallop at a pace equal to that of a fast horse, leap wide gulfs with ease, swim fast enough to catch a salmon, and dive like a seal or an otter. They heartily enjoy their play, but are dangerous animals. No creatures are more carefully kept at arm's length by their keepers. Men who will rub their hands over a lion's face and eyes or pat the neck of a tiger, shift a bison bull across its stall like a bullock, or handle a python like a length of rope, would think it rash to put hand or limb within reach of these bears. . . . The fierceness of the polar bear is probably due to his enforced carnivorous diet. Every other bear is largely a fruit, vegetable, and insect feeder; but in the frozen north the polar bear lives by necessity mainly on fish, carrion, seals, walruses, and birds. Its notion of an 'egg for breakfast' is rather amusing. It will clear an islet of eider-ducks' eggs in a few hours."

Dispersal of Fresh-water Shells.—A recent book by Mr. H. W. Kew deals with the means by which fresh water and land shells are dispersed. The occurrence of these shells is sometimes very puzzling, as when fresh-water shells are found in isolated ponds. It is surprising how varied the means of distribution are. The animals are carried down stream on various floating objects. A case is cited by the author in which a number of anodons were carried away by a whirlwind and fell with the rain. Canon Tristram found the eggs of a mollusk attached to the foot of a passing mallard which he shot in the Sahara a hundred miles from water. A few instances have been noted in which birds on the wing have been shot with bivalves adhering to their toes. Insects also lend their aid, and a water-beetle has twice been captured on the wing with *Sphærium* attached to its legs. Another specimen was caught with *Ancylus* attached to its wing-case, and other aquatic insects have been found with mollusks attached to them. The actual process of transportation of land shells has not often been observed. Some live snails were once found in the stomach of a wild pigeon three days after it had been shot, and an operculated land snail has been found dragged along on the foot of a bumblebee on which it had caught. An isolated dew pond after an existence of ten years will generally yield several species of fresh-water mollusca, and a mediæval fish pond has a considerable fauna. A church or castle built of limestone, but surrounded by non-calcareous desert, is for a large group of land snails the equivalent of an isolated pond; but it is only on very old buildings that one finds colonies of the special limestone species. Mr. Kew also discusses the dispersal of shells by human agency.

Hearing of Infants.—In her Notes on the Development of a Child, issued in the series of University of California Studies, Milicent W. Shinn reports that the infant started violently while nursing, when a paper was torn some eight feet away, on the third or fourth day after birth, and at several times on that and the few following days she started and cried out even in sleep when a paper was rustled sharply as her father sat by the bed. During the first week she did not seem to notice when on his return in the afternoon her father sat close by, reading aloud or talking, but in the second and third weeks she always became restless at this time. The more modulated voices of women who were in the room the rest of the time appeared not to affect her at all. The sensitiveness to sound seemed variable, for on the twenty-third day, when Miss Shinn purposely rustled paper near the baby, it produced no clear reaction, nor did a table call bell struck suddenly and sharply at two feet and even one foot from her head. On the twenty-seventh day she showed no sign of hearing *single notes* on the piano from the highest to the lowest, yet she started at a hand-clap behind her head. Ten days later, while the baby was lying half asleep on Miss Shinn's lap, the servant brought in a tin bath tub and set it down abruptly so that the handles rattled. The infant started violently with a cry so loud that it brought in her grandfather from two rooms away to see what was wrong. She also put up her lip with the first crying grimace she had ever made, and showed the effect of the fright in a disturbed face for five minutes. Yet throughout the first two months there were also many times when she failed to pay any attention to sounds quite as striking as the few she did notice. The great variation in sensibility was especially noticeable in the second month.

The Tropical Climate.—Respecting the climatology of tropical Africa, E. G. Ravenstein represents that by ascending a mountain we might, even in tropical Africa, enter a region the mean temperature of which coincided with that of England; but if we at the same time considered the annual and daily ranges of temperature, we should find that a tropical climate differed exceedingly from that of the temperate regions. In the latter the annual range was considerable, the daily range small. The character of a tropical climate was the very reverse, for there the difference between the coldest and warmest months of the year was small, while the difference between the temperature of day and night was very great. Nor could we escape these features, even though we ascended the loftiest mountains to be met there. These conditions inevitably led to anæmia and racial degeneracy. Malaria prevailed throughout, even on the plateaus, and some of those explorers who had been loudest in praising the climate as being thoroughly well adapted to European constitutions had fallen victims to its deleterious influences. Europeans might certainly "live" in Africa with occasional holidays in Europe, and they could superintend native labor, but no locality had been discovered as yet where it would be advisable for European agriculturists and colonists to settle down. The districts most favorable to European settlers appeared to him to be some of the hill stations and the steppelike plateaus which occupied so large an area in eastern Africa, and extended southward into Cape Colony. Speaking of the rainfall, Mr. Ravenstein said that it was sufficient in most parts, but very irregular, so that works of irrigation would be required wherever agriculture on an extensive scale was to be carried on. The humidity, which in combination with great heat produced a climate very trying to the strongest constitutions, was, fortunately, not excessive over a considerable portion of Africa, including all the steppe lands.

Human Characteristics in Apes.—Human characteristics, according to Dr. Lydekker in Knowledge, are most largely developed in the teeth and jaws of the young of the manlike apes and of the gibbons at all ages, and in the skull of the former class. Among other features in which the manlike apes differ from monkeys and resemble men are the absence of dilatable pouches in the cheeks for the storage of food, the loss of the tail, and the flattened instead of laterally compressed form of the breastbone. The gibbons alone retain the naked patches on the buttocks characteristic of the monkeys, but only in a much reduced condition. The gorilla and chimpanzees further differ from the other members of the group, and thereby resemble man alone in the loss of the so-called central bone of the wrist—a bone occupying a nearly central position between the upper and lower rows of small bones of which this joint is composed. What may be the object of the disappearance of this bone it is not easy to say, but the fact that it is wanting in the two genera of apes just mentioned is very significant of their close structural affinity with man. In one respect the manlike apes stand apart from both the human and the monkey type, namely, in the great relative length of the arms as compared with the legs, the disproportion being most strongly marked in the gibbons, which are actually able to walk in the upright posture with their bent knuckles touching the ground. The present distribution of the anthropoid apes clearly points to the existing species being the last survivors of a group which was once widely spread over the Old World, when warmer climatic conditions prevailed over what we now call the temperate regions. Of the four existing genera of manlike apes the chimpanzees (*Anthropopithecus*) are clearly those which come nearest to man. The chimpanzees and the gorilla alone resemble man in having seventeen vertebræ between the neck and the sacrum, and likewise in the absence of the central bone in the wrist, although they differ in the comparatively unimportant feature of possessing an additional pair of ribs. The gibbons, while they are much differentiated from man, are the only apes which habitually walk in the upright position; and although they frequently aid themselves by applying the hands to the ground, they often while walking clasp them together at the back of the head. In addition to this peculiarity these creatures are remarkable for the extreme agility of their movements and their loud, unearthly cries. The delicacy of their touch is well marked. It is shown by the animals in the London Zoölogical Gardens when they amuse themselves by playing with spiders, which they allow to descend by spinning a thread attached to a finger, then suddenly jerk them back into their hands, and eat them with evident relish.

Exploration of the Upper Air.—Among the ways in which the upper air may be explored for the determination of its physical and dynamical qualities, Prof. M. W. Harrington, chief of the Weather Bureau, mentions investigation of the ray of light that has passed through it by spectroscopic examination and by observations of the twinkling of the stars and of the fluctuations on the margins of the larger celestial bodies when viewed in the telescope. The information obtained in these ways must, however, always be vague, because the total result received by us is the integration of the individual effects at each point of the path, and it is not practicable to separate the sum into its parts; while the knowledge obtained would be otherwise incomplete. Other means of systematic exploration of the free air are by towers, like the Eiffel Tower in Paris, kites, pilot balloons (without aëronauts), and balloons carrying aëronauts. Towers do not reach to the height it is desired to explore. The method by kites has been studied especially by Mr. William A. Eddy, of Bergen Point, N. J. Mr. Eddy uses tailless kites, placing them in tandem, and recommends that they be flown in groups of three. By such means he has attained heights of between four thousand and five thousand feet, and expects to reach fourteen thousand feet without great difficulty. Three tailless kites will fly when any one of the three will not in mild surface winds. They easily right themselves when reversed, and a tandem series of kites tends to prevent the jerking which might put the instruments out of order. The best possible anemometer is a balloon which is immersed in the air and moves freely with it. While such balloons can be employed only for the study of air currents, by a proper selection of places and dates and the assistance temporarily of theodolites and persons capable of working with them they could be made very useful. They would enable us to study the arrangement of air currents about definite meteorological phenomena, such as centers of high or low pressure. A more instructive but more expensive method is that of pilot balloons carrying automatic registering instruments. Balloons sent up by M. Hermite in 1892 carried means for the automatic record of pressure and temperature, but were disabled from registering the temperature by the cold stiffening the ink. They also carried a device for releasing and dropping cards for tracing the course of the balloon, which did not operate very satisfactorily. Much better service than this would be given by systematic work by a meteorologist who would make the ascension himself. Evidence points to the conclusion that the cloud layer and perhaps the upper cloud service is a region of especial activity in meteorological phenomena, but the facts on which such a conclusion could be verified are of such character that they would probably escape any automatic registry. Prof. Harrington furnishes estimates showing that the cost of operating any of these methods could be brought within reasonable limits.

Telpherage Lines.—The telpherage method of transportation is much better known in Spain, Italy, and the British colonies than in England and the United States. Its history may be hypothetically traced as an evolution from the single-rope bridges of the Himalayas and Thibet—cables made of twisted birch twigs on which the passenger crosses seated in a hoop, which he hitches forward while he holds the rope above with his hands. The next development is to fasten a cord to the hoop by which it is drawn to either side. A similar rough form of transport, except that buckets and wheels were used instead of the hoop, was employed for many years in the lead mines of the Peak of Derbyshire. A great impulse was given to the method by the invention of twisted steel cables, which made the lines stronger and more lasting. More than two thousand miles of telpher line are now in working order in Spain, Italy, South America, India, Cape Colony, China, and Japan. A line at Hong Kong, rising ten hundred and ninety feet in two miles, is used for the transportation of the European workmen at the port up the mountain at night, in order that they may sleep in purer air. It is led straight up the mountain side on high steel trestles, and carries, in little back-to-back cars, three persons on each side. At Table Mountain, Cape Colony, the suspending wire is carried in a single span fourteen hundred and seventy feet to the edge of the cliff, and thence in another span fourteen hundred feet to the top of the mountain. At the Rock of Gibraltar the wire runs, after a first leap of eleven hundred feet, straight to the summit on a series of lofty trestles in an ascent of one foot to every foot and a half. At

Bilbao, in Spain, nine lines run from the station at the foot of the mountain to the mines at different levels along the summit, and carry on an average twenty-three hundred tons of ore a day, none of which touches the level of the ground through its journey of five miles. It is calculated that one hundred thousand tons of ore can be carried on each of these cables before it becomes unfit for service. In crossing wide ravines or rivers, where one bank is lower than another, the gravity system is employed, the descending load being used to haul up the ascending car. In the Italian Alps a span of fifteen hundred yards is crossed without a support, and the method is soon to be applied to distances of two thousand yards.

Effects of Freezing on Plants.—The study of the effects of freezing upon plants has made less advance than that upon the best temperature to promote their growth. Some observations on the subject have been published by Signor Sebastiano Cavallero in Italian journals. All plants, aside from a few tropical species, resist temperatures ranging from the freezing point to 110° F. Beyond these extremes their resistance varies with the species. It is well known, moreover, that woody plants and many herbaceous plants freeze and thaw without being visibly injured. Forests of larches, birches, and pines grow in Siberia as high as the seventy-second degree of latitude, where the temperature often falls below −50° F. Several kinds of pines, willows, junipers, and alders grow along the Mackenzie River in latitude 69°. Mr. C. Gibbs, of Abbottsford, found in 1882 that the apple crop of twelve Russian villages, on the western bank of the Volga and south of Kazan, was valued at fifty thousand dollars a year. The fruits are sold in the markets of Nijni-Novgorod and Kazan. The region is subject to temperatures, as was experienced in 1887, of −40°. So apples grow well in the northern United States, where such temperatures are not unusual. The greatest resistance to cold is offered by seeds. Next in power of endurance are the cryptogams—mosses, algæ, and fungi. Except the hardy trees and shrubs of the temperate and frigid zones, and the hardy perennial herbs, most of the phanerogams perish between the freezing point and −20°. The most obvious effects of freezing upon plants are noticed in herbs and bulbs, which are stiffened and assume a shining appearance, often oleaginous and transparent. The effects of frost on trees are not visible unless the temperature descends to near zero, when they are often cracked to the center. Internally the sap is congealed in the tissues. Until recently the death of the plant was attributed to the frosts dilating the cells and distending the tissues. During the winters of 1887–'88 and 1888–'89 Signor Cavallero found, with a microscope magnifying three hundred times, that the tissues of a frozen vine were not torn and that the cells were not frozen. The crystals of ice, on the other hand, were formed only in the intercellular spaces. These facts do not afford indications of the vital condition of the plants, for they are observed in those that resist the cold as well as in those that succumb to it. The chemical modifications are of much greater importance, for they determine or attend the death of the frozen plant. Signor Cavallero's data agree with those of MM. Sachs and Jumelle, and point to the thawing as the principal factor of the death, for frozen plants may be made to live by taking precautions to thaw them slowly. In fact, while the plant is thawing rapidly, the water leaves most of the tissues before it is reabsorbed by them; and the abnormal concentration of the tissues provokes death. But when the thawing process is slow, most of the water returns to the cells and restores the equilibrium which primarily existed in them.

Sounds made by Ants.—That ants are capable of producing sounds intelligible to their fellows and even audible to our ears seems to be proved by the experiments of Sir John Lubbock, Landois, Robert Wroughton of Bombay, C. Janet, Forel, E. Warsmann, and others. It also seems to be determined that the sounds are produced by the rubbing together of superficial portions of the body. A simple yet ingenious contrivance is described for enabling an observer to hear and study these sounds. A glass funnel is set, small end down, in the middle of a square of window glass of five or six inches side, fitting closely enough to prevent the insects crawling out under it. A bunch of ants about as large as a chestnut and free from any foreign substance is dropped through the tunnel, and that is lifted up at once. While the ants are still confused, and before any of them can reach the edge of the glass, it is covered with another square like it, which has been surrounded, a short distance from its edge, by a pad of putty. This confines the ants and prevents their being crushed. The two plates of glass are pressed together to within about the thickness of an ant's body, but closer on one side than on the other, so as to hold some tight and leave others free to take such positions as please them. On applying this box of ants to the ear as one would a watch, a regular buzzing may be heard like that of water boiling in an open vessel, and with it some very clear stridulations. The ants may be kept alive several hours and even days in this prison if it is not air-tight; and whenever the ants are excited the stridulations may be heard very numerous and intense. The stridulations are supposed to be produced by rubbing the rough scaly surface of the chitinous covering, which is described as looking, when seen in one direction under the microscope, like the teeth of a saw.

Ancient Use of Copper.—The range of metals and alloys at the disposition of the craftsman is really very wide, but he, nevertheless, Prof. Roberts-Austen says, restricts his efforts within narrow limits, and employs but few materials. The pure metals and fine wrought-iron work are seldom used, and have hardly any applications in art industries except when in union with other metals. The two series of alloys which have prominence in the history of art metal work are those of copper and tin, the bronzes, and the copper-zinc series—the brasses. Next in importance should come the lead-tin alloys—the pewters. Of the alloys of the precious metals, the gold-copper, the gold-silver, and the silver-copper are the most important. Taking the bronzes first, the important question at once suggests itself whether copper was employed before the general adoption of the alloy of copper and tin in industrial art. Berthelot has given us the analysis of a little Chaldean statuette of a god, now in the Louvre, which is considered to date from 4000 B. C., and it proved to be of metallic copper. There is also an analysis by Berthelot of the scepter of King Pepi I of the sixth Egyptian dynasty. This scepter, believed to be thirty-five hundred or four thousand years old, now in the British Museum, is of pure copper. From the anthropological point of view copper plays an essentially different part in prehistoric culture now from what was assigned to it a short time ago. Whereas it had been assumed that copper periods existed in Europe only in a few localities, finds of it have recently increased to such an extent that the assumption of a special copper age, which was prior to the bronze age and contemporary with the later stone age, seems to archæologists now inevitable. Many of the objects found in Schliemann's first prehistoric city, Ilios, were of nearly pure copper. Other articles in the third city were of bronze. Our knowledge as to the first appearance of bronze has recently received new evidence in a rod found by Dr. W. Flinders Petrie at Meydum, of the fourth Egyptian dynasty, about 3700 B. C., which proves to be a bronze having about the ratio of nine parts of copper to one of tin, characteristic of far later and even of modern bronzes. Two works in the South Kensington Museum, one Etruscan and the other Greek, afford clear evidence of the introduction of tin into the art of those nations in the fifth century before Christ. The fact that the presence of lead in bronze enabled it to be more easily fused and also to assume a beautiful velvety-brown patina was, in the opinion of the author, recognized far earlier than has been supposed. Lead occurs in the analysis of a fragment of Greek bronze of a date about 450 B. C. The use of zinc is indicated in the descriptions in detail by Pliny of the various shades of color presented by bronze. The use of brass, which was common enough in Roman times, does not seem to have prevailed in England until William Austen, in 1460, made of it the magnificent monument of Richard Beauchamp, Earl of Warwick.

Preservation of Virginian Antiquities.—An Association for the Preservation of Virginian Antiquities was formed in 1888, at the suggestion of ladies of Williamsburg, and chose the wife of Governor Fitzhugh Lee as its first president. Mrs. Lee was succeeded at the expiration of Governor Lee's term by

Mrs. Joseph Bryan, who is now president. The first work of the society was to secure the "old Powder Horn," or powder magazine, in Williamsburg, which was built in 1714, and was the object of historical disputes between Governor Lord Dunmore and the Commons, among whom Patrick Henry was prominent. This building was in a state of decay. It has been repaired and restored to its old proportions and appearance. Next the society saved the picturesque home of Martha Washington in Fredericksburg from being carried off to the Chicago Exhibition by purchasing it. It has been made to look, within and without, as much as possible as it did when Martha Washington lived in it. The house is to be used as a museum for colonial and Revolutionary relics. The churchyard at Jamestown, with its ruin and twenty acres of land adjoining it, have been presented to the association by the owner, Edward F. Burney, and will be preserved and kept in order. The restoration of the Old Brick Church (St. Luke's) in Smithfield, Va., which was built in 1632, is contemplated as the next work of the association; and it is negotiating for the possession of the old lighthouse at Cape Henry, which was used for about one hundred years, but was abandoned about fourteen years ago for a new and more modern structure.

Discovery of a "Missing Link."—Dr. D. G. Brinton communicates to Science an account of the discovery in the early Pleistocene strata of Java of three fragments of three skeletons, that introduce us to a new species, a new genus, and a new family of the order of Primates, *Pithecanthropus erectus*, standing between the apes and man—in other words, apparently supplying the "missing link" which has been so long and so anxiously waited for. The material, Dr. Brinton says, "is sufficient for a close osteological comparison. The cubical capacity of the skull is about two thirds that of the human average. It is distinctly dolicocephalic, about seventy degrees—and its *norma verticalis* astonishingly like that of the famous Neanderthal skull. The dental apparatus is still of the simian type, but less markedly so than in other apes. The femora are singularly human. They prove beyond doubt that this creature walked constantly on two legs, and when erect was quite equal in height to the average human male. Of the various differences which separate it from the highest apes and the lowest man it may be said that they bring it closer to the latter than to the former. One of the bearings of this discovery is upon the original birthplace of the human race. The author (Eugene Dubois, of the Dutch army) believes that the steps in the immediate genealogy of our species were these: *Prothylobates; Anthropopithecus sivalensis; Pithecanthropus erectus;* and *Homo sapiens*. This series takes us to the Indian faunal province and to the southern aspects of the great Himalayan chain, as the region somewhere in which our specific division of the great organic chain first came into being."

The Work of the Naturalist.—With its second number, January 11th, Science gets into good working order, and gives a budget of excellent scientific papers from first hands. Among them is a clear summary of the proceedings of the Baltimore meeting of the American Society of Naturalists during the last Christmas vacation. At this meeting the influence of environment upon the successive steps of development, and as a cause of variation, was discussed with considerable freedom. Prof. Charles S. Minot, of Harvard, spoke on the work of the naturalist in the world, defining his object to be to discover and publish the truth about Nature. First and foremost of the conditions of success is truth. The naturalist's first business is to get at the truth, in the way of which stand as the most prominent obstacles the limitations of his own abilities and the limitations of accessories for carrying on his work. The naturalist must observe, experiment, and reason, and his training must necessarily be along these lines. The great work of the future is to be done by experimenters. Again, the reasoning faculty is one of our weakest points. The naturalist must learn to distinguish carefully between discussion and controversy, and while being led and taught to indulge freely in the former with all the intelligence at his command, he must also be taught to avoid the latter. The naturalist is exposed to many evils like this matter of controversy, which tend to cause him to depart from his proper mission of getting at the truth. He is especially liable to be led away by impatience to get results. Preliminary communications are a very great as well as a very prevalent evil. The greed for priority leads many even fine workers far astray. The tendency to speculate is a third evil, and a fourth is the disposition to accept too readily simple and well-finished conceptions. It is the function of original memoirs to assimilate crude facts and render them digestible. Details not bearing directly on the subject should be carefully excluded. Most original papers could be "boiled down" to one half and some even to one tenth of the amount that is really published. The effect of the work of the naturalist upon his own character is best shown by his optimism. One drawback in the naturalist's life is his comparative loneliness and isolation. Seldom has he in his own neighborhood another interested in the same particular line as himself. Reunions of naturalist societies counteract this to a considerable extent, but there is need of even greater affiliation. Naturalists should exercise influence in teaching men competence. The solution of our present political troubles lies not so much in restricting the right to vote as it does in restricting the right to be a candidate. We, as naturalists and as citizens, should uphold competence. The naturalist should see that the schools educate, with science in its proper place.

The Senses of Plants.—The conclusion is reached by J. C. Arthur in a president's address before the Indiana Academy of Science on The Special Senses of Plants, that plants seem to react sensitively to gravity, light, moisture, heat, and contact. Each is a special kind of sensitiveness having its own method of reaction. Two or more kinds of sensitiveness may reside in the same organ, when its position will be a resultant of the several forces. There are consequently no exclusive organs of sense, although there is more or less localization in certain parts, and there are no nerves, although the motor impulse may be transmitted some distance, even so far as twenty inches or more in very vigorous Sensitive Plants—that is, in *Mimosa*. There are also no muscles in plants, although they execute movements of very considerable amplitude. The real mechanism by which the movements are accomplished is not well understood. There is agreement, however, in assuming it to be due to the movement of water. All the senses, except that of contact, have for their end the adjustment of the plant as a whole, and of each of its organs, in a suitable position for heat development. The contact sense has been more variably developed, aiding the plant to climb, to catch insects for food, and, if we are to accept Darwin's suggestion, enabling the Sensitive Plant in particular to escape the injury of hailstones. All the movements are very slow, except a few like insect-catching and hail-avoiding movements, and their wonderful diversity and extent are realized only by instituting carefully devised experiments and the use of delicate instruments. It is to be noted that the same organ always responds to the same stimulus with the same corresponding movement. There is no opportunity for choice, no volition, and consequently no mental activity, no psychic life of even the most humble and rudimentary nature.

Characteristics of Maps.—Maps, said Dr. R. H. Mill, in a lecture on Holiday Geography at the Royal Geographical Society's rooms, may be viewed as a kind of shorthand, and are easier to read than books. Far more information is given in a map than could be written or printed upon a piece of paper of equal size, and a map could point out to several persons coming from different directions the way to a certain place, since it does not introduce the confusing notices of right and left, as verbal instructions do. In Aberdeen the confusion is avoided, because there a man is told to go north or south instead of to the right or left; and it is even said that in some places in Scotland the position of the dishes on the table is regulated by the same principle. The value of maps depends on their purpose and their accuracy. A map that had been taken from a tramp, exhibited to the audience, though worthless for the measurement of distances, was very valuable to the beggar, since all the houses were marked upon it, and the character of their inhabitants, together with the presence of dogs, were indicated by peculiar signs. In a number of old pictorial maps various strange animals were seen disporting themselves. Such maps, like a bird's-eye or "balloon" map, give a very good idea of the locality, but in them the scale is continually changing, so that they do not fulfill the true function of a map, to enable measurements to be made. In plans, as distinguished from maps proper, the ground is treated as if level, and no notice is taken of the curvature of the earth. A map proper makes allowance for mountains and hills and the earth's curvature. The speaker referred to the pleasure a traveler might obtain from marking out his journey day by day on a map. Nothing can more convince a man how little he knows of his own country than a map on which are indicated all the railways he has traversed. He would find the places he had seen much less numerous than those he had not.

NOTES.

The course of eighteen lectures and conferences on social problems of the day, which was begun February 13th under the auspices of Columbian University, Washington, is to be continued, with three lectures a week, till March 28th. The conferences have special reference to the labor question, which will be considered from the points of view of ethics, economics, politics, education, and religion. Each conference is introduced by an address from a chosen speaker.

Attention has been recently directed to the artificial cultivation of India-rubber trees. Those of mature size of one species are found in the Royal Botanic Gardens at Trinidad to produce the gum in paying quantities; and several species of the genus have thriven there. Dr. Ernst urges that every effort be made to extend and preserve the forests, thickets, and groves on the Orinoco, and suggests that collectors be required when they work a grove to plant a certain number of trees. Only by such means, and by adopting a chemical mode of coagulation instead of the present crude way of evaporating the juice in the dense smoke of a wood fire, can the India-rubber production of the Amazon territory be increased in quantity and improved in quality.

The clock school at Furtwangen, in the Black Forest, Germany, established by the Duke of Baden in 1877, furnishes three years' instruction in preparatory, clockmaking, and supplementary courses. It comprises theory and practice, the higher mechanics, and electricity. The means of instruction include a large collection of all kinds of tools, instruments, drawings, models, etc., and carefully constructed and equipped school premises. Factories, electric plants, etc., are often visited under the direction of the teachers or of the mechanics employed in the places visited. The library contains books relating to clock and watch making, and the technique and mechanics of clock and watch making and electricity. Reading rooms, drawing rooms, laboratories, etc., are open to the pupils daily.

In the department of reptiles of the Paris Museum is a snake which climbs up the vertical smooth wall of its glass cage. It is about a foot long, and starts on its climb by lifting its head against the glass to a height of about six inches. It then disgorges through its salivary and lachrymal glands an abundant secretion of viscous mucus, which serves as an adhesive liquid and permits it to raise itself still higher till the hinder end of its body is no longer in contact with the floor of the cage. It climbs thus all the way up, very slowly.

Assuming that if man was already present in the United States when the Indian tribes first came here, his remains would be most likely to be found in caves near the Appalachian Mountain passes, Mr. H. C. Mercer, of the University of Pennsylvania, examined the caves of the New, Kanawha, and Ohio Rivers along six hundred miles of their course, and failed in all to find any traces of pre-Indian wanderers. He remarks also, in his paper describing his research on the absence from the caves of remains of any of the older animal inhabitants of the region.

The final report of the committee of the British Association on the Circulation of Underground Water represents that the exceptionally dry season rendered a special inquiry necessary as to the rate of descent of the underground water line and the rate of its subsequent restoration. The drought had made clearly plain the weakness of gravitation water supplies. The quality of the water in the best reservoirs steadily deteriorated as the quantity stored was reduced. The great value of underground water supplies was strongly brought out by the present yield of the Gainsborough Local Board well. Its total depth was thirteen hundred and sixty-one feet, and the yield of twenty thousand gallons an hour, in spite of the drought, did not fall off.

A curious list of laws is published as having been enacted at a recent grand palaver of the inhabitants of Abbeokuta, West Africa, who call themselves Egbas. They provide that "the practice of striking English silver coins upon the ground or upon stones to test them should cease, and that all English silver coins, whether new or old, should be received as a legal medium"; that the worship of the Shopernee, or smallpox, be discontinued throughout the country; and that vain boastings against the white men should stop. Other enactments relate to the prohibition of the slave trade and of seizure of strangers for debt.

A picture reproducing two photographs of the little bittern, in the attitudes it assumes to favor concealment, shows, in one of the figures, the bird standing in a reed bed erect, with neck stretched out and beak pointed upward, and looking very much like one of the reeds; the other picture representing the bird crouching against a tree stump at the riverside, in an attitude equally deceptive. W. H. Hudson remarks that the South American little heron, in the reed beds of the pampas, can not, when lost sight of, be found without the aid of dogs, even when the spot where it had lighted is marked.

OBITUARY NOTES.

The science of astronomy lost three of its most devoted servants during December, 1894. The first was Dr. Carl Friedrich Wilhelm Peters, Director of the Königsberg Observatory, who died December 2d. He was a son of Prof. C. A. Peters, and was born in 1844 at the Pulkowa Observatory. Having studied at Berlin, Kiel, Munich, and Göttingen, he was made a member of the staff of the Hamburg, then of the Altona, and then of the Kiel Observatories, and finally, in 1883, Director of the Königsberg Observatory and Professor of Astronomy in the university. His name is associated with valuable work in pendulum observations; chronometer tests for the determination of the influence of magnetism and atmospheric moisture on the daily rate; and calculations of the orbits of the planet Sylvia, of several comets, and of the double star 61 Cygni. His labors in astronomical literature were considerable, and included the publication of numerous popular papers and the editing of important books.

Father Francesco Denza, who died in Rome, December 14th, was Director of the Vatican Observatory: He was born in 1834, entered the order of Reformed Franciscans and afterward of Barnabites; showed himself very proficient in mathematics at college; and, combining his favorite studies with his theological course at Rome, became a pupil of Father Secchi in astronomy and meteorology. He was active in promoting the study of meteorology in Italy; invented several meteorological instruments; determined the magnetic elements at various places in Italy, Dalmatia, and Africa; observing meteors, he furnished the materials from which Prof. Schiaparelli deduced his theory of those bodies; adapted the Vatican Observatory to the requirements of modern astronomy, and took part there in the international work of charting the heavens; and wrote a volume entitled The Harmony of the Heavens, besides many papers on meteorology and physics.

Arthur Cowper Ranyard, editor of Knowledge, died at his home in Bloomsbury, London, on the same day with Father Denza, December 14th. He was born in 1845, and was a pupil of Prof. De Morgan. He was trained to the law, but his strong attachment to mathematics and astronomy prevailed. He was elected a Fellow of the Royal Astronomical Society when only eighteen years old. He co-operated with George De Morgan in founding the London Mathematical Society, and became one of the honorary secretaries of it. He was a member of the Council of the Royal Astronomical Society and honorary secretary for six years. He was predominantly interested in solar physics and astronomical photography; undertook three different expeditions at his own expense to observe the solar corona during eclipses; was also diligent in the study of the structure of the stellar universe. Results of his devotion to these fields of research are seen in the Old and New Astronomy, which he completed after Mr. Proctor's death, and in the pages of Knowledge, where he struck out a line for himself and which fairly shone with its reproductions of solar photographs.

Dr. F. B. Hawkins, one of the oldest members of the medical profession in England, and a member of the Royal Society of sixty years' standing, died December 7th, at the age of ninety-eight years.

Prof. Lewis R. Gibbs, of the College of Charleston, S. C., died November 21, 1894, aged eighty-four years, he having been born in August, 1810. He had been a professor in the College of Charleston from 1838 to 1892, or about fifty-four years—first, of mathematics, afterward of astronomy, chemistry, and physics. Previous to 1838 he had been tutor in mathematics in South Carolina College, and had afterward studied in Europe. From 1848 to 1853 he was engaged by the United States Coast Survey to make observations for determining the difference of longitude between Charleston and Washington, D. C., Charleston and Savannah, Ga., and Charleston and Raleigh, N. C. Beginning with 1858, he wrote articles on subjects connected with astronomy, natural history, etc., for various publications, among which were the Charleston Mercury, the Boston Journal of Natural History, the Proceedings of the American Association, the Charleston Courier, the Proceedings of the Elliott Society of Natural History of Charleston, and the Canadian Entomologist. An article on the Occultator, published in the American Journal of Science, March, 1869, was reprinted in journals in England and France. While his favorite study was astronomy, he was at home in almost every branch of modern science.

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SOME CURIOSITIES OF THINKING.*

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IT is evident to any one who has kept abreast with the recent progress in psychology that the advance in the knowledge of mental processes has been greatly aided of late by contributions from certain collateral branches of science. The older method of introspection had, indeed, resulted in establishing many facts and in formulating numerous laws of psychical action. But this method had many defects, and it must be admitted by any candid observer that the debt which psychology owes to more modern methods of research is a deep and lasting one. To these methods also we owe much of our present knowledge of what may be termed the mechanism of thinking.

It may not be without interest, therefore, to review some of the results which modern studies have reached, especially as such a review will bring before us some entertaining curiosities of thinking.

And, first, we must mention the remarkable discoveries in regard to the localization of brain functions which may be traced to physiological experimentation upon the lower animals. It was long ago determined by Fritsch and Hitzig, Ferrier, Munk, and Beevor and Horsley that in the lower animals certain districts upon the surface of the brain could be laid down, to each of which a definite sensory or motor function could be assigned. Within the past decade it has been absolutely proved by pathologists,

* Read before the Philosophical Club of Princeton.

among whom Charcot, Nothnagel, and Ferrier must be named, that the same statement may be made with regard to the brain of man. To-day a practical application is being constantly made in our hospitals of these important discoveries. For they not only enable us to determine the position of disease in the brain, but also afford a guide to the surgeon, who can cut through an apparently healthy head and skull and remove the diseased tissue. The results of brain surgery form one of the triumphs of medical science of which physiologists may justly take the credit. It is now well determined that from the eye, or from the ear, or from the skin definite nerve tracts can be traced to special regions of the brain. It is well known that all impressions received by the eye, or ear, or skin set up impulses which traverse these tracts and reach these special areas of the brain surface or cortex. When an impulse reaches the cortex a conscious perception is produced, and of this perception a definite memory remains, which memory is necessarily connected with the brain cells in the special area primarily excited. If disease destroys a sensory area, perceptions are no longer possible in the sensory organ to which it belongs, and memories stored up in that area are permanently lost. From this loss of particular perceptive power and of memories it is possible to determine the position of disease in the brain so exactly that it has been found feasible and justifiable to proceed to the removal of the disease, such as a clot or tumor, producing the symptoms.

It would afford material for an entire paper to study defects of memory and to describe some of the curiosities of thinking which result from such defects. A few examples may be related.

I saw lately a business man of keen mind and good general memory, who was not paralyzed in any way, and was perfectly able to understand and to talk, but who had suddenly lost a part of his power of reading and of mathematical calculation. The letters *d*, *g*, *q*, *x*, and *y*, though seen perfectly, were no longer recognized, and conveyed no more idea to him than Chinese characters would to us. He had great difficulty in reading—had to spell out all words, and could not read words containing three letters. He could write the letters which he could read, but could not write the five letters mentioned. He could read and write some numbers, but 6, 7, and 8 had been lost to him; and when asked to write them his only result, after many attempts, was to begin to write the word six, seven, or eight, not being able to finish these, as the first and last contained letters (*x* and *g*) which he did not know. He could not add 7 and 5 together, or any two numbers of which 6, 7, or 8 formed a part, for he could not call them to his mind. Other numbers he knew well. He could no longer tell time by the watch. For a week after the onset of the disease he did not recognize his surroundings. On going out for the first time the streets of the city no longer seemed familiar; on coming back he did not know his own house. After a few weeks, however, all his memories had returned excepting those of the letters and figures named; but as the loss of these put a stop to his reading and to all his business life, the small defect of memory was for him a serious thing. Experience has shown that such a defect is due to a small area of disease in one part of the brain. Such cases are not uncommon, and illustrate the separateness of our various memories and their dependence upon a sound brain.

Among the curiosities of thought which the physician meets with, unexpected perceptions suddenly appearing before the mind with the same vividness as ordinary perceptions, but without any accompanying external excitant, are not uncommon. A person may look at an empty chair and yet see a familiar form seated in that chair, and may even hear remarks made by this imaginary figure and not doubt for a moment that the figure is an actual entity.

I have seen persons talking with such imaginary individuals, and have had them assure me that they were as sure of their presence and of their voices as they were of my own. I have seen persons manifest the greatest alarm at the presence of animals about them, and refuse to believe from assurance that those animals were not there.

A young woman, having once been frightened by the sudden presentation to her of a white mouse, has been troubled for years by seeing this mouse running about her, upon her clothing, upon anything she is handling, and even upon her food; and, as a result, she is in a state of constant agitation and perplexity, though at times convinced that this is the product of her mind. She washes her hands and her clothing frequently because she is convinced that this animal has made them dirty; and she can not divest herself of the belief that it is real.

I have sometimes been able to convince persons that such fancied figures were not real by asking them to push one eyeball up a little with the finger. This makes all objects about them seem double, as any one can prove to himself, but it does not double the false image—the product of the mind. The young woman just mentioned was much comforted by this device.

Argument alone does not suffice in such a condition to convince one that an impression is erroneous. Thus, a woman who had gradually become totally blind, and was willing to admit that she could see nothing whatever, could not be convinced that she was not surrounded constantly by multitudes of little gnomelike pygmies, whom, she persistently declared, she *saw* before her, and whom she was afraid that she would step upon or crush by any movement of her body. Yet she was blind. And when these false perceptions occur in the domain of hearing, either taking the form of definite commands, such as "You shall not eat," "You can not move," "You are a lost soul," or such a terrible order as "You must cut your throat," the impression which is produced may be so intense as to dominate the mind and hamper all mental action; and if these commands are not recognized as products of internal disease, they may lead to actions, such as suicide or homicide, which a sound judgment would condemn.

Our knowledge of the localization of brain functions, so far as sensory impressions are concerned, has enabled us to explain not only defects of perception and of memory, but also these false perceptions which we term hallucinations. It has made it evident that such hallucinations are the result of irritative disease in the definite region of the surface of the brain in which the memory pictures were stored. Disease excites the cortical cell to activity. The mental result is a perception which consciousness has no means of distinguishing from an actual perception, and which in a diseased state it regards as real.

The localization of motor functions is no less precise than that of the sensory functions. Every movement of a voluntary character, from the coarse act of grasping an object to the fine touch of the pianist, or the delicate stroke of the artist, or the graceful balancing and light movements of the dancer, originates in a well-defined portion of the brain surface. Destroy this portion of the surface and no amount of volition will produce the desired act; or let this portion be irritated by disease and, without the will, the act will be performed over and over again in an automatic manner and apparently without purpose.

The mechanism of speech has also been determined by these investigations into the localization of brain functions. We know that the understanding of words when spoken or when seen in print, and the articulation of words in speech or their production in writing, are all dependent upon the integrity of definite regions upon the brain surface. So positive are we of this that in certain cases, when either the comprehension of language is suddenly suspended by disease or the power of utterance of language is hampered by disease, we can put our finger upon the spot in the brain which is affected; and if that spot is pressed upon by a clot of blood or by a new growth, we can remove it and thus restore the power of understanding speech or the power of utterance. Dr. McBurney has reported * the case of a physician whose speech was thus restored after three months of silence by the removal of a clot from the motor speech center.

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* Brain, 1891, p. 284.

It is thus evident that research in experimental physiology has had an extent and an application to human psychology which were hardly dreamed of by the original investigators twenty years ago; and it is clear that as, little by little, the facts to which I have just alluded have been established, they have been seen to throw much light upon psychological processes, and to make our knowledge of the mechanism of thinking both wider and more precise.

Secondly: There is another field of investigation from which rich results for mental science have recently been reaped—namely, physiological psychology. The determination of the special function of different parts of the brain, and the fact ascertained by anatomists that each of these parts is related to other parts by means of great bundles of nerve fibers which pass throughout the brain in many directions, joining the different functional areas with one another, have led to the study of the association processes which lie at the basis of most of our thinking.

Mental images never occur singly, but are usually in close relation with other images, the result of simultaneous perceptions. The various qualities of an object perceived by different senses are united in our concept of the object. The beautiful form of the rose, its charming color, its delicate odor, the soft, velvety feel of its petals, and the sharp prick of its thorns all come into my consciousness through various channels, but, being simultaneous in their perception, are all joined with one another in a complex unit—the concept; and when I call to mind a rose, it is not one memory of a single sensation which comes into my consciousness, but it is the associated memory pictures of sight and smell and touch which, by a flash of consciousness, rise together into the mind. And since it is possible to analyze these sensations, it is also possible to trace the association between them. I do not hesitate to call to mind the appearance of the rose, even though I merely perceive its delicate perfume, and there is hardly a flower whose name is not brought up the moment I see or smell it. Yet this process of calling up the image of the flower from its odor, or of calling up its name when I see it, involves a process of transmission of physical impulses from one region of the brain to another—a process of which the physiological psychologist has actually determined the time. We measure associations in hundredths of a second, and with decided accuracy. The mental act of ordinary single association may be said to occupy an eighth of a second. The time of the transmission of these impulses varies decidedly at different periods of life, though it requires no delicate apparatus to convince one of the contrast between the quick, acute association of the young man and the slow, uncertain, halting memory of the aged. It has been found by Kroepelin that the rapidity of the association processes can be altered by the use of certain drugs. Thus alcoholic beverages make the sensory perceptions and the process of thought slower than normal. They increase the rapidity of motor acts for a short time, but finally retard these, too. Tea has just the opposite effect, making sensations and intellectual acts more rapid, while it delays the motor actions. Morphine has at first much the same effect as tea, but soon after it delays all mental acts.

I have noticed that one of the early signs of beginning disease in the brain is a decided lengthening in the processes of association, even where none of these processes are absolutely suspended.

The number of associations permanently established with any given idea has been made the subject of tests, and it has been said that it is a better measure of the mental capacity of an individual to ascertain the number of associations which he possesses with any given subject than to require him to pass an examination upon his knowledge of the subject.

Among the curiosities of thought we may mention some queer disturbances in these processes of association. We may find that association tracts are apparently blocked so that a perception which should call up a certain concept fails to do so.

I have seen a man look at his own son and yet fail to recognize him—that is, the perception of the face no longer resulted in the quick spreading outward over a thousand associated tracts to other parts of the brain of impulses calculated to call up the numerous memory pictures usually associated with that face. Not long ago I asked a man who had one of these forms of defective association what his occupation was. He replied: "What I do? My business? I know just as well as I know all of it, but I can't tell." The idea of his occupation was unable to carry him on to its name. He was a printer. He assured me that he could call to mind his office with its presses and frames, but he could not name his occupation; yet he recognized the word printer at once when I spoke it, and knew it was what he wanted to say. One process of association, at least, in his brain was suspended.

Some of the extraordinary disturbances of consciousness in which an individual's personality appears to be divided, instances of which I shall give later, seem to be explicable only on the theory of the cessation of activity of the association fibers of the entire brain for a time.

I may mention here an unexpected association, a sort of spontaneous association between unrelated perceptions, which is observed in some minds. You may have heard that there is such a thing as color-hearing—i. e., persons subject to this forced association find that certain colors awaken forcibly the memory of certain sounds, which memory may be so vivid as to be a hallucination. A color may cause a shrill sound to be heard. I was told lately of a lady who was overcome by such a sound on entering a room where decorations, hangings, and furniture were red in color. On the other hand, certain sounds may awaken the idea of colors. I have heard of a man who seemed to see the color green when he heard a violin played; another person always had a sensation of red at the sound of a trumpet. Another person,* who had become blind, had retained this persistent association, and when the vowel sounds were pronounced slowly he had, accompanying each, a sensation of color like a transparent colored sheet a short distance in front of his face. Each vowel sound had its own corresponding tint, which was always the same for that vowel: *a* was red; *e*, gray; *i*, black; *o*, white; *u*, green. When the vowel sounds were uttered in rapid succession there appeared to be a confused, rapidly changing faint screen of color, but it did not obtrude itself on his consciousness unless he expressly directed his attention to it. This association persisted after this man had become blind. Many such instances have been recently collected by Flournay in his interesting book, Des Phénomènes de Synopsie. It is said that twelve per cent of people have such a power of color-hearing. It is certainly a fact that the most of us have an unpleasant involuntary feeling on hearing certain sounds. We all dislike the creaking noise of a slate pencil drawn across the slate or the sound produced by a man filing a saw. I think this is more than mere dislike of sound—it is a real sensation of a non-auditory and painful character—a forced, unnatural association.

Thirdly: The study of child life and of the mental development of the infant is the third line of research which has been of great service in the investigation of mental action. It is not possible for one accustomed to think without regarding his mental processes to suddenly stop in the course of thought and analyze accurately his methods of thinking. The rapidity of associations, their determination in certain lines by habit and by use, and their enormous number in the active mind, baffle all analysis. But if we watch the growth of thought in the child, if we notice the accumulation of memory pictures, the gradual building up of concepts and the formation of the links in the chain of reasoning, we can get at the elements of many complicated mental processes. Thus the study of the mental growth of the child throws light upon the study of adult thinking.

And here, too, the value must be recognized of the study of those imperfect minds which are arrested in their development at certain points. Thus, there are children whose powers of perception appear to grow with their growth, whose powers of recogni-

* Lancet, March 31, 1894.

tion of persons and objects about them are good, but who seem to stop short at the point where these individual perceptions and memories should be grouped together into general ideas. There is an inherent activity in the brain of a child which leads to thought and soon to actions and speech; yet there are children who never get to the point of definite purposeful activity. Such children are usually in constant motion, but their movements have no object. Such children can not be taught to talk, or, if they can be instructed in repeating words after another, they seem to attach little significance to the words that they say, and appear to have no spontaneous wish to talk. Back of any spontaneous desire to speak, there must be the idea which presses for utterance, and thus we conclude from the study of these defective, speechless creatures that while perception may be active, the mind has not grasped the subjects perceived, has not gone on to any generalization about them, or initiated a train of thought to issue in action or articulation. Such a child, then, reveals to us the order of progress in mental growth. It has the rudimentary power of simple perception and memory and association of memories; but it lacks the next higher power of thought, the power to group ideas together, to contrast them with each other, to generalize. And since it is this generalizing and analyzing power which stimulates thought and leads to natural curiosity, we find such children fail to give evidence of that desire for knowledge which a healthy child displays.

Another type of child far less defective is not uncommonly seen, who has nevertheless failed to reach that point of development which is evidenced by the power of self-control. These children may have the power to recognize objects, to analyze their qualities, to reason upon them, and to accumulate a little store of knowledge. They can talk, and learn to do many acts of a complex nature and of delicate manipulation. But the power of concentration of the mind upon a definite subject, the power of paying strict attention to one thing to the exclusion of all recognition of the thousand impressions which ordinarily press in upon consciousness and which the attentive mind ignores, this power they seem to lack, and hence, because of this defect in the attentive faculty, or of the power of controlling and directing mental action, these children are incapable of giving any stable direction to their life and conduct. I have a young man under my observation who is capable and active mentally in many directions, has apparently no gross intellectual defects, yet who complains that he is utterly unable to direct his mind continuously to any topic. He is a college graduate, but for the past ten years he has drifted about from one occupation or profession to another—eager for a time in each, then losing all interest, finding himself unable to fix his attention any longer on his work, lapsing into a state of apathy and mental inertia, disappointed at himself and at his failure of interest, but incapable of arousing himself to effort. This is not laziness—it is an inherent mental defect.

Again, there is a type of mind which seems deficient only in the perception of the true relation between events and actions. These people are the victims of their fancies. They are constantly originating most impracticable undertakings. They expend their energy in devising and attempting to carry out the most useless, absurd, and extravagant schemes—sometimes selfish, sometimes apparently philanthropic. They appear to ignore or else can not appreciate the force of common-sense objections, or the reality of insuperable obstacles to their projects; and, finally, if they are defeated, they never blame themselves, but either complain of the lack of human sympathy, or become the victims of a delusion that they are the objects of a conspiracy by enemies whose existence is purely imaginary. The patent office contains a striking museum of such hopeless and visionary schemes and inventions.

It is impossible in the study of defective minds to draw any sharp lines between different individuals; and we can not help feeling that between the man of giant intellect on the one hand, and the speechless idiot on the other, there is an unbroken line of descent, and every possible variety of mental defect.

It is in some of these degenerate brains that we find some of the strangest curiosities of thinking, and some of those extraordinary developments in one line of mental capacity with a corresponding suppression of all other lines. One has only to think of such an individual as "Blind Tom," the pianist, who was a genius in music, able without instruction to reproduce upon the piano with marvelous elaboration of harmony almost anything musical which he had heard, and yet who was almost a brute so far as his moral nature was concerned, and almost an idiot so far as his intellectual powers could be measured. We might also cite a remarkable person recently seen in New York, "Inaudi," who, though until the age of twenty unable to read or write, because too stupid to learn, and manifestly defective in mental capacity, has a power of mathematical calculation which is most extraordinary and inexplicable. The most abstruse problems in arithmetic, such as cubes of numbers in four figures, or a square root of figures in millions, it takes him but a few seconds to solve, and this he has been able to do ever since a little boy, without being able at all to explain his methods of doing it. He is as accurate as a calculating machine (and just about as intelligent on other subjects). He relates his history as follows:*

* New York Herald, March 25, 1894.

"I was born at Onorato, in Piedmont, on October 13, 1867.

"I began life as a shepherd boy, and when about six years old I went with my father into France. There I made a little living by wandering about from *café* to *café* dressed in my Savoyard's costume, and exhibiting some white mice which I had taught to perform some tricks.

"My brother taught me the names of the figures and their values, but the symbols which represent them were quite unknown to me. Indeed, it is only within the last five or six years that I have become at all familiar with them.

"As a matter of fact, the sight of figures embarrasses me even yet. It is through the sound, through the name of a figure, that my mind recognizes its value. If I see the sign which stands for it, I have to translate it, as it were, into a name familiar to my ear. Indeed, my eyes play no part at all in my process of calculation. 'Nine' conveys a distinct impression; the figure 9 has to be translated into 'nine' before I can do anything with it.

"The instant the names of the figures strike my ears the process of calculation begins. As one thing after another is disposed of, I place it on one side ready for reference in getting at the final result—not by mental vision, but by mental audition. I never, in thinking about numbers, see the figures; I hear them.

"My processes of calculation I had to invent. You see, I never learned arithmetic. When I had been taught the names of the figures by my brother my education came to an end. Instinctively I began to perform certain simple calculations. And, like all uneducated persons, I always calculate from left to right, instead of from right to left, beginning with the highest value instead of with the unit."

He himself, although perfectly conscious of the process through which his faculties work out the desired result, can not explain how he can arrive at that result so quickly. "It is there," he said, touching his head, "but the answer comes mechanically, without effort, without research, mechanically even."

"After a difficult calculation, do you experience any fatigue, M. Inaudi?" he was asked.

"Not the least in the world. I am quite unconscious of anything that is going on. Even the methods by which I arrive at the required result are so mechanically employed that it is simply like reading a newspaper." This indifference is proved by the fact that no interruption deranges M. Inaudi. He will listen and join in the conversation while continuing his unraveling of the problem. As an example of the rapidity of his power of calculation, it may be mentioned that it took him but twenty-three seconds to reckon the square of 5,892.

"When I take a pencil I work much slower than you would, and am not at all reliable. When I make a calculation mentally, the least error seems to strike my organ of hearing. I feel, if I can so express myself, the inaccuracy. When, on the other hand, I work with pen and paper, I might make several errors and should not discover them until I made the proof mentally."

This was naturally to be expected from one who frankly avowed that until a few years ago he was perfectly illiterate.

"I have no memory, however, for other things except figures," said M. Inaudi. "Nothing else seems to make any impression upon me. If I read anything, I forget it almost immediately. If anything is told to me, the result is the same. Few things interest me save numbers. In fact, I have no aptitude for anything else."

It is evident that Inaudi has a mind developed largely in one direction, but undeveloped in others.

Another instance of a lightning calculator may be mentioned, because he presents a wholly different method in his mental action. I refer to M. Diamandi, who has recently been examined carefully by Prof. Binet, of Paris.* Diamandi is able to perform wonderful feats of mathematical calculation with great rapidity, but he can not make his calculations until the numbers given him are written down. In other words, he is a visualist; he calls to mind numbers as they appear when seen. He says the numbers appear as if written on a mental table, which he sees and reads when he is asked to repeat numbers from memory. If Diamandi receives a problem by ear, he hesitates, appears embarrassed, commits errors, and demands a repetition. It is necessary for him to call up the visual image of the numbers heard. But when a problem is given in writing, he glances at the paper, then closes his eyes, makes an effort to call these numbers to mind, quickly goes through the calculation, and reaches the result, which he seems to himself to read off from the mental tablet. According to his statement, the numbers appear to him as if written in his own handwriting. Thus, if the problem is written in ink on a white paper, the figures in his mind appear in the same black color on white; but if it is written with chalk on a blackboard, it is thus that the result comes to his mind. His time of calculation is slightly longer than that of Inaudi, but he is equally exact. Some ingenious tests were made by Binet to prove the different methods of calculation in the two men. Several numbers were written beneath one another, forming a square, thus:

9	7	6	4	5
6	3	2	1	4
5	4	3	7	8
3	8	6	5	1
7	9	1	4	2

and these were committed to memory by the two men. Diamandi looked at them. They were read to Inaudi. They were then asked to give the numbers, reading them downward instead of across and diagonally instead of across. Diamandi, having the visual picture, was able to do this in half the time of Inaudi, who had to call to mind the sounds and make selections.

The more the processes of thought in such minds are analyzed and contrasted with those in normal minds, the more apparent it becomes that each individual has his preference in mental imagery, and that in each person the mind habitually works more actively through one sense than through the others. This distinction was most acutely drawn by Charcot, who classified people into "visualists"—those whose recollections were chiefly of things seen, who had to read a name in order to remember it;

* Revue Philosophique, March, 1894.

"audists"—those whose memories were of things heard, whose auditory sense was paramount; and "motors"—whose powers were greatest in acts of expression, whose memory depended upon writing a thing down, whose talents lay in action. One can easily determine to which class one belongs by ascertaining in any act of memory whether he sees or hears or feels the thing remembered most easily, and by watching one's habitual references to memory. It may be remarked that such a discussion as that concerning universals in logic, in which the logicians ranged themselves in the rival camps of nominalists, realists, and conceptualists, probably had its origin in the various methods of habitual thinking in different minds. And in view of the facts of localization already described, it may be asserted that these inherent differences of thinking depend on various degrees of development of various districts of the brain cortex, or of the association fibers in these districts.*

Fourthly: From this type of mental development—presenting an excess in one direction, with or without defects in other directions—we will pass to another type of defective mind which has of late been most carefully studied, especially by M. Magnin, of Paris, the foremost French alienist.

There are certain persons in the community, usually the children of nervous or alcoholic parents, who present mental peculiarities which force upon us the conviction that there is a lack of equilibrium in their mental acts. They are not defective in faculties of sensation, memory, reasoning power, or action. They are often persons of brilliant qualities in certain directions, and perhaps have attained distinction in art or in the professions. But they may be the victims of sudden, unreasoning impulses, desires, doubts, or fears, which so dominate for the time their thought and acts as to lead one to the conclusion that their minds are not well balanced, though it can not be said that they are insane.

Let me give some examples from my own experience. A nervous woman began to notice her breathing, and for three months was beset with the fear that it would cease to continue if she did not watch it. She moved one of her fingers synchronously with her respiration; or else rocked in a chair, keeping time with the act of breathing. It was impossible to take her mind off of it. If she talked of something else, she was thinking of it all the

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* The examination of Laura Bridgman's brain supports this assertion. For this woman, who was unable to see or to hear, but whose means of communication with the external world was entirely by touch and by motion, had a brain whose visual and auditory regions were undeveloped, but whose sensori-motor region far exceeded in size that of a normal brain.

time and watched it. If she tried to stop thinking, she became anxious and distressed and had to continue. Finally, this condition passed away as suddenly as it came.

This, then, is an example of a fear relating to a simple physiological act, which calls the attention to the act, and gives rise to great distress of mind. I have seen persons who were unable to talk or to move a hand, or to walk, because of such a fear that they could not move; the fear appearing to suspend the power of volition. When the fear was quieted, and assurance regained, the power returned. In other cases, an imperative desire to do some absurd or useless thing seems to take possession of the mind. Thus, a little girl of delicate nervous organization, and who had been studying rather too earnestly in school, was suddenly seized with the impulse to count everything. If she enters a room she counts the chairs, the objects on a table, the bric-a-brac, or the pattern in a carpet. If she begins to talk, she has to count the words she says, or the words spoken by any one else, so that she is obliged to talk slowly, and is often so occupied in counting that she forgets what she is going to say before it is done. If she is made to stop, she feels great distress and a sense of anxiety which is painful.

Such fears may extend to higher mental acts involving volition.

One of the postmen whose duty it is to collect letters from the corner boxes in New York was recently discharged because he was always behind time on his rounds. He was much distressed at this, and finally revealed the reason: As he went about he would empty a box and lock it, but after going a few steps he would be seized with a fear that he had not locked the box, so he would go back and feel of it and assure himself that it was locked, and then start on again, but only to be again seized with this fear, which led to the impulse to return and try the box again. Thus, he would often return three or four times to each box emptied, and, of course, the delay made him so late on his rounds that he lost his place. He could not control the fear, or reason against it. The anxiety overcame him each time, and it was impossible to avoid the return.

A middle-aged lady, of much intellectual force and a keen power of analysis, had suffered from distressing mental tendencies ever since a child. These became very intense about her fortieth year, and remained for five years. She is abnormally conscientious—constantly imagines things which she ought to have done, and reproaches herself with not having done; or thinks of things which are wrong which she might do, and then reproaches herself for the thought. She once thought that she might thrust a needle into the eye of a person whom she loved;

she then reproached herself for this idea, felt that she had done this person a wrong, felt that she must make amends in some way, confessed her idea to the person, and was met by natural remonstrances which increased her distress. She lives with some relatives, and has a frequent impulse to go behind them and push them downstairs. She has never done so, but reproaches herself for the idea. If she sees a rug on the floor lying crooked, the idea comes to her that one of these relatives may stumble on it, and this for the moment gratifies her; then she reproaches herself for the thought, goes and fixes the rug; is not satisfied with the way she has fixed it; wonders if she could have placed it so that it could trip up this relative; fixes it again, over and over, sometimes twenty or thirty times, and can not get rid of the idea that after fixing it she would be guilty if her relative slipped upon it. The doubts extend to other things. She will turn out the gas on going to bed, then has to go back and feel of the fixture to be sure that it is turned out, and often repeats this twenty times before she can get rid of the idea that it is really turned on. In her room she has to arrange everything in a very precise manner, and often spends hours placing and replacing objects before she can satisfy herself that they are right. It is impossible for her to argue with herself regarding these matters, and if she resists the tendency to repeat an act she gets into a state of distress, with palpitation of the heart and every evidence of intense anxiety, which nothing will quiet except the repetition of the act.

A lady aged twenty-nine had mental symptoms since the age of eighteen, when great timidity in driving began. She gets nervous at any excitement. She is subject to morbid fears; sees a match-box, wonders if the matches are safe—might they get out, and be lighted and set things on fire?—hence, goes to the match-box, and makes sure it is shut; then goes back again, and so may repeat this twenty times. She can not reason with herself. Or, she wonders if the windows are shut; has to go and put her hand on the window to be sure, and this she does again and again. If she has medicine, she fears it will get out of the bottle; she goes and feels to see if the bottle is corked. She has the constant fear that things are not right, and has to reassure herself. Has to say things in a special way, and over and over, so it is hard for her to talk, and she repeats words. In reading she notices each word and can not read fast, but must read exactly; hence, she takes no pleasure in reading. Her condition makes her restless and melancholy. She is perfectly sane, but she is the victim of a morbid tendency to doubt the certainty of any idea which presents itself to the mind.

In all these cases the act which is done, and which is apparently absurd, is the outcome of a process of reasoning starting from a premise, which premise is an absurd fear or doubt. There is nothing wrong in the act or in the process of logical conclusion, granting the premise. The premise is, however, a false idea forced upon the consciousness so intensely as to carry conviction. It is quite analogous to a hallucination in the domain of sensory perception, but it belongs to the ideational sphere, or to the emotional sphere of mind. You will have noticed that the same sort of doubts occur to different minds.

It may be said that such fears, doubts, or impulses might occur to any one, but could be at once discarded. In the fact that they are not discarded, that there is a lack of self-control and mental balance which allows of their taking possession of the mind, lies the proof that in such cases there is a defect of mental development. Such cases show us clearly how important it is to sound normal mental action that a firm control over the tendencies of the mind to wander foolishly, to indulge in absurd doubts and fears, should be constantly exercised; and such control should be inculcated upon the child's mind as it develops, lest the individual come to yield to or to foolishly fear these abnormal impulses. That self-control is the highest quality of mind is evident from the fact that the first evidence of mental deterioration is seen in a beginning failure of this power.

You are all familiar with the fact that many acts of an insane kind are spontaneous, and not the result of a process of logical reasoning. Thus, a sudden impulse to steal, or to set fire to an object, may come upon one and lead to the act, for which no explanation can be given except the sudden onset of an abnormal and irresistible desire. These acts are in a way as unexpected as the hallucinations or the doubts or fears, and like them must be ascribed to sudden excitation of brain functions beyond our control from internal causes, the effects of disease. Such acts are not of much interest to the student of psychology, for they do not involve a process of thought. They are most commonly observed, however, in persons of the degenerate type which we have been studying. In these persons, then, of degenerate type we observe an imperfect mental equilibrium, which prevents a successful resistance of sudden impulses, and a successful suppression of sudden doubts and fears, and which thus deprives the victim of his liberty of action in spite of his conscious knowledge that the impulses or doubts are absurd or wrong. From time to time in their lives these persons suffer for weeks and months from their mental distress; then, for unknown reasons, they may be free from it, but usually it returns, and it is an annoyance through the entire life. One of the most interesting studies of the mental processes of a person thus afflicted has been published by Prof. Royce, of Harvard, in the American Psychological Review—the case of John Bunyan.

Lastly, there is one other curiosity of thinking which as yet remains unexplained, but which at present is exciting a considerable degree of interest. I refer to the condition known as double consciousness. Let me give an illustration.

A young man, a carpenter by trade, of fair intelligence and good physique, had a severe fall upon the head in January, 1879, and subsequently to that time suffered from occasional attacks of unconsciousness with convulsions, which were thought to be epileptic. He was treated from July, 1884, until January 10, 1885, for this disease, and during that time had no attacks. On January 10th he came home from work as usual, ate his supper, and went to bed. He slept with his brother, who is sure that during the night he had no convulsion. The patient says that when he woke up on the 11th of January he found himself in Bellevue Hospital, and learned to his surprise that it was evening. He has no recollection of anything which occurred beween going to bed on Friday night and waking in the hospital on Saturday night. From his family, however, it was ascertained that he got up as usual on Saturday morning, and while it was noticed that he acted a little strangely at breakfast nothing was said to him, and he went as usual to work. His employer thought that his eyes looked brighter (possibly his pupils were dilated) and that he did not appear natural, but he took no special notice of this, and soon after his arrival at the shop in Twenty-fourth Street he sent him up to a house in Forty-sixth Street (about a mile) on an errand, to obtain a carpenter's bit and brace. He went up to Forty-sixth Street, did the errand, and evidently explained himself intelligently, for he was given the bit and brace. The next trace he has of his movements was at Eighth Avenue, near Bleecker Street (about two miles away), though how he got there he does not know. He there went into a plumber's shop, and asked to be allowed to sit down and rest. He had nothing in his hands, so must have lost the bit and brace on the way. He soon got into a lively talk with the plumber, and became quarrelsome, so that he was told to go out. He went away, but in an hour came back, entered the shop, and tried to strike the plumber. This was for him an unusual proceeding, as he is of a mild and gentle disposition. An officer was summoned, who took him to the police station, where it was evident that he was out of his head; so they sent him to St. Vincent's Hospital, whence he was at once transferred to Bellevue. He fell asleep soon after admission to Bellevue, and on waking in an hour or so was surprised to find where he was. His manner of talking made it evident that nothing was the matter with him, and he was discharged at once and went home, rather indignant at having been sent to a hospital, and anxious to find out the reason. Being a very intelligent lad, he became interested in his own case at once, on learning a few of the facts, and ascertained by inquiry the various occurrences which have just been described. Soon after this I lost track of him, and do not know whether any similar attacks have since occurred.

It would be easy to offer other illustrations of a condition of mind very properly termed double consciousness. It is as if a single individual had two separate and distinct personalities, neither of which has anything in common with the other. All associations, all memories of one condition seem to be blotted out or suspended when the person is in the other condition. It is a remarkable fact that such a state is usually produced by a blow or a fall, and it is a well-recognized complication of railway injuries and of severe accidents that such a state of secondary consciousness may follow for several hours or days, but in the case here related nothing of this kind preceded the onset. And it must be remembered that such a state of secondary consciousness or abnormal personality may also be produced by hypnotic suggestion. Persons who are hypnotized are in a condition quite similar to that described as a state of secondary consciousness—that is, they have no recollection of what has happened before they were put in the hypnotic condition, and after they are awakened they have no recollection of what has happened in the hypnotic condition. Yet in that condition they are able to reply to questions intelligently, and if they are hypnotized a second time their memory of what has occurred on the first occasion is continuous with their memory of what occurs upon the second. Such cases have been described with much care by Paul Janet.

The same phenomena are observed in a less degree in somnambulists, for what a sleep-walker may do one night he may undo on a second night, though having absolutely no recollection of either occurrence in his waking hours.

There is no satisfactory explanation as yet found for these extraordinary alterations of consciousness and personality, and there is much opportunity for study and research in regard to these peculiar conditions. They remain among the curiosities of thinking, inexplicable yet interesting.

Montenegro has long enjoyed a complete system of local government. Among the people, three hundred thousand in number, are five hundred village councils, elected every three years, ruled by popularly elected officers, levying rates, distributing charities, appointing supervisors of education, whose duty it is to deliver popular lectures on its advantages, "and finding the solution of the problem of women's rights," says Mr. W. H. Cozens-Hardy, "in allowing women to speak in the village meetings as long as they may wish, but to vote not at all."

PLEASURES OF THE TELESCOPE.

By GARRETT P. SERVISS.

IV.—VIRGO AND HER NEIGHBORS.

FOLLOWING the order of right ascension, we come next to the little constellations Crater and Corvus, which may be described as standing on the curves of Hydra (map No. 8). Beginning with Crater, let us look first at α, a yellow fourth-magnitude star, near which is a celebrated red variable R. With a low power we can see both α and R in the same field of view like a very wide double. There is a third star of ninth magnitude, and bluish in color, near R on the side toward α. R is variable both in color and light. When reddest, it has been described as "scarlet," "crimson," and "blood-colored"; when palest, it is a deep orange-red. Its light variation has a period the precise length of which is not yet known. The cycle of change is included between the eighth and ninth magnitudes.

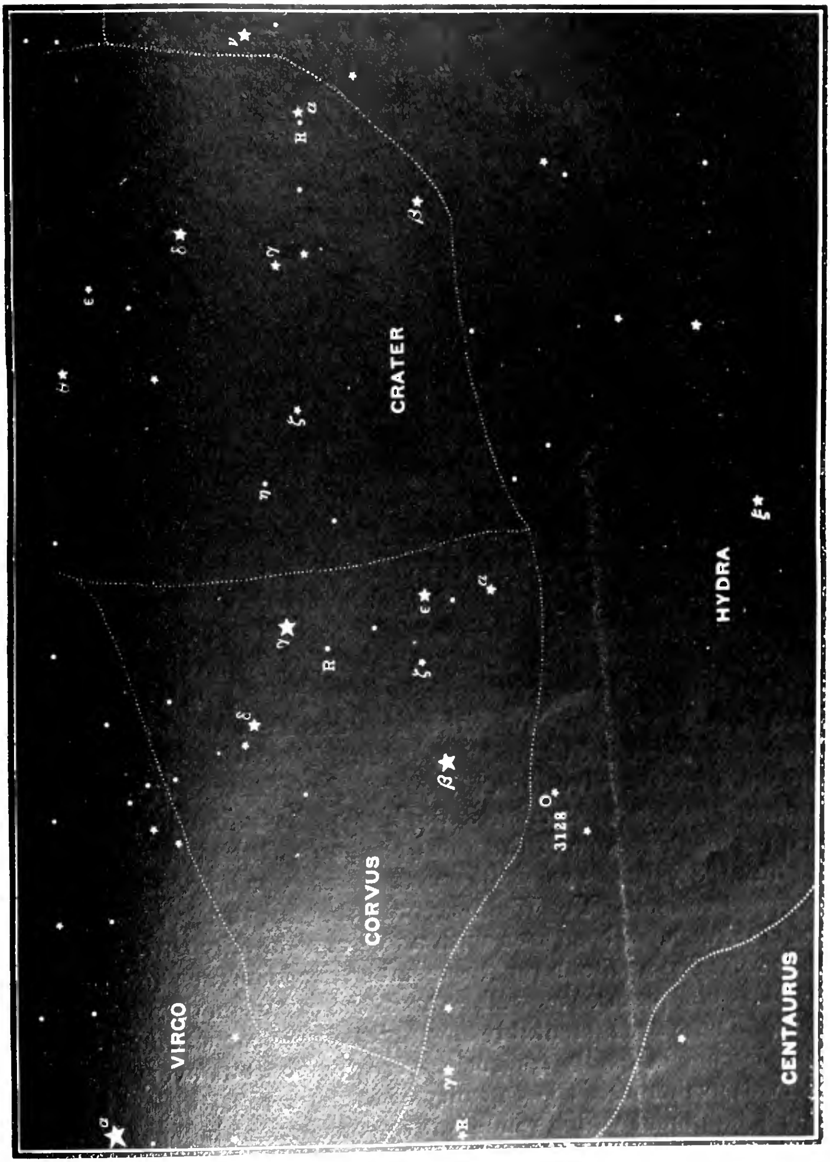
While our three-inch telescope suffices to show R, it is better to use the five-inch, because of the faintness of the star. When the color is well seen, the contrast with α is very pleasing.

There is hardly anything else in Crater to interest us, and we pass over the border into Corvus, and go at once to its chief attraction, the star δ. The components of this beautiful double are of magnitudes three and eight; distance 24″, p. 211°; colors yellow and purple.

The night being dark and clear, we take the five-inch and turn it on the nebula 3128, which the map shows just under the border of Corvus in the edge of Hydra. Herschel believed he had resolved this into stars. It is a faint object and small, not exceeding one eighth of the moon's diameter.

Further east in Hydra, as indicated near the left-hand edge of map No. 8, is a somewhat remarkable variable, R Hydræ. This star occasionally reaches magnitude three and a half, while at minimum it is not much above the tenth magnitude. Its period is about four hundred and twenty-five days.

While we have been examining these comparatively barren regions, glad to find one or two colored doubles to relieve the monotony of the search, a glittering white star has frequently drawn our eyes eastward and upward. It is Spica, the great gem of Virgo, and, yielding to its attraction, we now enter the richer constellation over which it presides (map No. 9). Except for its beauty, which every one must admire, Spica, or α Virginis, has no special claim upon our attention. Some evidence has been obtained that, like β Aurigæ, it revolves with an invisible companion of great mass in an orbit only six million miles in diameter. Spica's spectrum resembles that of Sirius. The faint star which our larger apertures show about 6′ northeast of Spica is of the tenth magnitude.

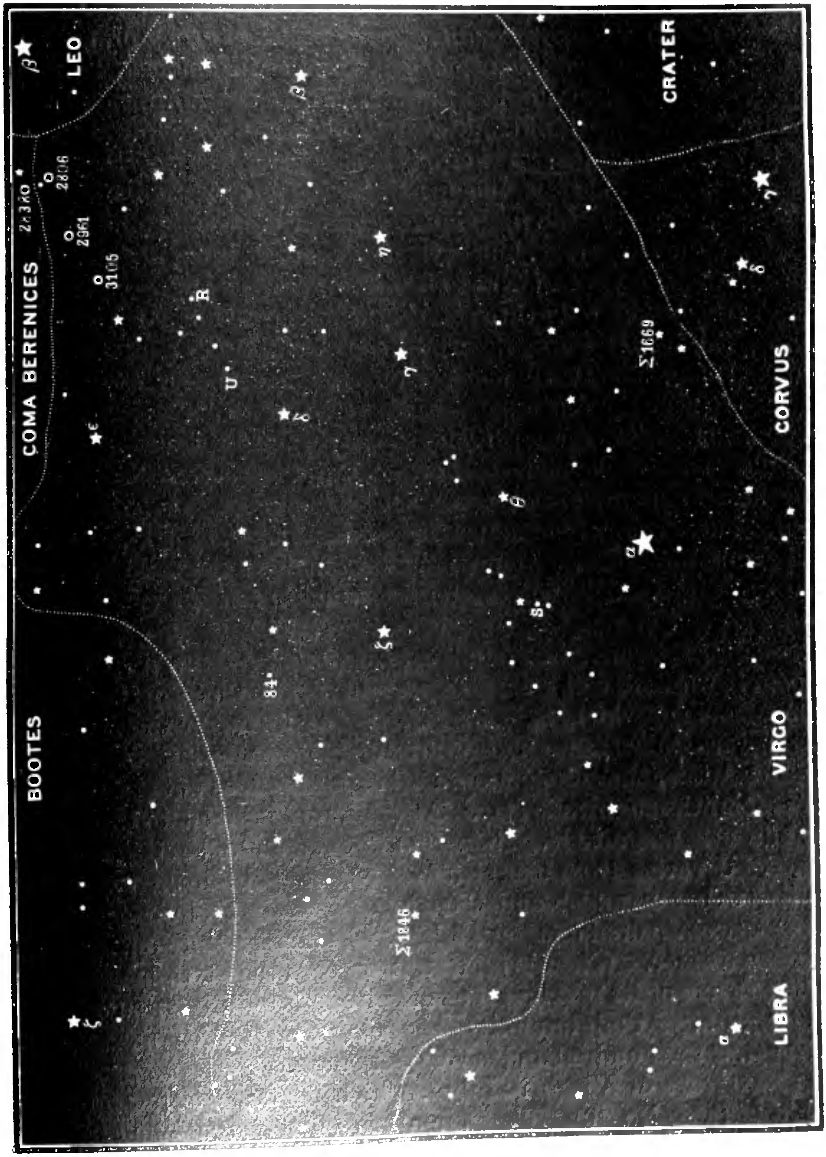


Sweeping w[illegible] upon Σ 1669, a pretty little double with nearly [illegible] components of about the sixth magnitude; distance [illegible] But our interest is not fully aroused until we reach γ, a star with a history. The components of this celebrated binary are both nearly of the third magnitude, distance about 5·9″, p. 150°. They revolve around their common center in something less than two hundred years. According to some authorities, the period is one hundred and seventy years, but it is not yet certainly ascertained. It was noticed about the beginning of the seventeenth century that γ Virginis was double. In 1836 the stars were so close together that no telescope then in existence was able to separate them, although it is said that the disk into which they had merged was elongated at Pulkowa. In a few years they became easily separable once more. If the one-hundred-and-seventy-year period is correct, they should continue to get farther apart until about 1921. According to Asaph Hall, their greatest apparent distance is 6·3″, and their least apparent distance 0·5″; consequently, they will never again close up beyond the separating power of existing telescopes.

There is a great charm in watching this pair of stars even with a three-inch telescope—not so much on account of what is seen, although they are very beautiful, as on account of what we know they are doing. It is no slight thing to behold two distant stars obeying the law that makes a stone fall to the ground and compels the earth to swing round the sun.

In θ we discover a fine triple, magnitudes four and a half, nine, and ten; distances 7″, p. 345°, and 65″, p. 295°. The ninth-magnitude star has been described as "violet," but such designations of color are often misleading when the star is very faint. On the other hand it should not be assumed that a certain color does not exist because the observer can not perceive it, for experience shows that there is a wide difference among observers in the power of the eye to distinguish color. I have known persons who could not perceive the difference of hue in some of the most beautifully contrasted colored doubles to be found in the sky. Such persons miss one of the finest pleasures of the telescope. In examining θ Virginis we shall do best to use our largest aperture, viz., the five-inch. Yet Webb records that all three of the stars in this triple have been seen with a telescope of only three inches aperture. The amateur must remember in such cases how much depends upon practice as well as upon the condition of the atmosphere. There are lamentably few nights in a year when even the best telescope is ideally perfect in performance, but every night's observation increases the capacity of the eye, begetting a kind of critical judgment which renders it to some extent independent of atmospheric vagaries. It will also be found that the idiosyncrasies of the observer are reflected in his instrument, which seems to have its fits of excellence, its inspirations so to speak, while at other times it behaves as if all its wonderful powers had departed.

Another double that perhaps we had better not try with less than four inches aperture is 84 Virginis. The magnitudes are six and nine; distance, 3.5″, p. 233°. Colors, yellow and blue. Σ 1846



MAP No. 8.

is a fifth-magnitude star with a tenth-magnitude companion, distance only 1″, p. [illegible] the five-inch.

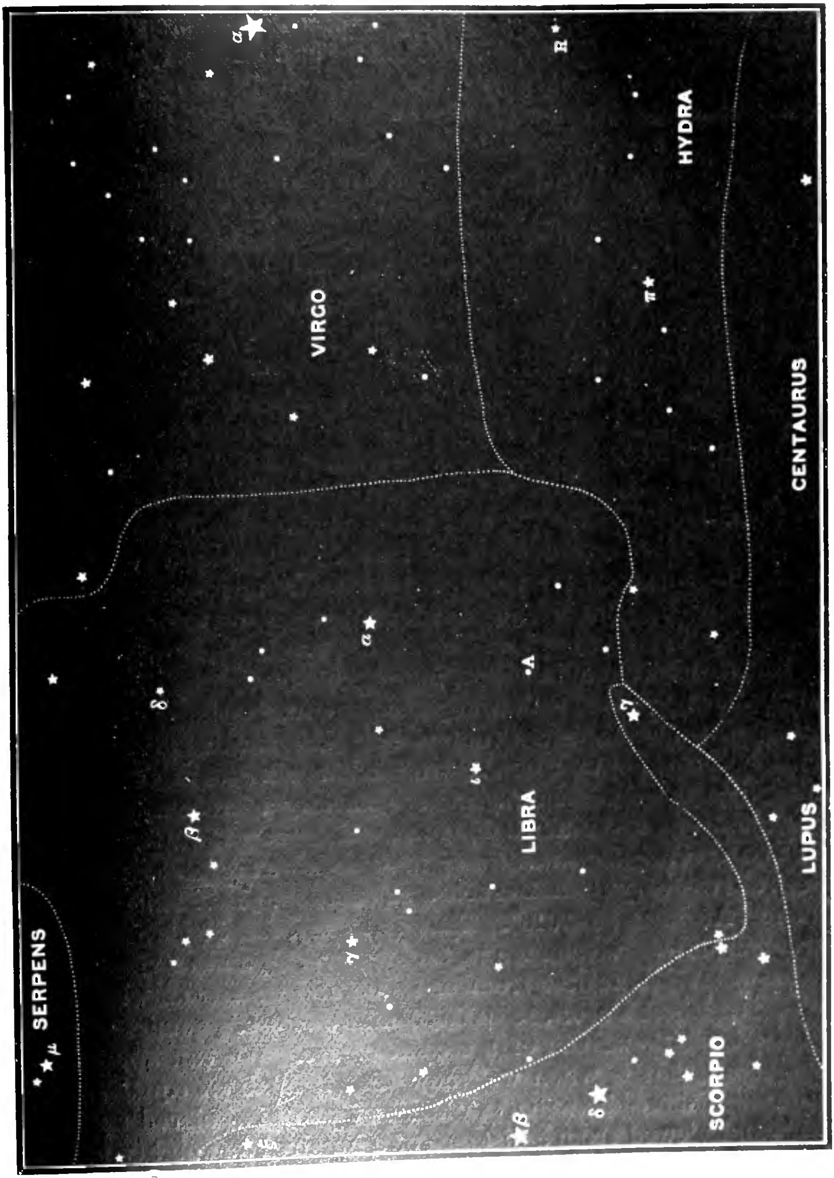
And now we are [illegible] something that is truly wonderful, the "Field of the [illegible] This strange region, lying mostly in the constellation Virgo, is roughly outlined by the stars β, η, γ, δ, and ϵ, which form two sides of a square some 15° across. It extends, however, for some distance into Coma Berenices, while outlying nebulæ belonging to it are also to be found in the eastern part of Leo. Unfortunately for those who expect only brilliant revelations when they look through a telescope, this throng of nebulæ consists of small and inconspicuous wisps as ill defined as bits of thistle-down floating high in the air. There are more than three hundred of them all told, but even the brightest are faint objects when seen with the largest of our telescopes. Why do they congregate thus? That is the question which lends an interest to the assemblage that no individual member of it could alone command. It is a mystery, but beyond question it is explicable. The explanation, however, is yet to be discovered.

The places of only three of the nebulæ are indicated on the map. No. 2806 has been described as resembling in shape a shuttle. Its length is nearly one third of the moon's diameter. It is brightest near the center, and has several faint companions. No. 2961 is round, 4′ in diameter, and is accompanied by another round nebula in the same field of view toward the south. No. 3105 is double, and powerful telescopes show two more ghostly companions. There is an opportunity for good and useful work in a careful study of the little nebulæ that swim into view all over this part of Virgo. Celestial photography has triumphs in store for itself here.

Scattered over and around the region where the nebulæ are thickest we find eight or nine variable stars, three of the most remarkable of which, R, S, and U, may be found on the map. R is very irregular, sometimes attaining magnitude six and a half, while at other times its maximum brightness does not exceed that of an eighth-magnitude star. At minimum it sinks to the tenth or eleventh magnitude. Its period is one hundred and forty-five days. U varies from magnitude seven or eight down to magnitude twelve or under and then regains its light, in a period of about two hundred and seven days. S is interesting for its brilliant red color. When brightest, it exceeds the sixth magnitude, but at some of its maxima the magnitude is hardly greater than the eighth. At minimum it goes below the twelfth magnitude. Period, three hundred and seventy-six days.

Next east of Virgo is Libra, which contains a few notable objects (map No. 10). The star α has a fifth-magnitude companion, distant about 230″, which can be easily seen with an opera glass. At the point marked A on the map is a curious multiple star, sometimes referred to by its number in Piazzi's catalogues as follows: 212 P. xiv. The two principal stars are easily seen, their magnitudes being six and seven and a half; distance 15″, p.

290°. Burnham found four other faint companions, for which it would be useless for us to look. The remarkable thing is that these faint stars, the nearest of which is distant about 50″ from



Map No. 19.

the largest member of the group, and the farthest about 120″, do not share, according to the discoverer, in the rapid proper motion of the two [illegible] difficult for our three-inch. The

In ι we find a [illegible]

components are of magnitudes four and a half and ninth, distance 57″, p. 110°. Burnham discovered that the ninth-magnitude star consists of two of the tenth less than 2″ apart, p. 24°.

No astronomer who happens to be engaged in this part of the sky unless his attention is entirely absorbed by something of special interest, ever fails at least to glance at β Libræ, which is famous as the only naked-eye star having a decided green color. The hue is pale, but manifest.*

The star δ is a remarkable variable, belonging to what is called the Algol type. Its period, according to Chandler, is 2 days, 7 hours, 51 minutes, 22·8 seconds. The time occupied by the actual changes is about twelve hours. At maximum the star is of magnitude five and at minimum of magnitude 6·2.

We may now conveniently turn northward from Virgo in order to explore Boötes, one of the most interesting of the constellations (map No. 11). Its leading star α, Arcturus, is the brightest in the northern hemisphere. Its precedence over its rivals Vega and Capella has been settled by the Harvard photometry. You notice that the color of Arcturus, when it has not risen far above the horizon, is a yellowish red, but when the star is near mid-heaven the color fades to yellow. The hue is possibly variable, for it is recorded that in 1852 Arcturus appeared to have nearly lost its color. If it should eventually turn white, the fact would have an important bearing upon the question whether Sirius was once a red or flame-colored star.

But let us sit here in the starlight, for the night is balmy, and talk about Arcturus, which is perhaps actually the greatest sun within the range of terrestrial vision. Its parallax is so minute that the consideration of the tremendous size of this star is a thing that the imagination can not placidly approach. Calculations, based on its assumed distance, which show that it *outshines the sun several thousand times* may be no exaggeration of the truth! It is easy to make such a calculation. Dr. Elkin's parallax for Arcturus is 0·018″. That is to say, the displacement of Arcturus due to the change in the observer's point of view when he looks at the star first from one side and then from the other side of the earth's orbit, 186,000,000 miles across, amounts to only eighteen one-thousands of a second of arc. We can appreciate how small that is when we know that it is about equal to the apparent distance between the heads of two pins placed an inch apart and viewed from a distance of a hundred and eighty miles!

Assuming this estimate of the parallax of Arcturus, let us see how it will enable us to calculate the probable size or light-giv-

* Has the slight green tint perceptible in Sirius deepened of late? I am sometimes disposed to think it has.

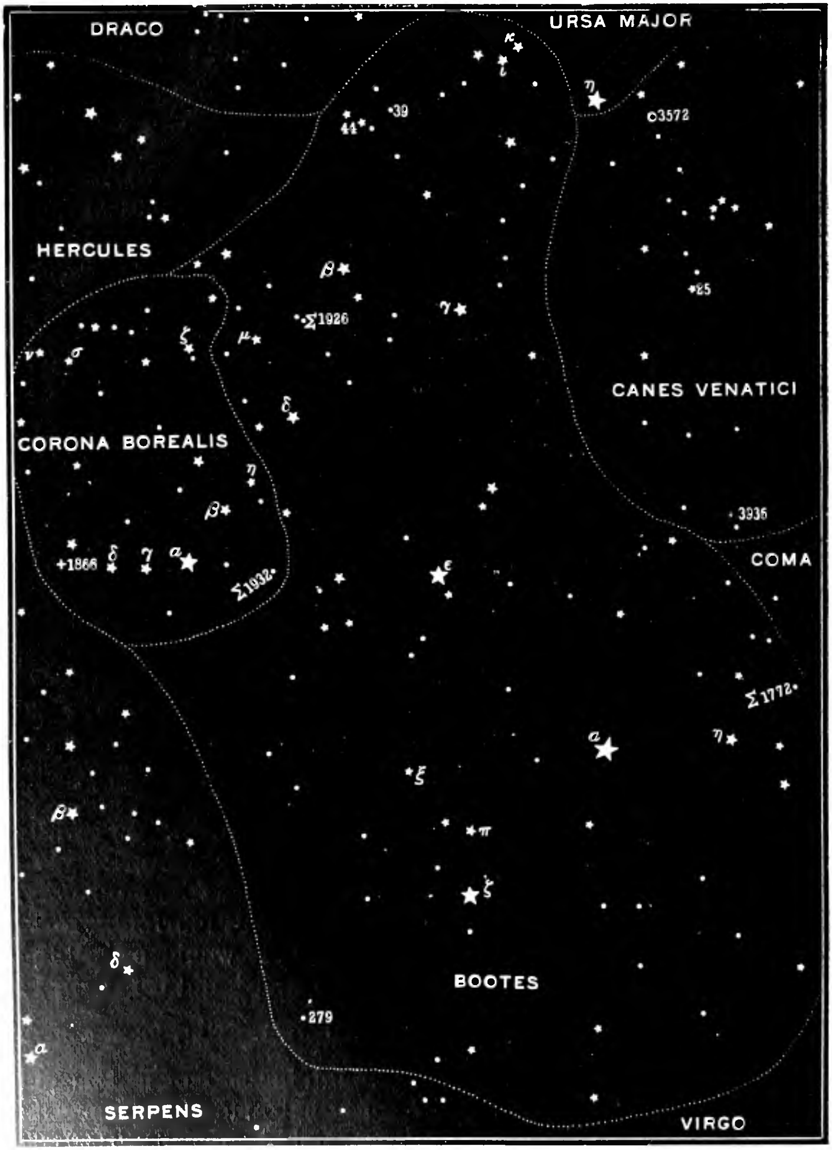
ing power of the star as compared with the sun. The first thing to do is to multiply the earth's distance from the sun, which may be taken at 93,000,000 miles, by 206,265, the number of seconds of arc in a radian, the base of circular measure, and then divide the product by the parallax of the star. Performing the multiplication and division, we get the following:

$$\frac{19,182,645,000,000}{\cdot 018} = 1,065,790,250,000,000.$$

The quotient represents miles! Call it, in round numbers, a thousand millions of millions of miles. This is about 11,400,000 times the distance from the earth to the sun.

Now for the second part of the calculation: The amount of light received on the earth from some of the brighter stars has been experimentally compared with the amount received from the sun. The results differ pretty widely, but in the case of Arcturus the ratio of the star's light to sunlight may be taken as about one twenty-five-thousand-millionth—i. e., 25,000,000,000 stars, each equal to Arcturus, would together shed upon the earth as much light as the sun does. But we know that light varies inversely as the square of the distance; for instance, if the sun was twice as far away as it is, its light would be diminished for us to a quarter of its present amount. Suppose, then, that we could remove the earth to a point midway between the sun and Arcturus, we should then be 5,700,000 times as far from the sun as we now are. In order to estimate how much light the sun would send us from that distance we must square the number 5,700,000 and then take the result inversely, or as a fraction. We thus get $\frac{1}{32,490,000,000,000}$, representing the ratio of the sun's light at half the distance of Arcturus to that at its real distance. But while receding from the sun we should be approaching Arcturus. We should get, in fact, twice as near to that star as we were before, and therefore its light would be increased for us fourfold. Now, if the amount of sunlight had not changed, it would exceed the light of Arcturus only a quarter as much as it did before, or in the ratio of $\frac{25,000,000,000}{4} = 6,250,000,000$ to 1. But, as we have seen, the sunlight would diminish through increase of distance to one 32,490,000,000,000th part of its original amount. Hence its altered ratio to the light of Arcturus would become 6,250,000,000 to 32,490,000,000,000, or 1 to 5,198.

This means that if the earth were situated midway between the sun and Arcturus, it would receive 5,198 times as much light from that star as it would from the sun! It is quite probable, moreover, that the heat of Arcturus exceeds the solar heat in the same ratio, for the spectroscope shows that although Arcturus is surrounded with a cloak of metallic vapors proportionately far more extensive than the sun's, yet, smothered as the great star



MAP No. 11.

seems in some respects to be, it rivals Sirius itself in the intensity of its radiant energy.

If we suppose the radiation of Arcturus to be the same per unit of surface as the sun's, it follows that Arcturus exceeds the sun about 375,000 times in volume, and that its diameter is no less than 62,350,000 miles! Imagine the earth and the other planets constituting the solar system removed to Arcturus and set revolving around it in orbits of the same forms and sizes as those in which they circle about the sun. Poor Mercury! For that little planet it would indeed be a jump from the frying pan into the fire, because, as it rushed to perihelion, Mercury would plunge more than 2,500,000 miles beneath the surface of the giant star. Venus and the earth would perhaps melt like snowflakes at the mouth of a furnace. Even far-away Neptune, the remotest member of the system, would be bathed in torrid heat.

But stop! Look at the sky. Observe how small and motionless the disks of the stars have become. Back to the telescopes at once, for this is a token that the atmosphere is steady, and that "good seeing" may be expected. It is fortunate, for we have some delicate work before us. The very first double star we try in Boötes, Σ 1772, requires the use of the four-inch, and the five-inch shows it more satisfactorily. The magnitudes are sixth and ninth, distance 5″; p. 140°. On the other side of Arcturus we find ζ, a star that we should have had no great difficulty in separating thirty years ago, but which has now closed up beyond the reach even of our five-inch. The magnitudes are both fourth, and the distance about 0·5″, p. 285°. It is apparently a binary, and if so will some time widen again, but its period is unknown. The star 279, also known as Σ 1910, near the southeastern edge of the constellation, is a pretty double, each component being of the seventh magnitude; distance 4″; p. 212°. Just above ζ we come upon π, an easy double for the three-inch, magnitudes fourth and sixth; distance 6″; p. 99°. Next is ξ, a yellow and purple pair, whose magnitudes are respectively fifth and seventh; distance less than 3″; p. 231°. This is undoubtedly a binary with a period of revolution of about a hundred and thirty years. Its distance decreased about 1″ between 1881 and 1891. It was still decreasing in 1894, when it had become 2·9″. The orbital swing is also very apparent in the change of the position angle.

The telescopic gem of Boötes, and one of "the flowers of the sky," is ε, also known as Mirac. When well seen, as we shall see it to-night, ε Boötis is superb. The magnitudes of its two component stars are two and a half (according to Hall, three) and six. The distance is about 2·8″, p. 326°. The contrast of colors—bright orange yellow, matched with brilliant emerald green—is magnificent. There are very few doubles that can be compared with it in this respect. The three-inch will separate it, but the five-inch enables us best to enjoy its beauty. It appears to be a binary, but the motion is very slow, and nothing certain is yet known of its period.

In δ we have a very wide and easy double; magnitudes three and a half and eight and a half; distance 110″, p. 75°. The smaller star has a lilac hue. We can not hope with any of our instruments to see the three stars contained in μ, but two of them are easily seen; magnitudes four and seven; distance 108″, p. 172°. The smaller star is again double; magnitudes seven and eight; distance 0·77″, p. 88°. It is clearly a binary, with a long period. A six-inch telescope that could separate this star at present would be a treasure. Σ 1926 is another object rather beyond our powers, on account of the contrast of magnitudes. These are six and eight and a half; distance 1·3″, p. 256°.

Other doubles are: 44 (Σ 1909), magnitudes five and six; distance 4·8″, p. 240°; 39 (Σ 1890), magnitudes both nearly six; distance 3·6″, p. 45°. Smaller star light red; ι, magnitudes four and a half and seven and a half, distance 38″, p. 33°; κ, magnitudes five and a half and eight, distance 12·7″, p. 238°. Some observers see a greenish tinge in the light of the larger star, the smaller one being blue.

There are one or two interesting things to be seen in that part of Canes Venatici which is represented on map No. 11. The first of these is the star cluster 3936. This will reward a good look with the five-inch. With large telescopes as many as one thousand stars have been discerned packed within its globular outlines.

The star 25 (Σ 1768) is a close binary with a period estimated at one hundred and twenty-five years. The magnitudes are six and seven or eight, distance about 1″, p. 137°. We may try for this with the five-inch, and if we don't succeed in separating the stars we may hope to do so some time, for the distance between them is increasing.

Although the nebula 3572 is a very wonderful object, we shall leave it for another evening.

Eastward from Boötes shines the circlet of Corona Borealis, whose form is so strikingly marked out by the stars that the most careless eye perceives it at once. Although a very small constellation, it abounds with interesting objects. We begin our attack with the five-inch on Σ 1932, and we may heartily congratulate ourselves if we come off victors, for this binary has been slowly closing for many years. The magnitudes are six and a half and seven, distance 0·94″, p. 317°. Not far distant is another binary, at present beyond our powers, η. Here the magnitudes are both six, distance 0·86″, p. 245°. Hall assigns a period of forty years to this star. It is widening,

The assemblage of close binaries in this neighborhood is very curious. Only a few degrees away we find one that is still more remarkable, the star γ. What has previously been said about 42 Comæ Berenicis applies in a measure to this star also. It, too, has a comparatively small orbit, and its components are never seen widely separated. In 1826 their distance was 0·7″; in 1880 they could not be split; in 1891 the distance had increased to 0·36″, and in 1894 it had become 0·53″, p. 123°. The period has been estimated at one hundred years.

While the group of double stars in the southern part of Corona Borealis consists, as we have seen, of remarkably close binaries, another group in the northern part of the same constellation comprises stars that are easily separated. Let us first try ζ. The powers of the three-inch are amply sufficient in this case. The magnitudes are four and five, distance 6·3″, p. 300°. Colors, white or bluish-white and blue or green.

Next take σ, whose magnitudes are five and six, distance 4″, p. 206°. With the five-inch we may look for a second companion of the tenth magnitude, distance 54″, p. 88°. It is thought highly probable that σ is a binary, but its period has simply been guessed at.

Finally, we come to ν, which consists of two very widely separated stars, ν^1 and ν^2, each of which has a faint companion. With the five-inch we may be able to see the companion of ν^2, the more southerly of the pair. The magnitude of the companion is variously given as tenth and twelfth, distance 137″, p. 18°.

With the aid of the map we find the position of the new star of 1866, which is famous as the first so-called temporary star to which spectroscopic analysis was applied. When first noticed, on May 12, 1866, this star was of the second magnitude, fully equaling in brilliancy α, the brightest star of the constellation; but in about two weeks it fell to the ninth magnitude. Huggins and Miller eagerly studied the star with the spectroscope, and their results were received with the deepest interest. They concluded that the light of the new star had two different sources, each giving a spectrum peculiar to itself. One of the spectra had dark lines and the other bright lines. It will be remembered that a similar peculiarity was exhibited by the new star in Auriga in 1893. But the star in Corona did not disappear. It diminished to magnitude nine and a half or ten, and stopped there; and it is still visible. In fact, subsequent examination proved that it had been catalogued at Bonn as a star of magnitude nine and a half in 1855. Consequently this "blaze star" of 1866 will bear watching in its decrepitude. Nobody knows but that it may blaze again. Perhaps it is a sunlike body; perhaps it bears little resemblance to a sun as we understand such a thing. But whatever it may be, it is there, and it has proved itself capable of doing very extraordinary things.

We have no reason to suspect the sun of any latent eccentricities like those that have been displayed by "temporary" stars; yet, acting on the principle which led the old emperor-astrologer

Rudolph II to torment his mind with self-made horoscopes of evil import, let us unscientifically imagine that the sun *could* suddenly burst out with several hundred times its ordinary amount of heat and light, thereby putting us into a proper condition for spectroscopic examination by curious astronomers in distant worlds.

But no, it is far pleasanter to keep within the strict boundaries of science, and not imagine anything of the kind.

THE SUCCESSOR OF THE RAILWAY.

By APPLETON MORGAN.

WITHIN the few years remaining to the nineteenth century, if not indeed already, will certainly pass away the human being who can remember a date when there were no railways. A railway then will be, if it is not already, as much part of a natural landscape as a mountain or a river, since no one can then recall a time at which railways as well as rivers did not run.

Our nineteenth century has been the railway age. Within its bounds the railway has been entirely conceived, invented, utilized, and perfected. But will the century which has been the birth and genesis of the railway witness also its exodus and its death? Perhaps not; and yet—perhaps. It has been anticipated and foreseen that electricity was to be the successor of steam, and experimental electric locomotives have already been operated with more or less satisfactory results. But the question appears at this moment to be, not whether the electric locomotive will supersede the steam locomotive, but whether locomotives themselves are not to be dispensed with, and tossed, together with drawings, models, plans, specifications, and estimates for a substitution of power, upon the scrap heap, while the substitution shall be, not of the motive power, but of the motor.

It looks, indeed, as if the next century, whatever it may have in the way of aërial flight in store for us, will have no difficulty, if it desires the honor, of being christened "the trolley age." For it is to this new traction system that the railway companies are already looking with that apprehension with which an heirless landed proprietor regards his hostile next of kin. Loaded down with their vast burden of fixed charges and costly maintenance, crippled by all sorts of parasites, legal, illegal, and mixed, there seems to be nothing for them to do but to wait patiently to be superseded.

For many years the railway companies had come to philosophize helplessly at the prospective diminution of suburban profits from the horse or dummy-operated tramway, and had missed the out-of-town patron who had begun to turn his back upon comfortable sittings and smokers, sumptuous saloons, luxurious upholstery, facilities for his traveling whist or chess, heat, water, and conveniences galore. They had without a murmur seen all these pale in attraction to the man of business, who needed not to await time tables or succumb to belated or missed trains, when the buzzing little trolley hummed along its inexpensive wires every five minutes, so long as it afforded him a board bench or a strap to hang on by. But when this unexpected trolley began to go farther and stretch its transportation powers to longer distances, the poor handicapped railways were led to look at their books and—if metaphors may be mixed—to button up their pockets and hint of receivers instead of dividends. And just at present they may be praying for time to turn around before a transcontinental trolley is upon them!

The trolley indeed has, in less space of time than that required to launch any other known improvement, practically captured the cheap transportation field. This newcomer, indeed, seems equipped with every opportunity that the railways have been coveting for fifty years, and to be getting for the asking everything for which the railways have to pay the heaviest. Its economies began at its very birth. In its construction it has no use for high-salaried engineering and locating parties; for woodsmen, excavators, dumpers, agents of rights of way, and for the long catalogue of machinery for surveying and making a railway line. All these become as superfluous and as clumsy as the Old Man of the Sea on Sindbad's back; for, while your principal assistants are putting on their rubber boots, your trolley—built in a night, like Aladdin's palace—is earning dividends, oblivious of summits or watersheds or grades, loops or bridges, trusses or cantilevers. It is only an item of the situation that, as fast as charters can be mobilized or capital adjusted or plants converted, the dummies are side-tracked, horses led to auction, while every species of tramway spins its overhead wires and becomes trolley-ized into remunerative investments. We sometimes smile at the non-perspiring Philadelphian pace; but here are in evidence, from the calm City of Brotherly Love, figures of a month's operation of a single line where the trolley has just replaced the horse, to wit: Four hundred and fifty horses that were formerly used on the road consumed in a month ninety-two and a half tons of cut hay, about eight thousand pounds of feed, and two tons of straw. This, with shoeing, cost the company about four thousand five hundred dollars. Offsetting this, the coal consumed in one month's working cost five hundred and eighty-five dollars, a clear saving by the trolley of three thousand nine hundred and fifteen dollars. On an average, eighty men were employed around the stables and in the car sheds for looking after these four hundred and fifty horses. For these the company substitutes two or three electrical operatives, and saves about five thousand dollars a month in expenses, and anticipates an increase besides of twenty-five per cent on receipts by the increase of business, by the saving of time and the doubling of train schedules.*

Against such startling economies as these economists would ordinarily place the usual offsets of more highly skilled and better-paid labor required to handle the more subtile and complicated motive. Such a rule should apparently best operate in a case when an invisible power is substituted for one, where ethereal energy so literally takes the place of brute force as when electricity supersedes a horse. In every other *situs* the rule would obtain. When we put a criminal to death by hanging, any boor could haul at or cut a rope, but when we electrocuted we were obliged to get a higher-priced aid—a rather more accomplished Jack Ketch. But not so the trolley. Its machinery was so purely and elementarily automatic—so in a nutshell and within the control of the faintest pressure—that the material out of which drivers and conductors were made was worked over in a day into electric motormen, who, instead of a wilder found a far more tractable and manageable horse—one that went without goad, reins, or word of command; one that needed not to be put in or out or changed for shorter or longer routes. Furthermore, the new steed not only guided but regulated himself, thus dispensing with a switchman; and a horse that not only hauls, but obligingly lights and heats the cars as well. Switchmen are dispensed with by the simplest of expedients at the busiest junctions; the simple placing of an insulated rail in a track, and of disconnecting a current supplied by the car passing over it, being found to throw and replace a switch with absolutely infallible accuracy. And, again, this docile horse will not only do its own work, but anybody else's; for it has been found that where two trolley lines cross, and an accident to one withdraws its power, the power used by the other will leap over into the unoccupied wires of the disabled road and operate them both. Against such figures as these the railways will not attempt to compete, but will struggle on, meeting their fixed charges when they can, and striving to keep down their daily deficits by reorganization committees, and ciphering on the backs of old envelopes instead of writing pads! †

* Of collateral economies, it is not improbable, for example, that insurance companies, chartered to handle electric risks alone, will make their appearance, nor will they find themselves without an exceedingly profitable investment area.

† A general order to this effect was sent out from the president's office of the Delaware, Lackawanna and Western Railroad a few months since.

But, summary as the above statements appear, these are only the secondary and mechanical effects of this insidious little humming bee—the trolley. The heavier and costlier revolution lies behind its operation and even behind its construction. The legal status of the trolley is that of a street railway. To construct the railway (and it may yet become convenient to adopt the English word "tramway," and apply hereafter arbitrarily the two, making the word *Railway* signify the great lines operated by steam, while the word *Tramway* signifies all lines operated by other traction systems), first of all, that slow-moving branch of the common law which we call "eminent domain" must be invoked with all its paraphernalia; and, of all large bodies, this power of the State, this "eminent domain," moves far the slowest. The jealousy with which it is guarded by legislatures, the reluctance with which it is authorized, the ten thousand and one commissions, boards, and councils which watch with sleepless eyes its control and its administration by the devoted railway company, are as harassing as they are beyond escape. A paternal Interstate Commerce Commission pre-empts the railway situation and pours out three or four octavo volumes a year of rules and regulations. Then the boards of railway commissioners of forty sovereign States take a hand apiece and issue each as many more pandects, edicts, decisions, restrictions, and findings again! Next the boards of aldermen of cities intervene with their ordinances and committees of investigation; and, when there are no boards of aldermen, the county supervisors, "boards of chosen freeholders," town committees, and what not gather around; and no authority, however brief or minute, but has its word in railway operation which, like Mr. Haggard's She, "must be obeyed!" Not only must all these be maintained sooner or later by taxes on the earnings of the railway, with liberal subsidies paid on the nail, but each and all of these are to be supported and placated with "passes"; courtesied to and consulted at every step; salaried, subsidized, and placated, too—for the sole purpose of making laws, rules, to restrict and never to benefit: to curtail but never to enlarge the earning powers of the long-suffering railway. For who ever heard of a law, rule, edict, or ordinance *in behalf of* a railway company—to bless and not to ban? And even courts, which construe a railway to be a quasi-public corporation, are most vigorous in denying it any public right (except, perhaps, the right to be bled and mulcted by everybody). But not so and such is the primal legal career of the blithe little trolley! Not only does it harness an invisible horse who works for no board and no salary, but the greater part of all this accumulated espionage and control is escaped. The "eminent domain" which it enjoys comes to it through the minor powers of annoyance and interference.

It takes its franchises by consent or by ordinance of the lesser municipal corporations above enumerated—the aldermen, the supervisor, the adjoining proprietors; who, lesser in place, are also lesser in appetite and cormorant capabilities. It escapes all but the local "heeler" and "striker." It needs no private funds or private pass-books; no discretionary accounts, except for the smaller appetites. Then, too, when the percentage of accident occurs, the losses are smaller and the damages more minute. The million-dollar disaster and the bankrupting cataclysm are impossibilities to them. Whether the trolley will always escape, as it appears at present to have escaped, the writer for the public press, who at every accident knows just what should have been done to avoid it, just wherein the corporation was criminal or criminally negligent, parsimonious, greedy of gain as estimating income beyond human life or limb, and so on, remains for demonstration. But for the present the trolley's strength, like a woman's, is in her weakness. She sings along her delicate wires, overcoming every obstacle, legal, natural, mechanical, temporal, and practical, dodging every expense, and, best of all, gathers in the ready nickels of everybody and his wife, while her laborious sister, the railway, must pose and turn and make rebates and special rates and ransack the catalogue of inducements if haply she may capture the more infrequent quarters and halves and dollars. With all these, it would seem to be at least common fairness on the part of the cadet of the transportation family to let her elder sister remain monopolist of long-distance traveling and freight transportation which makes her to live. But no! This ambitious young lady has already for long been flirting with freight problems, and has actually projected, incorporated, and capitalized lines ("systems" she probably has already learned to call them) between great centers like New York, Baltimore, and Washington, the carrying of mails and doubtless of our high-priced legislators (which latter will demand the vestibule, the buffet, and parlor and slumber cars, with all that these imply).

The truth is that the trolley is the coming parallel of the railway as to everything in the catalogue. Not even the protests of a nation could keep her off the sacred soil of Gettysburg. She goes where she will. She has even—if the newspapers are veracious —been "held up" in true railway style. Indeed, I foresee nothing that the trolley can not do and nothing that she will not attempt.

With her ambition, however, will come certain disabilities. When she crosses State lines and becomes of interstate dignity, she must not expect immunity from that terrible pigeonholer of freight schedules at Washington, our old mother antic the Interstate Commerce Commission, and that terrible "long and short haul" bugaboo which has already wrecked one of our most majestic American railway systems* for the benefit of its alien parallel, and which has precipitated three other vast plants into the miseries of receiverships! Will she who has come so swiftly into potent plutocracy, who pays dividends and fills pockets of all concerned, fall at last, as most men and women fall, by her own ambition and insatiate pride of power? Perhaps she can climb over the Interstate Commerce Commission and State boards of railway Solons above enumerated as deftly as she surmounts grades and laughs at incorporation and locating expenses! Let us hope, for her sake, that she does so. But possibly she can not expect, after dissolving the street railway, the narrow-gauge railway, the elevated railway, and all the other tramway devices except her own, to go scot-free of congresses and of State legislatures that sit nine months in every year to make new laws for this law-prolific United States.

It seems hard indeed to believe that the trolley, with all its easy dodging of expenses, can do much more for shippers than the railway has accomplished. In spite of tributes demanded, the American railway has reduced freights again to where they stood before the Interstate Commerce Commission sent them up, so that our railways now carry for an average of one dollar and twenty-two cents a ton, as against an average of two dollars and two cents for the rest of the world.†

The above are a few considerations which lie on the surface of the present enormous development of an invention which had hardly been born at all, but it had leaped like Minerva, adult and armored, from the alleged front of Jove. It may almost be said that it came in obedience to a reluctant summons which was only uttered after almost every other conceivable form of rapid transit had been tried, retried, rejected, and tried over again! In the city of New York, for example (to take the most crowded spot on two continents, where business urgencies of every conceivable character are cramped between waterways upon a narrow island), almost all the varieties of tramway transportation played at leap-frog with each other for years before the trolley came! The history is a curious one, and will bear repeating. But the most curious thing about it is, after all, the long and slow mental processes by which New York capitalists—after sinking hundreds of millions of dollars in building railways across trackless forests and frozen mountains and over unpopulated prairies—arrived at

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* This railway, as it happens, was chartered not by any State, but by the United States, and surely the nation has a right to wreck its own railway by its own laws if it sees fit.

† The actual figures are to-day in Europe: Germany, $1.22; Austria, $2.10; Belgium, $1.54; Denmark, $2.76; France, $2.14; Italy, $2.40; Luxemburg, $1.92; Norway, $3; Holland, $1.52; Roumania, $2.64; Russia, $2.32; Finland, $1.98; Switzerland, $3.36.

the proposition that the place to build a railway was where the people to ride on it lived! right at home in their own packed and overcrowded city!

Surely the history of cheap interstreet transportation in New York has been a veritable whirligig. The archaic hackney coach, then the lumbering old Knickerbocker stages, the driver of each a true Tony Veller, and then the tardy appearance of a street-car line or two on the extreme avenues east and west, as if the old impetus which settled the city along its water fronts must first be consulted in land passenger transportation: and then, as horse-car lines began to appear nearer the spinal center of the city, an effort for a choice of passengers. As who does not remember when the old red Third Avenue cars bore the titles of those departed localities—Yorkville and Harlem (as forgotten now as Greenwich or Chelsea or Strawberry Hill); or, when one could read on certain of the yellow sides of the lumbering Sixth Avenue cars, "Colored people allowed to ride in this car"; and how Broadway, the best and cream of all thoroughfares for traffic lines, was left for a generation to "stages" of lighter models and better lines than the old Knickerbockers, but still as clumsy and lumbering as they could well be made; and how, when the "Gilbert" elevated road ran one day, carrying all who came to demonstrate its safety and speed, New-Yorkers woke up next morning to find these familiar old hulks a thing of the past! (We wise ones know how many of them are still waiting to carry us precariously from some local station to some modern hamlet in the Jersey foothills, perhaps, but we never mention it!)

It is rather a remarkable fact that the very first elevated railway ever proposed to be built in the city of New York (in 1867 or 1868) was intended to be operated by the same contrivance as, thirty years later, was to be adopted by the costliest street surface railway plant in the world! This first tramway, as everybody remembers, the Greenwich Street, or one-legged road, was built on pillars shaped like a letter Y, the rails being on the top of the two arms, while between them, over sunken wheels, traveled a continuous cable operated by steam power generated in stations built in pits dug under the street corners at considerable intervals along the line. These plants were failures, and after a few passenger loads were taken off the cars in ladders, the proprietors gave it up and sold the road for old iron to the highest bidder. This old one-legged road stood where it was, however, the purchasers either defaulting or allowing their purchase to remain unmoved. It was the later success of the "Gilbert" elevated railway which stimulated another company to acquire ultimately this old one-legged road and rebuild it after the Gilbert pattern, thus bringing it into the same system as it now remains. Meanwhile, upon the completion of the Gilbert elevated railway, a panic seized the street railway companies. They did not disappear in a night as the stages did, but they one and all began building the small "bobtail" cars—now happily, in New York city at least, illegal—which ran without a conductor, the passenger on entering being exhorted by signs at every turn to put his money in a box, first asking the driver to supply him with change up to two dollars, if necessary, in an envelope, while Providence took care of the horses. The Sixth Avenue line went further and constructed a couple of enormous two-story cars, which it ran up and down its Sixth Avenue line, to claim the air above as well as the earth beneath, and so to make the Gilbert elevated railway and its constructors trespassers. The present writer remembers well the ridicule this move excited, and how a daily illustrated newspaper (the only daily which in those days dared to print a picture) published a picture of one of these huge arks with the second story lettered in capitals, "Law offices of ——, —— & ——!" (being the then firm of attorneys which represented the Sixth Avenue Railway in its fight with the elevated road, and was supposed to have advised the futile demonstration). The laugh was still louder at the Sixth Avenue surface line, however, when it developed that the "Gilbert" elevated, from Carmine Street to Central Park, called for a track elevation on Sixth Avenue which actually cleared by a few feet the highest point of the "double decker" or two-story cars which they had built to assert their title *a cœlo ad orcum!* (a right which, while undoubtedly inhering in the owner of a fee, may perhaps be questionable as accompanying a street-car franchise, especially in a city where the people and not the city own the streets)! Well, the elevated railways remained. Not only did they not decrease the revenues of the surface roads, but the surface roads were obliged to build more cars! Human beings are queer freight! And it was about an equation of the long-distance passenger who rode to the Battery, or the passenger on the lesser routes who in a day or two grew tired of climbing stairways and took the surface roads in preference! The marvelous growth of the city did the rest. No doubt the Sixth Avenue surface road wished that it had the million dollars it had spent in fighting the elevated railway back in its pocket. And now, not only are there scores of surface roads in New York city which feel no inconvenience from the elevated railroads, but there is actually another stage line, while trolley lines are being projected without number to parallel the surface roads, the elevated roads are projecting extensions, and there is at least one subway railway which is reaching out for capital. But what would be a subway except another conduit along which the trolley should string its local wires?

Nor will this adventurer, before which everything succumbs, rest here. Prior to its advent, wise men were predicting the disappearance of the waterways, since, however economical, they might not be made economical of that costliest of all commodities—of "time"! Just as the inland canal was about to die of superannuation, the trolley has come to its relief. To apply to the canal a circuited instead of a simple overhead wire is a trifling matter, and along it the canal-boat pole ends will yet trundle, until the lazy barges will perhaps rival in bustle the trolley car on land. It may, I think, be confidently expected that, as one resultant of the supersedure of the invisible agency of electricity applied to transportation, considerable and important changes in the law of employed and employer and of negligence will almost immediately become necessary and will attract the attention of the higher courts. Just as the introduction of steam caused important modifications of the rigid and often cruel rules that the employee accepted the risk of his employment, while the employer was quit of responsibility for the negligence (as to each other) of employees; by the corollary that employers must act in touch with scientific improvement, and provide the best and safest implement of service to date: so the utilization of electricity will doubtless add the further qualification that employers must exercise due care in the selection of employees, familiar as nearly as possible with the laws of this new, constant, and invisible force. And it is equally probable that there will be considerable modulation in the assessment of what is or what is not contributory negligence, inasmuch as the peril of casualty by electric operation is and must be for a long time to come peril from an unseen source. Perhaps we shall see a revival of the old legal doctrine of overruling necessity or unavoidable accident ("act of God," as the old lawyers called it), the benefit of which of late years has been refused absolutely to the railway companies. In actions against railway companies for the last quarter of a century it has been permitted to the immediate beneficiaries of an enterprise of a quasi public nature to amerce a corporation merely because, through an inevitable accident, a few persons were killed, when many millions were carried with safety, speed, and comfort, thus imposing upon innocent corporations burdensome restrictions and conditions which hamper the exercise of their independent judgment and sound discretion in matters which virtually affect the public welfare as well as industrial and commercial progress. And it certainly is to the credit of these corporations that such procedure has not induced them to lower rather than to advance either their charges or their efforts in behalf of absolute safety. Whether casual operation of some electric principle or corollary as yet undiscovered—the change in charging power of a plant by reason of some atmospheric condition, some rise or fall of the barometer or of the thermometer—

will be held to be gross negligence, to be responded for in damages on the part of a common carrier who operates his plant by electricity, remains to be seen. With all its advantages and economies even the trolley can not hope to escape all the penalties of success.

To sum it all up, there has suddenly and silently burst upon us an enormous economic agent, and one which, by cheapening the facilities not only of capitalists and manufacturers, but of the least and poorest of consumers, is actually and practically solving those social and agrarian problems which within a few years had threatened serious upheaval in the body politic. With the trolley competing in the field against the railway (selected by the communist as the solid and material symbol of arbitrary power which he should burn and dilapidate and destroy, to assert his popular rights), who shall say that a relief has not come; who shall say but that the railway, with diminished dividends and a divided patronage indeed, may have received from an unexpected quarter immunity from the peril-destroying forces and the hostility of the masses, and at last enjoy its meager surplus of profits over fixed charges, pay roll and maintenance disbursements, in something like peace! Meanwhile the people have been passed from the tender mercies of the larger to those of the smaller capitalists—from the reign of King Log, as it were, to the reign of King Stork. Whether a time will come when our paternal Government will be urged to seize the trolleys and license every one who would operate his own conveyances upon them, remains to be seen. Possibly to the railway-haters the advent of the trolley has come both as a revelation and an extinguisher! At any rate it has brought them the cheap transportation for which they worried, without the expense of building their own railway coaches, and so a revelation in solving their difficulties with unexpected rapidity. But has it also silenced them? They can not demand that Government seize the railways without seizing the tramways. But have they been emancipated, or only had their masters changed? Who shall guess whether the twentieth-century trolley company will not be as remorseless a tyrant as the poor superseded railway company was alleged to have been in its days of dominant usefulness and prosperity?

From the circumstances attending the discovery of argon, the *Revue Scientifique* draws the lesson that notwithstanding the precision of science, and in spite of all the brilliant discoveries that have been made, there are very simple facts of which we know nothing, and which we may live by the side of for a long time, blind to them, because we have not learned to see them.

SOME OF THE "OUTLIERS" AMONG BIRDS.

By R. W. SHUFELDT, M. D.

As in all other departments of biology, the classification of birds was not placed upon a rational basis until midsummer of the year 1858. It was at that time that Darwin and Wallace demonstrated the principles of the law of organic evolution, and gave to the world of science their views upon it and the results of their labors. Prior to their day, when a new form of bird came to the hands of the ornithologist, he considered his duty done, in so far as classification was concerned, after he had generically and specifically christened it, placed it in the family and order where it apparently belonged, and, finally, published its description. Species were thought to be immutable, and consequently the questions of morphology, affinity, and geographical distribution meant little or nothing. If the bird was a duck, with the ducks it went; if a sparrow, then with the sparrows, and so on. Ever and anon, however, a bird form would come to hand that could not be fit with exactness into any of the set and prescribed groups. When this was the case, one author would, for given reasons of his own, place it in this genus, family, and order; while another, for reasons apparently quite as good, would array it elsewhere. Thus these perplexing species were, by one ornithologist or another, tossed about from group to group, and there was no unanimity of opinion as to where they really did belong. This is not at all surprising when we come to consider the views of creation and of Nature that prevailed in the early part of the present century. It was thought by many that birds were created for the admiration of man, and when they sang they sang for man's amusement, and in glorification of their creator. Some very curious notions were entertained in regard to the meager examples of fossil birds known in those days, and the causes for the extinction of existing species were often considered to be "beyond the scope of human reason."

All this and many other crude ideas upon the subject were completely revolutionized when the laws of evolution came to be known. With it came the most remarkable revelation, and the entire science of ornithology passed, as it were, through a transformation scene, and came at once to be regarded from an entirely different point of view. "Classification," as Newton has said, "assumed a wholly different aspect. It had up to that time been little more than a shuffling of cards, the ingenious arrangement of counters in a pretty pattern. Henceforward it was to be the serious study of the workings of Nature in producing the beings we see around us from beings more or less unlike them, that had existed in bygone ages, and had been the parents of a varied and varying offspring—our fellow-creatures of to-day."

"Classification for the first time was something more than the expression of a fancy. Not that it had not also its imaginative side. Men's minds began to figure to themselves the original type of some well-marked genus or family of birds. They could even discern dimly some generalized stock whence had descended whole groups that now differed strangely in habits and appearance—their discernment aided, may be, by some isolated form which yet retained undeniable traces of a primitive structure. More dimly still, visions of what the first bird may have been like could be reasonably entertained; and passing even to a higher antiquity, the reptilian parent, whence all birds have sprung, was brought within reach of man's consciousness."

When all this came to pass it was those very isolated forms—the so-called "outliers" among birds—to which Prof. Newton alludes in the last paragraph, that then came to be regarded with a peculiar interest by the scientific ornithologist; and, although at the present writing there is by no means a unanimity of opinion as to the position many of them occupy in the system, they nevertheless at once threw a powerful light upon the whole field of ornithology. Ornithotomists everywhere, the world over, carefully investigated their anatomical structure, and groups of birds long thought to be widely separated were seen to be, through these forms, more or less nearly related to each other, and the fact as a whole was demonstrated beyond all cavil that the class *Aves* had arisen from primitive reptilian stock.

Without further dwelling upon this phase of the subject, we will say here that it is the object of the present article to call attention to some of the more prominent species of birds that, to a greater or less extent, are considered to represent these "outliers" of the class. Although hardly to be regarded as belonging among them, the very interesting group of forms that we commonly designate among them as the "ostrich group" are important, inasmuch as through them we are enabled, by the aid of many fossil and subfossil types, to trace birds directly back to some of their reptilian stock. Among the existing ostrichlike types we have the *Apteryx* or *kiwi*, of New Zealand, a bird now supposed by some of our best authorities to have kinship with the rails. Then there are the emeus and cassowaries, rhea, or the South American representative of the ostriches, and, lastly, the true ostriches themselves.*

* The great moas (*Dinornis*) of New Zealand are now extinct, though we have their remains in plenty. This is the case also with the huge *Æpyornis* of Madagascar, the *Gastornis*, the *Struthiolithus* of lower Russia, and the curious fossils found in the Siwalik rocks of

Technically, the common African ostrich is known as *Struthio camelus*, and so the ostrichlike birds, as a group, have come to be spoken of as the "struthious types," or those with "struthious characters." Again, the group as a whole has been designated as the *Ratitæ*, which primarily has reference to the fact that the breastbone or sternum in any one of them lacks a *keel*, and so is "raftlike" as compared with a sternum possessing the character.* With but one or two exceptions, all the rest of existing birds have a more or less well-developed median keel on their sterna, and as the *Carinatæ* they form the second great division of the class *Aves*. Carina is the Latin word meaning "a keel," hence the name for the group. To this keel are attached the *pectoral muscles*, which are so essential to the power of flight.

Linking together the ratite and carinate avian groups, we have an interesting subgroup of birds known as the tinamous.† In 1827 L'Herminier thought that the nearest kin of the tinamous among the carinate birds were the rails (*Rallidæ*). They are South American and Mexican types, and about fifty species of them are known, and systematists have consigned these to some nine or ten genera. All these forms have a general external resemblance to each other, and, as many observers have noted, to those birds we call "partridges." The largest tinamous are about the size of our "prairie chickens," and the smallest about the size of the least of our "quails." They are fine eating; fly pretty well, but are foolish and easily captured. Some of them have but three toes on either foot, others four, and all lay wonderfully handsome eggs. These latter may be of various shades of green, blue, pink, or orange, varying with the species, but in all they have highly burnished shells resembling porcelain or brilliantly polished metal. Little is as yet known of their habits.

Sharpe speaks of the tinamous as "struthious partridges," and Hudson claims that some of their "habits are thoroughly partridgelike," ‡ and if they lead in the direction of the gallinaceous

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India, which are also of birds which were of this group. All of these, both existing and fossil, are or were flightless birds, and the African ostrich, no doubt, the most specialized of any of them. According to Cope, there was a gigantic ostrichlike bird that lived in Texas and New Mexico during the Eocene time (*Diatryma*). It was double the size of an ordinary ostrich. The largest moa, *Dinornis giganteus*, was nearly ten feet high.

* It is probable that all the early ancestors of birds were flightless, and consequently all had *keelless sterna*, except such forms as *Ichthyornis*, and, no doubt, its predecessors were ratite birds, in the sense that they had non-carinate breastbones.

† These birds have deep keels to their sterna, but at the same time possess so many struthious characters in their organizations that they have been designated by Huxley as the *Dromæognathæ*—the genus *Dromæus* containing the emeu—and emeus and tinamous have the structure of the palate much the same.

‡ Nowadays most scientists refer to the tinamous as the *Crypturi*, from the fact that their tails are concealed by the coverts (Gr. *krupto*, I conceal, and *oura*, the tail).

types, the student will there be confronted with at least two families, the exact position of either of which has more or less puzzled the ornithologist—I refer to the megapodes * and those curious little quail-like birds the hemipodes or "button quails." The former leave their eggs to be hatched without incubation, simply burying them in the ground as many reptiles do, or heaping over them a mound composed of leaves, earth, and other materials. There are several species and genera, and the chicks of all are highly developed at birth.† Again, these gallinaceous types, or the "fowls" or "chicken types," ‡ including as they do everything after the fowl order, as turkeys, pheasants, quails, peacocks, and a perfect host of related kin, are beautifully linked with the pigeons # through the true intermediate forms—the sand grouse. ||

The sand grouse are small, columbo-partridge forms given to remarkable erratic migrations over certain parts of Europe and Asia. Related to the pigeons we have the extinct dodo, and the nearly extinct "tooth-billed pigeon" of the Samoan Islands (*Didunculus strigirostris*). Other birds possessing galline affinities are the well-known curassows,^ and they in their general appearance somewhat remind us of the curious "hoactzin," ◊ one of the veriest "outliers" among birds in existence.

Even at the present writing, avian taxonomers are by no means agreed upon the question of the exact relationships of this bird. Buffon placed it among the curassows, while Gmelin and others arrayed it with the pheasants. ‡ Early in this century Illiger created for it the genus it now occupies, since which time it has received the closest possible attention from ornithotomists in various parts of the world. ↕

Opisthocomus has a size about equal to the chachalaca of our Texan border, and is extremely remarkable in its anatomy, its appearance, its nesting, and its habits. It is found in tropical South America, and but the one species of it is at present known.

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* *Megapodiidæ.*

† Huxley made an independent group for the hemipodes (*Turnicomorphæ*), but other authors still retain them with the galline birds as the *Turnicidæ*. The first-named great authority is probably correct in his position in this matter, or, if retained among the gallinaceous types, they are at least entitled to superfamily rank.

‡ *Gallinæ.*

Columbæ.

|| *Pterocles, Syrrhaptes,* to *Geophapes.*

^ *Craces.*

◊ *Opisthocomus cristatus.*

‡ *Phasianus.*

↕ According to Newton, who, referring to Huxley's and Garrod's opinion, "*Opisthocomus* must have left the parent stem very shortly before the true *Gallinæ* first appeared, and at about the same time as the independent pedigree of the *Cuculidæ* and *Musophagidæ* commenced, these two groups being, he believed [Garrod], very closely related, and *Opisthocomus* serving to fill the gap between them." This quotation is from Newton's A Dictionary of Birds, a work now passing through the press. The figure of the hoactzin herewith presented, and drawn by the present writer, is also from the same excellent work.

The head of the hoactzin is ornamented with a semipendent crest composed of rather long, loose, yellowish feathers, as shown in the figure below. Below, the body is of a dull chestnut, while above it is olive splashed with white. Its large tail is conspicuously tipped with yellow, while its wings are short and rounded.

These birds congregate in loose companies in the undergrowth found upon the banks of streams and sloughs. Here they are

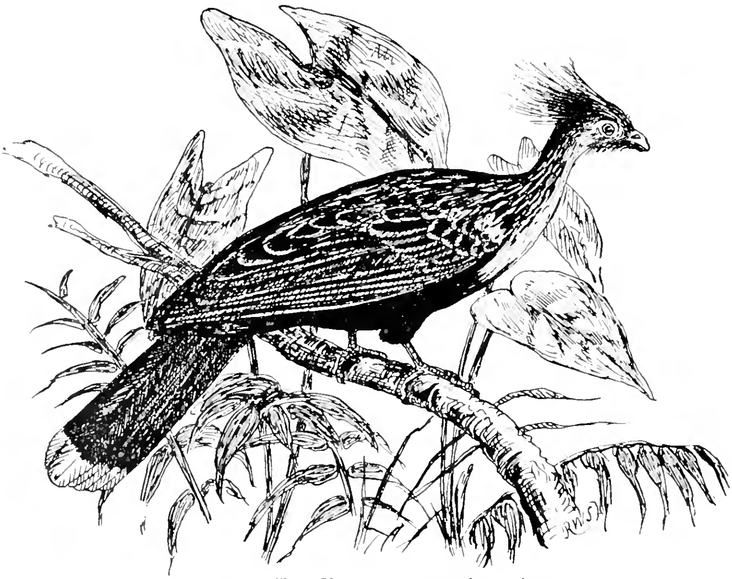

FIG. 1.—THE HOACTZIN (*O. cristatus*).

easily approached, inasmuch as they are weak fliers and seldom take to wing. They are believed to be polygamous, and it is known that in the manner of their nesting and the appearance of their eggs they strongly remind us of the gallinules and rails. This is a curious circumstance, for it falls into line with another gallinuline character. The claws on the indicial digits of young gallinules are pretty well developed—so much so that they can use them to help crawl out of their nests with, by catching on to twigs, and so forth, in their way and neighborhood. These claw joints are even better developed in the hoactzin, where in the young they are more or less functional. *Opisthocomus* lives upon fruits, leaves, etc. "Its voice is a harsh, grating hiss, and it makes the noise when alarmed, all the individuals sibilating as they fly heavily away from tree to tree when disturbed by passing canoes" (Bates). In British Guiana it is called the "stink bird," from the disagreeable odor it has, and which, according to Newton, Deville likens to that of a cow house. No fossil forms of opisthocomine birds are known.

In studying the group of rail-forms and their kin we meet with many interesting types.* This great rail group appears to be connected with or linked to the pygopodous birds or divers † by two genera of very interesting and as yet little known birds. These are *Heliornis* and *Podica* of the family *Heliornithidæ*, and commonly known as "finfeet." Very little is known of their anatomy, and absolutely nothing of their eggs and nidification.‡

New Zealand, which furnishes us with so many remarkable types, has another genus leading off from the rails. These are the "ocydromes," # curious birds with perfect wings yet incapable

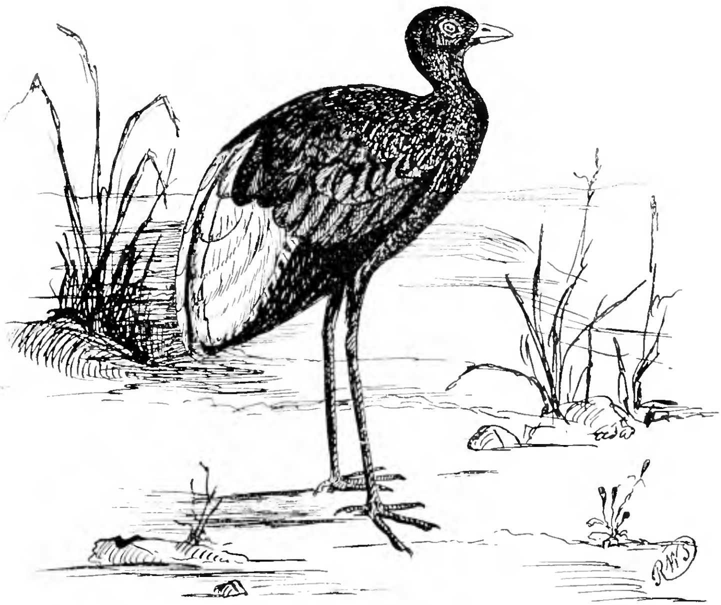

FIG. 2.—THE TRUMPETER (*Psophia leucoptera*). By the author, after Mitchell.

of flight. They are doomed to speedy extinction, and their anatomy and life history stand sadly in need of careful working up.

Another great center of bird life is seen in the plover-snipe group, and some important types link it as "outliers" with various other groups. For instance, in the first place, we have that

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* Our room here will not permit of more than to name some of these, and the student will do well to look into the history of that peculiar genus of exaggerated gallinules known as *Notornis*, as *N. mantelli*, and its fossil relative *Aptornis*, described by Owen, and both from New Zealand. *Porphyrio* and the remarkable genus *Tribonyx* of Australia are still others to be especially noted. They all belong to the gallinuline series of subpartial rail outliers.

† *Pygopodes*.

‡ Prince Maximilian of Wied claims to have shot a male *H. fulica* that had under its wings two new-hatched, naked young. This species occurs from Guatemala to Paraguay, while *Podica* is an African genus.

Ocydromus.

curious, generalized type, the *Dromas ardeola*, that web-footed, long-legged, black and white bird found on the shores and some of the islands of the Indian Ocean. At different times ornithologists have placed this form not only in various families, but in various orders. It has even been associated with the terns, and Sharpe has said it "is in habits a plover, in many points of structure larine [gull], but it burrows in the sand and lays a white egg, like that of a petrel—surely a combination of characters which demand that it shall have a separate rank as the representative of a definite suborder." British ornithologists call it the "cavalier," and place it near the stilts.

Again, we have the "pratincoles," all of the single genus *Glareola*, which are curious little ploverlike birds which have a flight resembling that of the swallows, and, like them, they feed upon the wing. There are nine or ten species of these, being found in Europe, Asia, Africa, and even Australia. They are distinguished for their trim build and marked delicacy in the coloration of their plumage. They nest upon the ground.* With the gull group, the plovers are beautifully linked by those very types of outliers, the sheathbills of the genus *Chionis*. Among the limicoline birds their nearest allies are seen to be the oyster catchers,† while their structure goes to show that, besides the gulls, they have affinities with a number of other groups. Sheathbills are of great interest to the ornithologist, as they are undoubtedly the descendants of very ancient and generalized types. There are at present only two species of them known—the one, *C. minor*, from the Kerguelen Islands, and the other, *C. alba*, from some of the islands of the antarctic seas. In life they somewhat resemble pigeons, and both species are pure white in plumage, while they receive their English name from the little saddle of horn ensheathing the base of the upper part of the bill. Numbers of their eggs have been taken, and they are said to resemble those of a plover. *Chionis* lives upon shellfish and certain sea weeds, and some authorities aver that they have been known to eat the eggs of other birds. Unanimity of opinion among naturalists as to their systematic position as yet by no means exists, and a thorough examination of their anatomy is still a thing much to be desired.‡

Returning once more to the neighborhood of the rails and

* Some of our best systematists believe they connect the plovers (*Limicolæ*) with the cranes—that is, the true *Charadrii* through the coursers, the thickknees (*Œdicnemi*), and the bustards (*Otis*).

† *Hæmatopus.*

‡ As other avian outliers, and in some ways related to the sheathbills, we have those curious South American forms belonging to the genera *Thinocoris* and *Attagis* of the family *Thinocoridæ*. Our space will only permit of our mentioning their names here.

cranes, we meet with some very remarkable birds—forms that attract the attention of anatomists and ornithologists all over the world. Some of these birds are as yet but very imperfectly known either in the matter of their habits or their morphology. Conspicuous among these stand the trumpeters (*Psophia*) of South America, of which some seven species have been described (see Fig. 2), and all referred to the family *Psophiidæ*. They get their name from the loud and peculiar note they utter—a power associated with the singular structure of the windpipe in the male. *Psophia* appears to be related to the fowls, the rails, and the

Fig. 3.—The Sun Bittern (*Eurypyga helias*). By the author, after Newton.

cranes, and may be a subspecialized descendant of an ancient generalized group, to which the last two may also be traced back. The species vary in size and color, the best-known form being *P. crepitans* of Guiana, which is the "*oiseau trompette*" of the French and the "*trompetero*" of the Spaniards. Big as a small turkey in body, it has longer legs and neck and a beautiful plumage, and even its legs are said to be of a "bright pea green."

These birds are noted for forming in captivity the strongest attachment to man as well as to the domesticated fowls and animals of the barnyard. Some remarkable stories are told by travelers and others in this connection. Although these birds have been known since the middle of the last century, we are still quite ignorant of their habits in Nature, and their nidification and a great deal of their anatomy.

Right here I would invite attention to another peculiar bird, one which we have in the United States, it being confined to the peninsula of Florida. This is the "limpkin" (*Aramus*), a most perfect "go-between," connecting the rails and the cranes. To American ornithologists and others the bird is well known, and it no doubt is indirectly related to *Psophia*. The limpkin has also been found in the West Indies, the Atlantic coast of Central America, and elsewhere.*

We have next to touch upon two genera of birds that are generally recognized to stand among the most conspicuous outliers to be found in the entire range of the science of ornithology. These are the sun bitterns of South America and the kagu of New Caledonia (see Figs. 3 and 4).† If we take as example the better known of the two species of sun bitterns—*E. helias*, the one shown in our figure—it is seen to be a bird about the size of a willet, with a wonderfully variegated plumage, composed of different shades of brown, black, gray, and white, the whole being arranged and distributed so as to form a pattern quite as *bizarre* as that of a whip-poor-will. Very little has been recorded of the habits of the sun bittern, it merely having been stated that it resorts to the undergrowth found along the muddy banks of sluggish streams, where it feeds upon insects and small fishes.

Newton, who has observed it in captivity, at the gardens of the Zoölogical Society of London, says: "It soon becomes tame, and has several times made its nest and reared its young." It has a plaintive, piping note, and "it ordinarily walks with slow and precise steps, keeping its body in a horizontal position, but at times, when excited, it will go through a series of fantastic performances, spreading its broad wings and tail so as to display their beautiful markings." These sun bitterns were known fully three quarters of a century or more to science before anything at all akin to them was found; but when the island of New Caledonia became colonized, a bird there discovered, and nowhere else, at last furnished an ally. This was the kagu, mentioned above, now described by ornithologists as *Rhinochetus jubatus*. Externally the kagu bears but little resemblance to a sun bittern,

* Madagascar, from her avifaunæ, also gives us a fine example of an outlier, a bird known to science as *Mesites variegatus*—a most peculiar type, to which, further on, I shall briefly refer again.

† Of the sun bitterns there are two species (*Eurypyga helias* and *E. major*), and probably of all existing birds none have so puzzled the systemist with respect to their position in the class. They have in early times been referred to the herons, to the rails, and even to the snipes!

though its internal structure, which has been carefully examined, proves the relationship (see Fig. 4). Considerably larger than *Eurypyga*, it has its head ornamented by a hanging crest of long and soft feathers. Both its legs, which are rather long, and its beak are of a livid red color. Its ample wings are marked

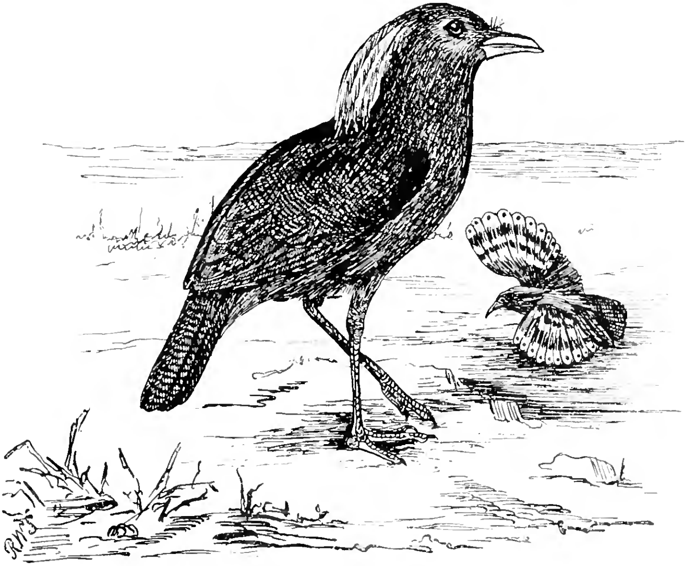

FIG. 4.—THE KAGU (*Rhinochetus jubatus*). Drawn by the author after Newton's figure.

something after the pattern seen in the sun bittern, while its chief body color is a pale slate, shading lighter below. Numerous transverse bars embellish the tail, and these markings, though far less distinct, are seen on the wing coverts also. Ordinarily it is a very passive bird, standing motionless for several minutes at a time, when it will step off briskly for a short distance, only to again assume its attitude of rest. This is by no means, however, the invariable behavior of this extraordinary bird, for when aroused by excitement it will even quite outdo a sun bittern in its extravagant and fantastic "show-off." Holding one of its wings or the extremity of its tail in the most remarkable manner, it will violently spin about in giddy dance, the like of which is never performed by any other known member of the class *Aves*. Unfortunately, this extremely interesting type, it is now said, is becoming rapidly exterminated.*

* It is not at all unlikely but that *Mesites*, the sun bitterns, and the kagu all sprang from some common, generalized, ancestral type long ages extinct, and that all the other host of allies, save the three just mentioned, coming from the same common stock, have also long since died out. Forbes seems to think that "the Malagash *Mesites* is perhaps

Once more in South America we meet with still another oddity among birds—the very prince of outliers—I refer to the far-famed seriema (*Dicholophus cristatus*) (see Fig. 5), a form that has puzzled the best of taxonomers since the middle of the seventeenth century, and even we moderns are as yet by no means agreed upon its exact affinities. With the digestive apparatus of a heron, with an external resemblance to the secretary bird (Fig. 6), with other points in its structure hinting at an alliance with the bustards (*Otis*), or peradventure with some of the plovers, and with habits distinctly its own, it is a fact hardly to be wondered at that the classifiers of birds have at various times placed it with

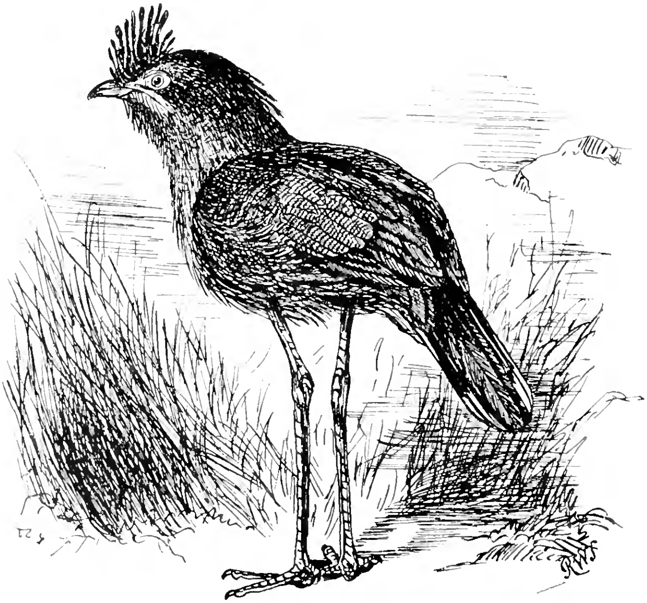

Fig. 5.—The Seriema (*Dicholophus cristatus*). Copied by the author from Newton's figure.

great certainty in divers orders, families, or of other sections of the class *Aves*. It is, however, safe to say that the seriema has descended with but little modification from some very ancient type, and one that thrived, perhaps, even before a number of our present groups of birds came to be differentiated.

There is a fine living specimen of this bird in the National Zoölogical Gardens of Washington, where the writer has frequently studied it. In body it is about the size of a small turkey, but owing to its long legs and neck it has a height, when stand-

more nearly related to the New Caledonian *Rhinochetus* than to the neotropical *Eurypyga*." Remarkable indeed are some of the interrelationships of birds.

ing, of over two feet. We are at first struck with the peculiar crest of vertical feathers at the base of the upper bill, and this latter being a bright red, and its large and handsome eyes of a clear yellow, the bird has a very animated mien, which is in no way lessened by its stately carriage. The eyes are surrounded by a pale green or bluish skin, while in its general plumage the seriema is a slaty gray, shading off beneath to a soiled white. On the throat, neck, and sides the feathers are loose and long, and are variegated by fine, irregularly transverse lines. The wings and tail are darker and mottled, while the legs are of a pinkish red. The home of this bird are the elevated plains of Brazil, where, in the high grass of those regions, the traveler not infrequently meets with it. Upon being approached it lowers its body and rapidly skulks away, and, unless the observer be mounted and take after it, it rarely can be induced to take to wing. It lives upon a variety of small animals, as snakes, lizards, and the like, and also eats certain insects, berries, and land snails. Instead of building its nest upon the ground, as one would naturally be led to suppose, it constructs it in the dense undergrowth of bushes, or even some six or seven feet above the ground in a tree. Its two eggs are said to resemble those of some of the crakes or land rails, and the down-covered young long remain in the nest after being hatched.*

We have said above that the seriema bore a general resemblance to the secretary bird. Now this latter is a well-known type, and is itself a true "outlier" of the class which inhabits certain parts of Africa (see Fig. 6). It derives its vernacular name from the fact that it possesses pairs of long, black feathers, which hang loosely from the back of the head and the neck, resembling, in the eyes of some of its describers, the quill stuck above the ear of a clerk. These feathers, when the bird is excited, are capable of erection and dilatation, giving their possessor at such times, an aspect of great fierceness. Standing some four feet in height, and with its raptorial-appearing head, the secretary bird, for all the world, looks like some kind of a falcon on stilts. Its general plumage is a slate blue with black wings. The tail is tipped with white, but what is more peculiar about it is that the middle pairs of feathers are greatly elongated, and give to the bird a very singular appearance.

Living chiefly upon the ground, over which they can run with considerable speed, they nevertheless build their great massive nests in bushes or trees, and deposit therein their two spotted

* Farther south, or in the Argentine Republic, we meet with another bird—the *Chunga burmeisteri*—which is undoubtedly a near ally of the seriema, and has been, by anatomists, but generically separated from it.

eggs; and, as in the case of the seriema, the young remain in the nest for a great length of time, being quite helpless at three or four months of age. Many of them have been reared as pets, and in some localities are useful in destroying vermin about the prem-

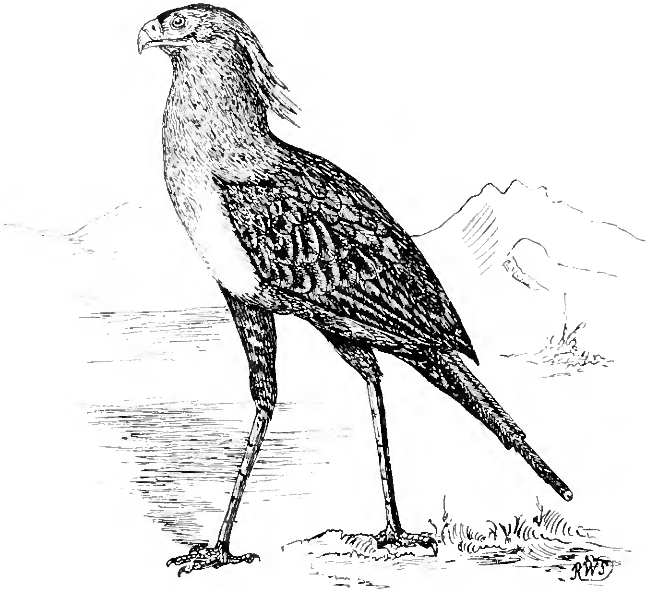

Fig. 6.—The Secretary Bird (*Gypogeranus serpentarius*).

ises. *Gypogeranus* lives chiefly upon reptiles and insects, and in nature will kill and devour the most venomous species of snakes. A great deal has been written about this last-named habit, and it is the one which has given the bird its popular notoriety. When it meets a big snake of the most venomous variety it will at once advance upon it with stately strides and commence the attack. It will strike the reptile with its knobbed wings and kick forward at it with its feet, until its victim is completely worn out by its fruitless attempts to withstand such an onset, whereupon the merciless victor pounces upon it, crushes its head with a blow from its powerful beak, and at once proceeds to devour its prey. These heronlike falcons are distributed over the greater part of Africa.*

Speaking of the herons, and while we are still in Africa, I desire to call attention to two other strange outliers, both of which are found in that country.

* They doubtless represent a type which, little modified in time, has descended from some generalized ancestor, long since extinct, and from which not only the *Accipitres* (falcons and their kin), the storks, and herons have been derived, but also the seriema. *Gypogeranus* should be retained in the suborder *Accipitres* as a superfamily—*Gypogeranoidea*.

The first to be noticed is that singular bird known as the hammerhead, a heronlike form about as big as an average-sized bittern, which derives its name from the fancied resemblance of its head to a hammer. This only holds true, however, when its otherwise erectile crest is lowered so as to be in a line with its beak (see Fig. 7). It has been known to science since 1760, when Brisson described it, it being the *Scopus umbretta* of ornithology, and ranges over the greater part of the African continent. In plumage it is of a dingy brown with purplish reflections, while a series of blackish bars mark its tail across. Inactive by day, it is lively enough as night approaches, at which latter time, it is said, it gives itself up to a behavior of a very remarkable order. According to Sharpe, its nest is "a structure of great bulk, with chambers inside, built of branches and twigs and five or six feet in diameter, capable of bearing the weight of a man." This nest has a roof to it and is carefully lined with clay, the entrance being

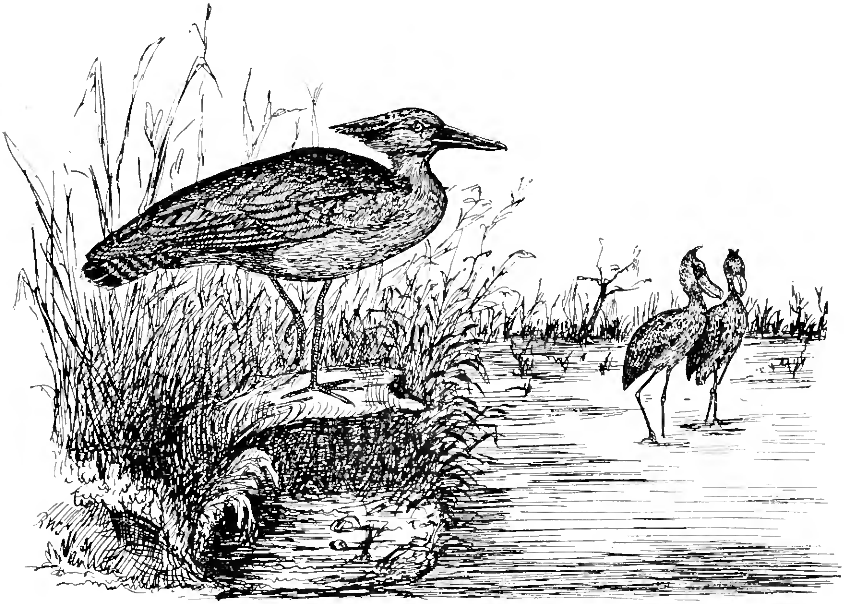

FIG. 7.—THE HAMMERHEAD (*Scopus umbretta*), WITH A PAIR OF SHOEBILLS IN THE DISTANCE (*B. rex*)

at the side. *Scopus* is known to lay white eggs, but up to the present writing the nestling has not been described. Recently the bird has been found in the island of Madagascar.

One other remarkable African outlier is the famous *Balæniceps rex*, known to English travelers as the "shoebill," a storklike heron. A pair of these birds is shown in the distance in Fig. 7 of the present article, and the whole of this figure, executed by the writer, is adapted from two drawings given us by Newton; and this distinguished authority has said that "in singularity of aspect few birds surpass *Balæniceps*, with its gaunt gray figure, some five feet in height, its large head surmounted by a little curled tuft, the scowling expression of its eyes, and its huge bill in form not unlike a whale's head—this last suggesting its generic name—but tipped with a formidable hook." These birds lay white eggs with faint markings upon them in an ordinary nest built in the high sedge in the near vicinity of the water. Before leaving this the young are fed by the parents for some time, as in the case of other heronlike types.

Flamingoes (*Phœnicopterus*) are other birds that formerly much exercised the avian taxonomer, and they were variously classified until Huxley and other anatomists clearly demonstrated that they should be awarded a group to themselves, and that they connected the ibises on the one hand with the anserine fowls (ducks, swans, geese, etc.) on the other, standing immediately between these two groups. Not so easy, however, has it been to decide upon the relationships of another most singular bird—that is, the screamer (*Palamedea cornuta*, Fig. 8) of Guiana and the valley of the Amazon—and it may with truth be said that its position in the system is as yet by no means fully understood. That in some strange way it is related to the duck group (*Anseres*) there seems now to be no question, but with what other main assemblages of birds there is a very considerable degree of doubt entertained. This form is as big as a small brant goose, and is noted for its very noisy screams, which make the very air resound when uttered. Either of its wings are armed with two sharp spurs, and on the crown of its head is reared a slender "horn," some three inches in length. Below it is white, while the rest of its general plumage is of a blackish gray, and its toes are very long for the size of the bird. Another strange thing about it is that its skin is separated from the muscles by an air filled cellular tissue, which gives rise to a crackling sound when the bird is handled, as in the case of certain gannets and cormorants. Screamers are abundant in some localities, where they live in pairs, especially in the marshy districts. They feed upon grain and aquatic herbs. A closely related genus is represented by the "crested screamer" (*Chauna chavaria*) of the swamps and sloughs of the lower Brazils and Paraguay, where it is known to the inhabitants as the "chaka." Not so large as its near ally and lacking its "horn," which latter is replaced by a hanging tuft of feathers, this species is as fully interesting to the ornithologist. It has considerable more white in its plumage, the face and throat being entirely so, while below it is more or less shaded with dusky. A black ring encircles the neck. Linnæus thought this bird to be a jacana (Fig. 8), in which he was entirely wrong, as the jacanas are now known to stand as a family—the *Jacanidæ*—connecting the rails with the snipe-plover group (*Limicolæ*), with the closer affinity with the latter. Young chakas are frequently reared by the natives from the nest and employed as guards in the poultry yards, a task performed by them with marked success, armed as they are with the spurs upon their wings. They in Nature build a light nest of rushes, often in the water in the shallowest parts of the lagoons where they resort, and in this they lay some half a dozen buffy-white eggs. Nestling chakas are

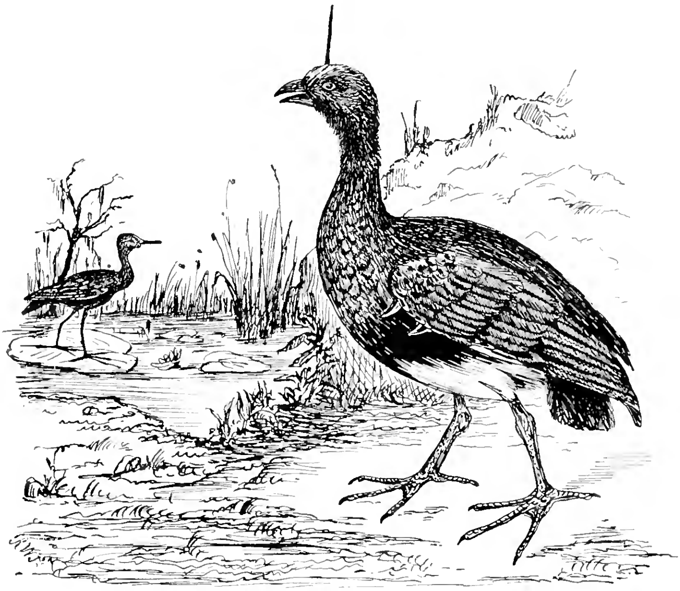

Fig. 8.—The Screamer (*Palamedea cornuta*), with a Jacana in the near Background. Drawn by the author.

covered with a clay-colored down, which is probably also true of the young of *P. cornuta*. These birds—that is, the crested screamers—are given at times to rising to great heights in the air, where they soar in circles, ever and anon uttering their piercing cries of "chaka!" "chaka!" "chaka!" and when a number of them are thus engaged it offers a sight not likely to be forgotten by the observer.*

Passing on next to the parrots,† we find them to be a wonder-

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* A darker-plumaged bird of this genus is also found in Central America (*C. derbiana*), which, in common with the others, has the same peculiar emphysematous condition of the skin. Grouped as a family, they are known as the *Palamedeidæ* of some and the *Anhimidæ* of others (Sharpe), and this family should be still further distinguished from other groups of birds by placing it apart in another of its own with at least subordinal rank.

† *Psittaci.*

fully compact group with apparently no very close allies, unless it be the raptores,* as has been suggested by some of their describers. They furnish us, however, with at least one very curious bird, and that is the kakapo of New Zealand (*Stringops habroptilus*), also known as the "owl parrot" or "ground parrot." This survivor of the primitive parrot stock is but another important type that appears to be doomed to early extermination, and that, too, unfortunately, before a thorough monograph upon its morphology and life history have been furnished by science. Most large museums are amply supplied with skins of the kakapo, and a dozen or more specimens have been transported to England alive and studied. But all this is but a very small part of what yet remains to be known of the species. *Stringops* is nocturnal in habits, almost entirely so, and feeds only toward dark, when it will issue forth from its hiding place under rock or root of tree to seek for the seeds and fruits upon which it lives. It also eats leaves, twigs, bits of roots, and even grass, moss, or other plants. Some of the flight muscles and the keel of the sternum are aborted in this parrot, so its powers of flight about amount to *nil*. It spends most of its time upon the ground, and goes up into trees only by climbing. Many of the introduced predaceous animals of the country are its enemies, and to them must be added the greatest destroyer of animal life of them all—man. This is one of the largest of the parrots, and it derives some protection from its plumage, which is of an earthy green, freckled and finely zigzagged over with snuff brown, with longitudinal dashes here and there of straw yellow. It has a powerful beak like a macaw, which it most efficiently uses. About the face the feathers are long and stringy, and so arranged as to remind one at once of a strigine physiognomy. It is an intelligent as well as an affectionate bird in captivity, but lacks the characteristic longevity of the group to which it belongs.† The owls,‡ which are more or less remotely allied to the goatsuckers# rather than to the true raptorial birds,‖ are in some strange way connected through that peculiar strigine nightjar—the guacharo or oilbird of northern South America and the island of Trinidad.△ This great goatsucker is a little larger than our barn owl, with a mottled plumage after the order of the whip-poor-will, only with more brown in it, and is in habit quite as nocturnal as either one of them. In immense numbers it resorts to caverns, coming out in noisy array only at dark to seek the nuts and fruits which constitute its food. *Steatornis* breeds by the hundreds in the vast

* *Accipitres.*

† No doubt it should occupy a family by itself, as the *Stringopsidæ.*

‡ *Striges.*

\# *Caprimulgi.*

‖ *Accipitres.*

△ *Steatornis caripensis.*

gloomy caves to which it resorts, laying three or four white eggs in a shallow clay nest. The young are overlaid with quantities of fat, and are collected by the natives for the oil they afford therefrom. This is an extensive and interesting industry, upon which much has been written.*

We have now passed into an extensive group of birds generally alluded to by ornithologists as the "picarian assemblage," that not only includes the goatsuckers, of which we have just been speaking, but also many other families.† Some of the relationships of the representatives of these groups are by no means as yet understood fully; many of them are interrelated; others exhibit characters which link them with another great assemblage of birds—that is, the *passerine* group, or the *Passeres*. This is the case with the woodpeckers, for example, and also with the swifts, which latter are related to the swallows (*Hirundinidæ*). All this with equal truth applies to the *Passeres*, of which we have just spoken, and to which the swallows belong. Quite a number of the families among the passerine birds, however, have been very carefully examined, and ornithologists the world over are agreed as to their affinities, while on the other hand we are at our wits' end in regard to the determination of the allies of some of the passerine outliers. A few of the more puzzling forms of these can now be briefly introduced. The little "American dipper" (*Cinclus*) of the Rocky Mountain region is one of these, a bird not much larger than a bluebird, which is completely aquatic, even to the extent of hunting for its food under water.‡

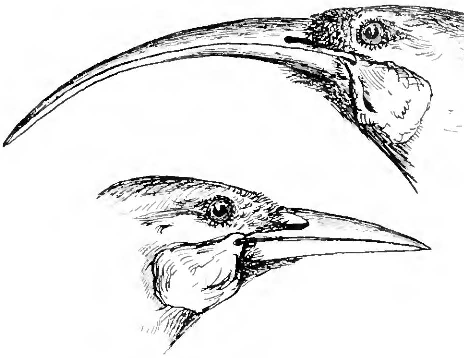

FIG. 9.—THE HUIA (*Heteralocha*). Upper figure, female; lower, male. Shufeldt, after Newton.

* As a type this form is the sole representative of a distinct family—the *Steatornithidæ*.

† As, for example, the cuckoos (*Coccyges*), the rollers (*Coraciæ*), the kingfishers (*Alcedines*), the hornbills (*Bucerotes*), the todies (*Todi*), the trogons (*Trogones*), the swifts (*Cypseli*), the woodpeckers (*Pici*), the bee-eaters (*Meropes*), the hummingbirds (*Trochili*), the motmots (*Momoti*), and hosts of others and all their various allies.

‡ *Cinclus* has by some been placed with the thrushes (*Turdidæ*), by others with the wrens (*Troglodytidæ*), while the present writer, after examining it osteologically, believes it to be related to the genus *Siurus*. Several of this last-named genus are "water thrushes," and the ovenbird (*S. aurocapillus*) at least builds a covered nest with a side entrance, as does the dipper (*Cinclus*).

New Zealand, that land of oddities in Nature, adds another to our list in this place. I refer to the species called the *huia* by the native Maoris. Owing to the fact that the bill is entirely different in the two sexes, the male and female have been referred to two distinct species (Fig. 9). Newton says: "According to the personal observation of Sir W. Buller, who enters at length on the natural history of the huia (Birds of New Zealand, second edition, vol. i, pp. 7–17), its favorite food is the grub of a timber-boring beetle, and the male bird with his short, stout bill attacks the more decayed portions of the wood and chisels out his prey, while the female with her long, slender bill probes the holes in the sounder part, the hardness of which resists his weapon; or when he, having removed the decayed portion, is unable to reach the grub, the female comes to his aid and accomplishes what he has failed to do. The huia is entirely a forest bird, and is doubtless one of those doomed to extinction, though at present it seems to maintain its existence. Except a white terminal band on the tail, the whole plumage in both sexes is black, with green metallic gloss; the bill is ivory white, and the large rounded wattles at the gape are of a rich orange" (Dictionary of Birds, part ii, p. 438).

Before concluding I will refer to one or two more of the puzzling outliers to be found among the passerine birds, and none of them have exercised the ornithologist more than the curious little "scrub birds" of Australia. Shortly after these were first made known to science they were simply regarded as belonging to the Australian warblers,* but after their internal structure was examined it was found that they constituted quite a distinct family, to which now the two species known have been relegated.† So far as I am at present aware, neither the nest nor the eggs nor even the female of either of the species of this family are known, and the only birds supposed to be allied to them are the famous "lyre birds" (see Fig. 10), also of Australia. These last are so curious, both in their external appearance and in their internal structure, that they have by various systematists and describers been assigned to all sorts of positions and considered to have been allied to widely separated groups. Originally thought to be a "pheasant," and subsequently a "bird of paradise," and by Huxley placed in a group by itself, the relationships of the *Menura* were by no means unraveled until Newton took it in hand in 1875, more than three quarters of a century after its discovery, and placed it in a distinct family—the *Menuridæ* of the great passerine group. He also declared its alliance with the "scrub birds," for which he created another family, the *Atrichiidæ*, as

* *Maluridæ*.

† *Atrichia clamosa*, *A. rufescens*, family *Atrichiidæ*.

above pointed out. The present writer shares this opinion with him.

The appearance of the Superb lyre bird is well shown in Fig. 10, and the adults attain a size about equal to that of our ruffed grouse (*Bonasa*), or rather less. It is only the adult male that possesses the extraordinarily developed tail shown in the drawing, although that appendage is quite lengthy in the female, and contains sixteen feathers. These birds have a smoky-brown plumage, loose in texture, which inclines to chestnut on the throat and tail

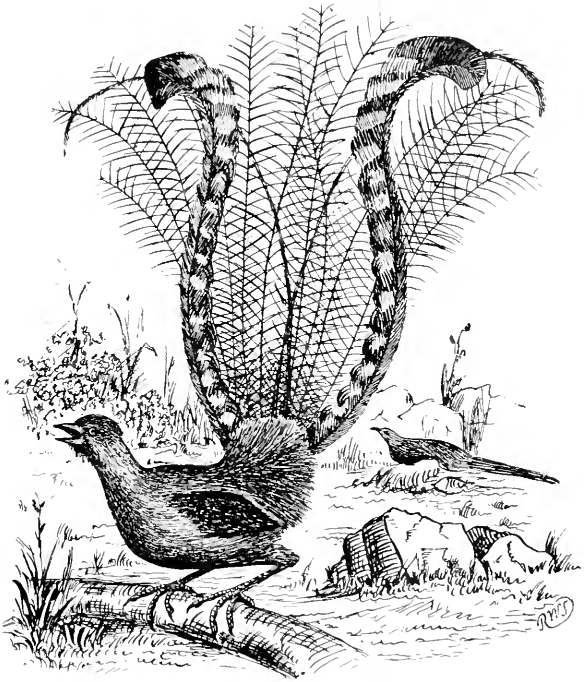

FIG. 10.—THE LYRE BIRD (*Menura superba*). Drawn by the author.

coverts. Their wings are rounded and short, while their legs and feet are strongly developed. They spend most of their time on the ground, have a loud call note, but, owing to their great shyness and the rocky, broken country they inhabit, are only taken with difficulty. They go in pairs, and Gould says they are most successfully hunted by treeing them with dogs. The bird is four years old before its gorgeous tail is fully matured, but after that it is molted and renewed every season. Its food consists of land snails and various kinds of insects, and its nest is a massive structure usually built on the ground, and has an entrance at the side. *Menura* lays but one egg, that is large for the size of the bird. It is blotched with purplish brown on a ground color of a purplish gray. Some of its habits are very extraordinary, while no doubt it has many others as yet unknown. Captivity is but illy borne by it, and it soon perishes in that state, and indeed it is said the species is on the highroad to extinction in its native land. No doubt this will be effected even before we are fully acquainted with all its habits and ways, and man will be responsible for sweeping off the face of the earth forever one of the loveliest forms that has ever graced it or ever will. Dismal indeed will be the forests and Nature's wilds when each and all such graceful creatures, such forms of life and beauty, are completely exterminated. Such work is going on in every quarter of the globe as I pen these lines, and with very marked rapidity. Still, this is but fate and the natural order of things; and we must believe that in the centuries to come the Earth will see the day when man's descendants will be her only inhabitants, with perhaps the merest remnant of any other forms of vertebrate life, and these completely subjected to his will and sway. How much the more, then, does it devolve upon us to fully record in all particulars the biology of those forms now in existence in our midst, and especially those types, the outliers—the connecting links—in all departments of Nature so essential to its understanding, and in order that our heirs and descendants may the more completely comprehend the history of the origin of organic life upon the face of the globe and the manifold mysteries of its evolution.

Regarding the manlike apes as our nearest relatives in the animal world, Dr. R. Lydekker observes, in Knowledge, that the relationship is to be spoken of as one of cousins and not of ancestry; and that we should at once free ourselves from any idea that there is a vestige of direct ancestral kinship between these creatures and ourselves. Such relation as does exist is of a comparatively distant kind; and the common ancestor must have lived ages before the mammoth roamed over the plains and valleys of England, since at that time man was as distinctly differentiated from the apes as he is in the present century. Whether this "missing link" will ever turn up, or in what country it is most likely to have lived, are questions impossible to answer; but from the extreme rarity with which fossil remains of manlike apes are found in countries where they are known to have existed for long ages, and from the probability that the distributional area of the aforesaid "link" was extremely limited, not much hope can be given that the researches of paleontologists will ever be rewarded by such a find.

M. Moissan has found, in his electrical furnace, that quite as distinct chemical actions go on in molten cast iron as those with which the chemist has long been familiar in aqueous solutions at ordinary temperatures. The actions are often very complex, because of the faculty which iron has of retaining many compounds as impurities. The author has precipitated carbon and carbide of iron in fusions by means of boron and silicon; all these substances behaving in the liquid iron precisely as the substances with which we deal in a similar manner behave in water.

STUDIES OF CHILDHOOD.

VII.—LATER PROGRESS IN LANGUAGE.

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IN a previous paper I traced some of the earlier steps in the child's acquisition of language. In the present study we may follow him in his later and more ambitious linguistic efforts.

The transition to this higher plane is marked by the use of the complete form of thought or sentence.

At first, as already pointed out, there is no sentence structure. The child begins to talk by using single words. His speech is monepic.

These words consist of substantives, such as "mamma," "nurse," "milk," and so forth; a few adjectives as "hot," "nice," "good"; a still smaller number of adverbial signs, as "ta-ta," "away" or "over," "down," "up"; and one or two verb forms, apparently imperatives, as "go." The exact order in which these appear, and the proportion between the different classes of constituents at a particular age, say two and a half or three, appear to vary greatly. Words descriptive of actions, though very few at first, appear to grow numerous in a later stage.*

In speaking of these words as substantives, adjectives, and so forth, I am merely adopting a convenient mode of description. We must not suppose that the words as used in this simple disjointed talk have their full grammatical value. It is not generally recognized that the single-worded utterance of the child is an abbreviated sentence or "sentence word" analogous to the sentence words found in the lowest known stage of human language. As with the race so with the child, the sentence precedes the word.† Moreover, each of the child's so-called words in his single-worded talk stands for a considerable variety of sentence forms. Thus the words in the child's vocabulary which we call substantives do duty for verbs and so forth. As Preyer remarks, "chair" (*Stuhl*) means "There is no chair"; "I want to be put in the chair"; "The chair is broken," and so-forth. In like manner "dow" (down) may mean "The spoon has fallen down." ‡ The particular shade of meaning intended is indicated by intonation and gesture.

* For lists of vocabularies and analysis of these compositions see Preyer, *op. cit.*, p. 361. Tracy, Psychology of Childhood, p. 76 ff.

† Cf. Romanes, *op. cit.*, p. 296 ff.

‡ See Preyer, *op. cit.*, p. 361; Romanes, *op. cit.*, p. 296 ff.

This sentence construction begins with a certain timidity. The age at which such conversation is first observed varies greatly. It seems in most cases to be somewhere about the twenty-first month; yet a friend of mine, a professor of literature, tells me that his boy formed simple sentences as early as fifteen months. We commonly have at first two-worded sentences formed by two words in apposition. These may be what we should call an adjective added to and qualifying a substantive, as in the simple utterance of the child C——, "Big bir" (bird), or the exclamation "Papa no" (papa's nose); or they may arise by a combination of substantives, as in the sentence given by Tracy, "Papa cacker"—i. e., "Papa has crackers"; and one quoted by Preyer, "Auntie cake" (German, "Danna Kuha"—i. e., "*Tante Kuche*") for "Auntie has given me cake"; and in a somewhat different example of a compound sentence also given by Preyer, "Home milk" (German, "Haim Mimi"), which interpreted is "I want to go home and have milk." In the case of one child about the age of twenty-three months most of the sentences were composed of two words, one of which corresponded to our verb in the imperative, as "go!"

Little by little the learner manages longer sentences, economizing his resources to the utmost, troubling nothing about inflections or the insertion of prepositions, so as to indicate precise relations; but leaving his hearer to discover his meaning as best he may; and it is truly wonderful what the child manages to express in this rude fashion. Pollock's little girl in the first essay at sentence-building, recorded at the age of twenty-one months and a half, actually managed a neat antithesis: "Cabs dati, clam clin"—that is to say, "Cabs are dirty, and the perambulator is clean." Preyer's boy, in the beginning of the third year, brought out the following: "Mimi atta teppa papa oi"—that is to say, "Milch atta Teppich Papa fui," which appears to have signified, "The milk is gone, it is on the carpet, and papa said 'Fie.'"

The order of words in these first juxtapositions is noticeable. It frequently differs from what we should suppose to be the natural order. Sometimes the subject follows the predicate, as in an example given by Pollock: "Run away man"—i. e., "The man runs" or "has run away"; and in the still quainter example given by the same writer, "Out-pull-baby 'pecs (spectacles)"—i. e., "Baby pulls or will pull out the spectacles." In like manner the attributive (adjective used as predicate) may precede the subject, as in the examples given by Maillet, "*Jolie la fleur*" (pretty flower), and so on.* Sometimes, again, the object comes

* Quoted by Compayré, L'Evolution intellectuelle et morale de l'Enfant, p. 206.

before the verb, as apparently in the following example given by Miss Shinn: A little girl, delighted at the prospect of going out to see the moon, exclaimed, "Moo'-'ky (sky) baby shee" (see).* Another kind of inversion occurs when more complex experiences are attempted, as in connecting "my" with an adjective. Thus one child said prettily, "Poor my friends." †

These inversions of our familiar order are suggestive. They have some resemblance to the curious order which appears in the spontaneous sign-making of deaf-mutes. Thus a deaf-mute answered the question, Who made God? by saying, "God made nothing"—i. e., "nothing made God." Similarly the deaf-mute Laura Bridgman expressed the petition "Give Laura bread" by the form "Laura bread give." ‡ Such inversions, as we know, are common in certain languages—e. g., Latin. The study of the syntax of child language and of the sign-making of deaf-mutes might suggest that our English order is not the spontaneous or natural order of expression.#

A somewhat similar inversion of what seems to us the proper order appears in the child's first attempts at negation. The child C—— early in his third year expressed the idea that he was not going into the sea thus: "No (his name) go in water, no." Similarly Pollock's child expressed acquiescence in a prohibition in this manner: "Baby have papa (pepper) no," where the "no" followed without a pause. The same order appears in the case of French children: e. g., "Papa non"—i. e., "It is not papa," and seems to be a common if not a universal form of the first half-spontaneous sentence-building. Here, again, we see an analogy to the syntax of deaf-mutes, who appear to append the sign of negation in a similar way: e. g., "Teacher I beat, deceive, scold, no"—i. e., "I must not beat, deceive, scold my teacher." In the use of special signs of affirmation the correspondence seems less close. Thus Pollock's child was wont to emphasize a positive statement in this way: "Es, es (yes, yes), baby's book there." The deaf-mute appears in such cases to append the affirmative sign.

Another closely related characteristic of this early childish sentence-building is the love of antithesis under the form of two balancing statements. Thus a child will often oppose an affirmative to a negative statement as a means of bringing out the full

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* Notes on the Development of a Child, p. 84.

† Canton, The Invisible Playmate, p. 32; who adds that this exactly answers to the form "Good, my lord!"

‡ See Romanes, *op. cit.*, p. 116 f, where other examples may be found.

\# The languages of savages appear to differ like those of civilized races in respect of order, the succession substantive, verb, attributive, as in "John is good," appearing alongside of the inverse—e. g., "Good is John." See article L'Importance des Langues Sauvages, Revue Philosophique, 1894, p. 465 ff.

meaning of the former. The boy C——, for example, would say "This a nice bow-wow, not nasty bow-wow." This use of negation by way of contrast or opposition took an odd form in the case of one child, who, at the age of two years and two months, would describe things by negations. Thus an orange was described by saying, "No, 'tisn't apple"; porridge, by saying, "No, 'tisn't bread and milk." It is interesting to note that deaf-mutes proceed in a similar fashion by way of antithetic negative statement. One of these expressed the thought, "I must love and honor my teacher," by the order, "Teacher I beat, deceive, scold, no! I love, honor, yes!" *

These first essays in sentence-building illustrate the skill of the child in eking out its scanty vocabulary by the help of a metaphorical transference of meaning. Taine gives a charming example of this. A little girl of eighteen months had acquired the word "*coucou*" as used by her mother or nurse when playfully hiding behind a door or chair, and the expression "*ça brûle*" as employed to warn her that her dinner was too hot, or that she must put on her hat in the garden to keep off the hot sun. One day, on seeing the sun disappear behind a hill, she exclaimed, "*A bûle coucou.*" †

It is a tremendous moment when the child first tries its hand at inflections, and more especially, in our language, those of verbs. Pollock's child made the attempt, and successfully, at the age of twenty-two months. Such first essays are probably perfectly imitative, the precise form used having been previously heard from others. Hence, while they show a growing thought-power, a differencing of relations of number and time, they do not involve verbal construction proper. This appears as soon as the child carries over his knowledge of particular cases of verbal inflection and applies it to new words. This involves a nascent appreciation of the reason or rule according to which words are modified. The development of this feeling for the general mode of verbal change underlies all the later advance in correct speaking.

While the little explorer in the *terra incognita* of language can proceed safely in this direction up to a certain point, he is apt, as we all know, to stumble now and again; nor is this to be wondered at when we remember the intricacies, the irregularities, which characterize a language like ours. In trying, for example, to manage the preterit of an English verb, he is certain, as indeed is the foreigner, to go wrong. The direction of the errors is often in the transformation of the weak to the strong form; as

* A curious example of negative antithesis is given by Perez, *op. cit.*, p. 196. On other analogies between the syntax of children and deaf-mutes, see Compayré, *op. cit.*, p. 251 f.

† On Intelligence, part i, book i, chaps. ii, vi.

when "screamed" becomes "scram"; "split" (preterit), "splat" or "splut," and so forth. In other cases the child will convert a strong into a weak form, as when Laura Bridgman, like many another child, would say "I eated," "I seed," and so forth.* These differences in the direction of the solecism would probably turn on differences in the word-forms serving as model or precedent which happen to be learned first and to make the strongest impression on the memory.

One thing seems clear here: the child's instinct is to simplify our forms, to get rid of irregularities. This is strikingly illustrated in the use of the heterogeneous assemblage of forms known as the verb "to be." It is really hard on a child to expect him to answer the question, "Are you good now?" by saying, "Yes, I am." He says, of course, "Yes, I are." Perhaps the poor verb "to be" has suffered every kind of violence at the hands of children.† Prof. Max Müller somewhere says that children are the purifiers of language. Would it not be well if they could become its simplifiers also, and give us in place of this heap of dissimilar sounds one good decent verb-form?

Other quaint transformations occur when the child begins to combine words, as when he says, "Am't I?" for "Am I not," after the pattern of "Aren't we?" An even finer linguistic stroke than this is "Bettern't you?" for "Had you not better?" where the child was evidently trying to get in the form "Hadn't you," along with the awkward "better," which seemed to belong to the "had," and solved the problem by treating "better" as the verb, and dropping "had" altogether.

A study of these solecisms, which are nearly always amusing, and sometimes daintily pretty, is useful to mothers and young teachers by way of showing how much hard work, how much of real conjectural inference, enters into children's essays in talking. We ought not to wonder that they now and again slip; rather ought we to wonder that with all the intricacies and pitfalls of our language—this applies, of course, with especial force to the motley, irregular English tongue—they slip so rarely. As a matter of fact, the later and more "correct" talk—which is correct just because there is a large memory-stock of particular word-forms, and consequently a much greater scope for pure uninventive imitation—is much less admirable than the early inventive imitation; for this last not only has the quality of originality, but shows the germ of a truly grammatical feeling for the

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* The same double tendency from weak to strong forms, and *vice versa*, see in the list of transformed past participles given by Preyer, *op. cit.*, p. 360.

† See Preyer's account of a German child's liberties with the same verb where we find *gebisst*, *binnst*, and other odd forms, *op. cit.*, p. 438.

general types or norms of the language, so far as this has become familiar.

The English child is not much troubled by inflections of substantives. The pronouns, however, as every mother knows, are apt to cause much heartburning to the little linguist. The mastery of "I" and "you," "me," "mine," etc., forms an epoch in the development of linguistic faculty and of the power of thought which is so closely correlated with these. Hence it will repay a brief inspection.

As is well known, children begin by designating themselves and those whom they address by names, as when they say, "Baby good," "Mamma come." This is described as speaking "in the third person," yet this is not quite accurate, seeing that there is as yet no distinction of person in the child language.

Later, when the little brain grows more cunning and the tongue nimbler, the child introduces differences of person, and uses the pronominal forms "I" or "me," "you," etc. So far as I can ascertain, most children begin to say "me" before they say "you." Yet I have met with one or two apparent exceptions to this rule. Thus the boy C—— certainly seemed to get hold of the form of the second person before that of the first, and the priority of "you" is attested in another case sent to me. It is desirable to get more observations on this point.

To determine the exact date at which an intelligent use of the first person appears is much less easy than it looks. A child is apt at first to use the forms "me" and "you" mechanically—that is, imitating exactly what another says, and so speaking of another person as "I" and of himself as "you." Here it is evident there is no clear proof of the pronominal form. Allowing for these difficulties, it may be said with some degree of confidence that the great transition from "baby" to "I" is wont to take place in favorable cases early in the third year. Thus among the dates assigned by different observers I find twenty-four months and twenty-five months (cases given by Preyer), between twenty-five and twenty-six (Pollock), twenty-seven months (the boy C——). A lady friend tells me that her boy began to use "I" at twenty-four months. In the case of a certain number of precocious children this point is attained at an earlier date. Thus Preyer quotes a case of a child speaking in the first person at twenty months. Schultze gives a case at nineteen months. A friend of mine, a professor of English literature, whose boy showed great precocity at sentence-building, reports that he used the forms "me" and "I" within the sixteenth month. Preyer's boy, on the other hand, who was evidently somewhat slow in lingual development, first used the forms of the first person "to me" (*mir*) at the age of twenty-nine months.

The precise way in which these pronominal forms first appear is very curious. Many children use "me" before "I." Preyer's boy appears to have first used the form "to me" (*mir*). "My," too, is apt to appear among the earliest forms. In such different ways does the child pass to the new and difficult region of pronominal speech.

The meaning of this transition has given rise to much discussion. It is plain, to begin with, that a child can not acquire these forms as he acquires the names "papa," "nurse," by a direct and comparatively mechanical mode of imitation. When he does imitate in this fashion he produces, as we have seen, the absurdity of speaking of himself as "you." Hence during the first year or so of speech he makes no use of these forms. He speaks of himself as "baby" or some equivalent name, others coming down to his level and setting him the example.

The transition seems to be due in part, as I have already pointed out, to a growing self-consciousness, to a clearer singling out of the *ego* or self as the center of thought and activity, and the understanding of the other "persons" in relation to this center. Not that self-consciousness *begins* with the use of "I." The child has, no doubt, a rudimentary self-consciousness when he talks about himself as about any other object; yet the use of the forms "I," "me," may be taken to mark the greater precision of the idea of self as not merely one among a group of things, but as something distinct from and opposed to other things—what we call the subject or *ego*.*

While, however, we may set down this exchange of the proper name for the forms "I" and "me" as due to the spontaneous growth of the child's intelligence, it is possible that education exerts its influence too. It is conjecturable that, as a child's intelligence grows, others in speaking to him tend unknowingly to introduce the forms "I" and "you" more frequently. Yet I am disposed to think that the child commonly takes the lead here. However this be, it is clear that growth of intelligence, involving that of interest in others' words, will lead to a closer attention to these pronominal forms as employed by others. In this way the environment works on the growing mind of the child, stimulating it to direct its thoughts to these subtle relations of the "me and not me," "mine and thine." The more intelligent the environment the greater will be the stimulating influence; hence, in part at least, the difference of age when the new style of speech is attained.

The acquirement of these pronominal forms is a slow and irksome business. At first they are introduced hesitatingly and

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* Cf. Study V, January number of this magazine, p. 351.

alongside of the proper name, the child, for example, saying sometimes "baby" or "Ilda," sometimes "I" or "me." In some cases, again, the two forms are used at the same time in opposition, as in the delightful form not unknown in older folk's language, "Hilda, my book." The forms "I" and "me," are, moreover, confined at first to a few expressions, as "I am" "I went," and so forth. The dropping of the old forms, as may be seen by a glance at C——'s lingual jargon and at Preyer's correct diary, is a gradual process.

Quaint solecisms mark the first stages in the use of these pronouns. As in the case of the earlier use of substantives, one and the same form will be used economically for a variety of meanings, as when "me" was used by the boy C—— to do duty for "mine" also, and "us" for "ours." Sometimes new and delightful forms are added, as when the same little experimenter struck out the possessive form "she's."

The perfect and free use of these puzzling forms comes much later. Preyer quotes a case in which a child, Olga, aged four years, would say, "She has made me wet," meaning that she herself had done it. But this perhaps points to that tendency to split up the self into a number of personalities to which reference was made in an earlier chapter.

There is one part of this child's work of learning our language of which I have said hardly anything—viz., the divining of the verbal context, of the meaning we put or try to put into our words. A brief reference to this may well bring this study of childish linguistics to a close.

The least attention to a child in the process of language-learning will show how much of downright hard work goes to the understanding of language. If we are to judge by the effort required, we might say that the child does as much in deciphering his mother tongue as an Oriental scholar in deciphering a system of hieroglyphics. Just think, for example, how many careful comparisons the small child-brain has to carry out—comparisons in the several uses of the word by others in varying circumstances—before he can get anything approaching to a clear idea, answering even to such seemingly simple words as "clean," "old," or "clever." The way in which inquiring children plague us with questions of the form "What does such and such a word mean?" sufficiently shows how much thought-activity goes in the trying to get at meanings. This difficulty, moreover, persists, reappearing in new forms as the child pushes his way onward into the more tangled tracts of the lingual terrane. It is felt, and felt keenly, too, when most of the torments of articulation are over and forgotten. Many of us can remember how certain words haunted us as uncanny forms, into the nature of which we tried hard but in vain to penetrate.

Owing to these difficulties the little learner is always drifting into misunderstanding of words. Such misapprehensions will arise in a passive way by the mere play of association which attaches the word to some features of the particular object or set of circumstances with reference to which the word happens to be used in the child's hearing. In this way, for example, general terms become terribly restricted in range, as when the child supposes that pudding is something made of milk, the church is a building with a spire and a yew tree, that ragged is having no shoes and socks, and so forth. Such a going off the track to side and accidental features seems to be reflected in much of children's quaint misapplications of more difficult words, as when a little boy of six used "consulted" for serious, talking of a thrush as looking consulted, and of people looking "concerned and consulted."

With these losings of the verbal road through associative by-paths may be taken the host of misapprehensions into which children are apt to fall through the ambiguities of our words and expressions, and our short and elliptical modes of speaking. Thus an American child, noting that children were "half price" at a certain show, wanted his mother to get a baby, now that babies were cheap.* With this may be compared the following: Jean Ingelow tells us she can well remember how sad she was made by her father telling her one day after dancing her on his knee that he must put her down, as he "had a bone in his leg." † Much misapprehension arises, too, from our figurative use of language, which the little listener is apt to interpret in a very literal way. It would be worth knowing what odd renderings the child-brain has given to such expressions as "an upright man," "a fish out of water," and the like.

In addition to these comparatively passive misapprehensions there are others which are the outcome of an intellectual effort, the endeavor to penetrate into the mystery of some new and puzzling words or expression. Many of us have had our special horrors, our *bêtes noires* among words, which have tormented us for months and years. I remember how I was plagued by the word "wean," the explanation of which was very properly, no doubt, denied me by the authorities, and by what quaint fancies I tried to fill in a meaning.

As with words, so with whole expressions and sayings. What queer renderings the child-mind has given to Scripture language! Mr. James Payne tells us that he knew a boy who for years sub-

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* Worcester collection, p. 21.

† Cf. the account Goltz gives of the anxiety he felt as a child on hearing that his uvula (*Zapfen*) had fallen down, *op. cit.*, p. 261.

stituted for the words "Hallowed be thy name," "Harold be thy name."* In this and similar cases it is not, as might be supposed, defective hearing—children hear words, as a rule, with great exactness. It is the impulse to give a familiar and significant rendering to what is strange and meaningless.† A friend of mine could recall that when a boy he was accustomed, on hearing the passage, "If I say peradventure the darkness," etc., to insert a pause after "peradventure," apprehending the passage in this wise: "If I say 'Peradventure!' the darkness is." In this way he turned the mysterious "peradventure" into a mystic "Open Sesame," and added a fine touch of romantic color to the passage. My friend's daughter tells me that on hearing the passage "shewing his mercy unto the thousands and visiting the sins of the fathers to the third and fourth generation," she construed the strange word "generation" to mean an immense number like billions, and was thus led to trouble herself about God's seeming to be more cruel than kind.

In some cases, too, where the language is simple enough a child's brain will find our meaning unsuitable and follow a line of interpretation of its own. Mr. Canton relates that his little girl, who knew the lines in Strumpelpeter—

> "The doctor came and shook his head,
> And gave him nasty physic too"—

was told that she would catch a cold, and that she at once replied, "And will the doctor come and shook my head?"‡ It was so much more natural to suppose that when the doctor came and did something this was done on the person of the patient.

There is something of this same desire to get behind words in children's word-play, as we call it, their discovery of odd affinities of verbal sound, and their punning. Though, no doubt, this contains a genuine element of childish fun, it betokens a more serious trait also, a deep interest in word-sounds as such, and a curiosity about their origin and purpose. It is difficult for grown-up people to go back in thought to the attitude of the child-mind toward verbal sounds. Just as children show "the innocence of the eye" in seeing the colors of objects as they are and not as our habits of interpretation tend to make them, so they show an innocence of the car, catching the intrinsic sensuous qualities of a word or a group of words, in a way which has become impossible for us.

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* In The Illustrated London News, June 30, 1894.

† Of course, defective auditory apprehension may assist in these cases. Goltz gives an example from his own childhood. He took the words "*Namen nennen Dich nicht*" to be "*Namen nenne Dich nicht*," and was sorely puzzled at the idea of bidding a name not to name itself.

‡ The Invisible Playmate, p. 35.

This half-playful, half-serious scrutiny of word-sounds leads to the attempt to find by analysis and analogy a familiar meaning in strange words. For example, a little boy about four years old heard his mother speak of nurse's "neuralgia," from which she had been suffering some time. He therefore exclaimed, "I don't think it's *new*ralgia, I call it old ralgia." A child called his doll "Shakespeare," because its spearlike legs could be shaken. Another child explained the "master" which he prefixed to his name by saying he was master of his dog. A little girl in her third year called anchovies "ham-chovies," mermaid "worm-maid," whirlwind "world-wind," gnomes "no-mans" (*Un-menschen*), seeming to take pleasure in imparting some familiar element into the strange jumble of word-sound that beset her ear.

This quasi-punning transformation of words is curiously like what may be called folk-derivation, when a word is altered so as to be made to appear significant and suitable for its purpose, as in the oft-quoted form "beef-eater" (corruption of *buffetier*, from *buffet*, sideboard), and in the form "crayfish" (from French *écrevisse* or O. H. German *Krebiz*), where the attempt to suit the form to the thing is still more apparent.* When, for example, a boy calls a holiday a "hollorday," because it is a day "to hollo in," we may say that he is reflecting the process by which peoples alter the forms of words, giving them a perfectly fanciful etymology, so as to make them seem to fit their objects. Some children carry out such transformation and invention of derivation on a large scale, often resorting to pretty myth, as when the butterflies are said to make butter or to eat butter, grasshoppers to give grass, honeysuckles to yield all the honey, and so forth.†

A child will even go further, and, prying into the forms of gender, create an explanatory myth which may dimly reflect the ancient myths of peoples which lay at the root of these distinctions of gender. Thus a little boy, aged five years and three months, who had learned German and Italian, as well as English, was much troubled about the gender of the sun and moon. So he set about myth-making on this wise: "I suppose people‡ think the sun is the husband, the moon is the wife, and all the stars the little children, and Jupiter the maid."

One other characteristic feature in the child's attitude toward words must be touched on, because it is, in a manner, the opposite of the impulse to tamper with words just dealt with. A child is

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* The other form of the word, "crawfish," seems a still more ingenious example of folk etymology.

† These last are taken from a good list of children's punnings in Dr. Stanley Hall's article, The Workings of Children's Minds.

‡ This is, I take it, the majority—viz., Italians and English.

a great stickler for accuracy in the repetition of all familiar word-forms. The zeal of a child in correcting others' language, and the comical errors he will now and again fall into in exercising his pedagogic function, are well known to parents. Sometimes he shows himself the most absurd of pedants. "Shall I read to you out of this book, baby?" asked a mother of her boy, about two years and a half old. "No," replied the infant, "not *out* of *dot* book, but somepy inside of it." The same little stickler for verbal accuracy, when his nurse asked him, "Are you going to build your bricks, baby?" replied solemnly, "We don't build bricks, we make them and then build *with* them." In the notes on the boy C—— we find an example of how jealously the child-mind insists on the *ipsissima verba* in the recounting of his familiar stories.

I have in this essay confined myself to some of the more common and elementary features of the child's linguistic experience. Others present themselves when the reading stage is reached, and the new, strange, stupid-looking word-symbol on the printed page has to do duty for the living sound, which for the child, as we have seen, seems to belong to the object and to share in its life. But this subject, tempting as it is, must be left. And the same must be said of these special difficulties and problems which arise for the child-mind when two or more languages are spoken. This is a branch of child-linguistics which, so far as I know, has never been explored.

THE PERSONAL EQUATION IN HUMAN TRUTH.

By REUBEN POST HALLECK.

WHETHER there is any such entity as absolute truth we leave for the metaphysician to determine. Out of a vast number of factors which may affect truth in general, we here select a few which are to-day deflecting and limiting human truth. There are factors inherent in the self at its present stage of development, or, more broadly speaking, certain psychical laws which man's present nature will not allow him to change or to evade. So long as the present intense struggle for existence continues, so long must the existence of the self be a constant menace to the full truth, and a partial truth is often worse than a lie.

Our own actions do not raise in us the same feelings as similar actions on the part of others. Egoistic emotion is more or less present with all. Egoistic emotion invariably warps the truth. We do a thing, and it seems all right; another does the same thing, and it seems all wrong. A man of high moral ideal found fault with his neighbor for working on Sunday about a suburban house. The following Sunday men came from the city with a view to purchasing some lots which the moral man was desirous of selling. He took the prospective buyers over the lots with great alacrity, showing the good points. The neighbor reproved the moral man, who became extremely angry. Laborers frequently denounce a trust with great bitterness of feeling, and yet they proceed to form a labor trust with the express purpose of making labor dear and shutting off competition. They refuse to let an outside workman mine coal, except at the risk of his life, although his children may be starving. Do the workmen experience the same feeling of indignation at their own conduct in forming a trust as they do toward other trusts? A woman was one day genuinely indignant because candidates lacking a certain characteristic had been elected members of her club. In less than a week she was trying to secure the admission of a friend who lacked precisely the same quality. No feeling of indignation at her own conduct ruffled that woman's brow this time. We frequently hear it said, "If I were to do as she is doing, how angry she would be!" There is one test which the majority of persons can apply to themselves. They have told another something in confidence, and have felt indignant because he betrayed that confidence. There are very few persons who have not at some one time in their life betrayed a confidential secret to some one else. Amusing as it seems, it is common to hear a person accuse himself of a breach of trust, saying, as he tells a secret, "This was told me in *confidence*." His egoistic emotion will not allow him to say, "I am not worthy of confidence," although he would unhesitatingly draw that conclusion in the case of another. His egoistic emotion prompts him to make the same kind of excuse that a murderer offered for his crime: "A person should expect to be murdered if he keeps so much gold about him." We occasionally hear some one remark, "I know of no person that has a higher ideal for others or a lower one for self."

It is confidently remarked that the egoistic emotions can not warp mathematical truths, for they are inflexible and unerring. Such a statement might do very well in schoolrooms, but it has no place elsewhere. A noted lawyer said: "I have a client who is a plaintiff in a damage suit. Now, a damage, if expressed at all, must be mathematically expressed. My client's damages amount to the sum of two and two, or four. But he can not possibly add his own two and two of damage without making the sum five. The defendant adds this same two and two and makes the sum three. If it were not for the fact that the emotions of self will not allow men to add units correctly, quite a percentage of my practice would be gone. If men were sure that selfish emotion would not prompt another man to take advantage of them when opportunity offered, a still larger percentage of my practice would be lost."

The undoubted fact that our own acts do not cause in us the same emotions as similar acts on the part of others is one of the strangest psychological truths. This legacy from unevolved man, from the times when brute might was the only right, has been handed down to us. This legacy is still a beam of varying size in every human eye. We shall probably long continue to excuse certain acts of our own and of our friends and to criticise our enemies severely for those same deeds. We see this tendency full-fledged in animals. A big, strong dog will take away a bone from a starving dog. A wealthy railroad president and wealthy directors will plan to wreck a rival road whose bonds and stock may constitute a large proportion of the investments of some orphans. These men would experience intense emotion if any one attempted to steal from a child of theirs. They will steal from the children of others without a qualm. The advance in intelligence has many times served to increase this tendency. Napoleon was a very intelligent man. The promoters of hydra-headed trusts are men of great sagacity. It is nevertheless true that, as a man acquires the habit of reflecting on his own actions, as he by an effort places himself in a neutral position, and from that changed point of view looks at his deeds with another's eyes, as he puts himself in the place of those whom his acts have inconvenienced or wronged, this brute legacy, so destructive of truth, will grow less and less. But only the possessor of a vivid imagination, either natural or acquired, can ever succeed in doing this. Children who are early taught to regard each act from the point of view of those affected by that act are placed in the royal road to overcome this tendency. A successful business man recently said that he did not wish his children thus taught, for such training would put them at a disadvantage in the struggle for existence.

True conceptions are hampered not only by those emotions which are popularly termed peculiarly egoistic, but by all emotion, which a searching investigation shows to rest upon a hidden foundation sunk deep in those feelings which affect the self for weal or woe. All emotion has a twofold aspect in regard to thought and the search for truth. On the one hand, emotion supplies all the interest we feel in any subject, and is thus absolutely necessary for all long-continued, earnest thought; on the other hand, there is thus a deflecting power necessarily at work in the center of every thought. The strong desire to prove a certain theory has led the most honest of men to look at certain facts through colored glasses. It is often dangerous to consult any medical specialist at first, because he will have a tendency to see unmistakable signs of the complaint which he treats. Only those truths in which we are interested, only those which strike our emotions, are fully operative; others pass us by without influencing our actions. The laws of life declare that those truths in which we have a selfish interest shall be the most numerous of all. Not only the lowest but the highest of life's truths, the truths of love and immortality, are emotional truths. Such truths are proverbially blind. Cold reason was never responsible for the lofty flights of love, or for the terrible alighting, which so frequently follows, on the hardest of ground. But any truth can never be a full truth to us until we have felt it. If there is such an entity as absolute truth roaming around loose, not affecting human feelings and actions, it might as well not be at large. All talk about veneration for truth in the abstract is merely talk. It is easy to prove this. Take some person whose self is not interested in the subject and talk to him about the truths of an echinoderm, a cephalopod, an amœba, or a series of latent chemical reactions, and notice how soon he becomes bored. Prof. Sully rightly says: "Even the scientific man who shows the speculative feeling in so intense a form is often surprisingly narrow in the range of his intellectual interest. The general or abstract sentiment, a pleasurable interest in all or any new ideas, is in fact a kind of fiction."

We are now brought face to face with another fact. The thought limitations of any human being so circumscribe the truth that we can never be sure that we have the whole truth. Our thinking is principally for the sake of our doing, and that must be definite, concrete, limited. A shoemaker's business renders his conception of the human being a narrow one, and for that reason an unfair one. The shape of the head, the hand, the trunk, may be neglected by him. He may be unacquainted with the relation of the auricles to the ventricles in the heart; he may not know whether the stomach is above or below the diaphragm; he may not be able to distinguish between the sympathetic and the cerebro-spinal nervous system. It is evident that his view of the human body is narrow and unfair. Allow one skillful physician to question another equally skillful, and the first will easily show how narrow and unfair are the ideas of the other. Everything is related directly or indirectly to everything else. No mortal eye can detect all those relations. Some undetected one may be vital, must be vital, to knowing the full truth about anything. Prof. James has well emphasized the fact that the Infinite alone can have a fair, impartial, or fully truthful view of any single thing. The Infinite alone can see all these myriad relations. Every time a man neglects one aspect of a thing he is unfair to it; if he neglects ninety-nine, he is still more unfair. We pick up a book; we notice the type and paper. Do we know all the crude attempts by means of hieroglyphics to communicate thought? Do we know the history of the first attempts at making type? Do we know all the processes in the manufacture of the type before us? That type is a metal, taken from the mines, perhaps formed in the Devonian or even the Archæan period of geological time. Earth's metals have definite relations to the sun's spectra, to the spectra of the fixed stars, to the spectra of the chaotic nebulæ floating like evening clouds through the starlit depths of space. If we do not know these, we must confess that we understand but little of the relations involved in the production of a book.

We pick up a piece of metal that we call gold. A chemist tells us that we are rash in calling this gold, for he suspects that, if its molecular relations were understood, it would be clearly seen to be nothing but hydrogen. He says that the last analysis would probably show sulphur, iron, lead, oxygen, silver, copper—in fact, all the metals and all the so-called elements—to be one and the same substance with a different molecular arrangement. The physicist says he shall no longer place hard and fast lines of demarcation between heat, light, and electricity. The psychologist has ceased to view perception, memory, thought, emotion, and will as different forces. The metaphysician declares that we might as well stop writing treatises on special subjects, for all the sciences are merely various phases of one great underlying science, though our ignorance has not yet allowed us to see the intimate relations between all, just as the chemist's ignorance has not permitted him to see that gold, silver, and lead are the same substance.

We proceed practically in this way to untie this unpleasant Gordian knot of ignorance. In the case of the book we say: "We shall deliberately disregard those relations which do not vitally concern our immediate selfish interests. Our present aim is to read that novel, and we do not now care how long mankind groped in ignorance, when books were first printed, how the type-metal is prepared, whence it came, or what relations the spectroscope shows it to have in common with the sun, the stars, and the nebulæ."

Considerations like these show us how incomplete is human truth, how one-sided and partial, how trivial and superficial it would seem to a being of complete intelligence. *So long as the struggle for existence continues, so long must human truth develop especially on its selfish side.* Electricity will be investigated along the line of its utility to the self. Engineering skill will construct bridges with vast spans over which trains may roll laden with flour and corn and beef. In justice to the aspirations of the human soul, it may be said that many a one has been forced to expend its energies in routine struggles for bread when that soul would gladly have devoted its powers toward climbing the steps of a broader and higher truth. The octopian struggle for existence with its deadly tentacles has throttled many a one that would have gladly climbed to loftier heights of truth.

Thus the emotions and the limitations of humanity deflect and narrow truth. There is also another powerful deflecting factor. This is called association or apperception by different schools. Each succeeding truth that comes to the mind is changed by the resultant force of preceding truths. A compass may point exactly north until it is brought near a bar of iron, when the direction of the needle is changed. This iron has an analogy to an idea already existing in the mind. To Turks and South Africans polygamy may not clash with a moral truth, because they have been brought up amid polygamous associations. Had we sprung from such ancestry and been reared in the same way, we should doubtless consider polygamy quite moral. The child of Catholic, Baptist, or Mohammedan parentage will commonly look at religion from the point of view of his early associations. When we hear a person, referring to a certain sect, saying, "I could never have belonged to this or that church," we may know that he would probably have been a Catholic, or Baptist, or a Mohammedan had he been born such. The truths of religion may not change, but our ways of apprehending them are largely determined by association.

Eminent German psychologists have said that we can not think as we will, but we must think as just those associations which happen to be present prescribe. When we come to view such statements as these in the light of what history has recorded, they furnish food for careful reflection. Had we been born in the times of religious persecution, should we not have joined the vast majority who believed in repressing heresy by lighted fagots? When every Christian nation from Scotland to Spain was torturing witches, should we have stood aloof from the councils of the wisest? At one time even the most intelligent in the Southern States were fighting for what early associations had taught the people to regard as the truths of slavery. The North, schooled differently, was fighting on the other side. History shows us that association has ever been a potent factor in our conception of truth, and association is often purely accidental.

All of the judges of the Supreme Court of the United States may be hearing the same testimony in a case, and yet these judges frequently express dissenting opinions, although no selfish end is to be gained by this course. This illustration shows the varying, even accidental, factors in the production of so-called truth. The truths of justice ought not to be less important than other truths, and yet here are judges, each equally desirous of awarding justice, expressing conflicting opinions from precisely the same data. One part of the testimony will attach itself to some former experience in the case of a certain judge. That testimony may thereby become powerfully swayed by that association, and may therefore assume undue importance. Other testimony may not receive sufficient attention, because there was no associated factor to intensify the impression. A jury is especially exposed to such deflections. If there is a damage suit over injury to a child, any jurymen who have children will be peculiarly sensitive to testimony showing carelessness on the part of the one who occasioned the injury, and peculiarly deaf to testimony establishing the fact that the child's own fault was responsible for the harm. In general, less important truths with a powerful attachment to something in our own experience will completely overshadow those more important with no such association. No one can forecast how many truths will affect certain people until he knows what associated ideas these truths have to contend with.

The association of ideas goes so far as even to affect the way in which we perceive things. A passing bird may be perceived, or, as some people prefer to say, "apperceived," by a lady as an ornament to her bonnet; by a fruit-grower as an insect-killer; by a poet as a songster; by an artist as a fine bit of coloring and form. The housewife may apperceive old rags as something to be thrown away; a rag-picker, as something to be gathered up. A carpenter, walking in a forest, would see the trees as possible sticks of timber. A botanist would notice the shapes of the leaves. A hunter would have an eye for coverts for game. A fisherman would regard the stream flowing through the wood as a good place for trout. An ornithologist would have an ear for the birds. A man's profession can soon be detected by the way he perceives things. The truths of our world are determined by what we see, and *we for the most part see only those things which we can join to something in our own line of experience. All other things do not exist for us. Their truths are not a part of our world.* After we have perceived a thing, the brain probably never returns to its former state. Any new perception will feel the deflecting force of former perceptions. A butcher and a cloth manufacturer perceive a sheep in an entirely different way. If their perceptions have differed, it is impossible for two persons to see a new thing in precisely the same way. It is of the utmost importance for success in life that this truth be fully apprehended. Men succeed in proportion to their fullness of understanding their fellow-men and influencing them. Educated persons ought to expect different men to look at the same thing in different ways, and the intelligent should be constantly prepared to meet such cases. If psychology is to have practical worth, such truths as these must be emphasized. There will then be less surprise when people quarrel and go to law because they can not see the same thing in the same way. Many a business failure might have been averted had this trouble been adequately known in advance. Where a danger is philosophically foreseen, the risks incident to it may be diminished.

We need constantly to remember that human truth is a variable incomplete entity; that it differs according to whether it is your truth or my truth; that it is subject to the deflections of emotion, at the mercy of the association of ideas and of the education and personal training received in any community at any time.

MANUAL TRAINING.

By Dr. C. HANFORD HENDERSON,
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II.

IT will be remembered by those familiar with biblical lore that when Saul, the son of Kish, went forth in search of his father's asses, he found, instead of these humble animals, a kingdom and a crown. Not every man is so fortunate. Indeed, as we all know, the experience is often reversed. Yet it does fall out from time to time that a very modest journey into the world of thought or action lands one in the midst of wholly unexpected possessions. The Burgomeister of Dessau, patiently gazing at the sun day after day for thirty years, and noting the sun-spots as they waxed and waned, to discover in the end their remarkable periodicity, is a more modern instance. Others might be cited. We go in quest of a given end. We travel a few paces. A chance experiment, an almost random thought, and behold—a new world! It is no miracle sprung full-grown from the womb of the impossible. It is an orderly sequence, the wider prospect which comes from a better point of view.

I have had a somewhat similar experience in this matter of manual training. I came in search of a quiet good; I find a kingdom.

We are inquiring into the inner content of manual training. Let us begin at the beginning—at the mystery of birth. It is a favorite starting point of mine, for life best stands out in all its cosmic relations when I view it as a sublime panorama, watching the human soul as it emerges from the mists of infancy and following it until it sinks below the horizon of the grave. It is a method which has the disadvantage of long prefaces, but perhaps the compensation of clearer conclusions.

A child, then, is born into the world—a puny, screaming, reddish creature—a very fragment of humanity. Were we gods, unacquainted, let us say, with the wheel of birth and death, and did we find ourselves for the first time face to face with infancy, we would see in it but little promise. If we found our infant, like Romulus, suckled at the breast of a she-wolf, and had we no more developed human with whom to compare it, our amazement would fast turn into repulsion. The child would appear a helpless parasite, sucking in the outer world and making no return. The picture would not attract, for it would be devoid of that element, dear alike to gods and men, the element of power. But add now another figure. Let it be the picture of mother and child. It is a picture which for many centuries has claimed the adoration of mankind—an adoration shown as well in its art as in its religion. And back of the art and back of the religion there is, I think, a significance still deeper and still more catholic. The second figure has changed our entire attitude. The helplessness no longer repels. It is seen to be a phase and not of the essence. What the one is, the other may become. We love the child for its sweet promise, and, though we may be disappointed a hundred times, the next-comer is the occasion of renewed hope.

Yet the mystery is not dispelled.

By what divine metamorphosis, we should ask, is this crude, rebellious organism transformed into the likeness of the serene and beautiful mother? We could only answer this self-put question if we stopped and watched the unfolding. What the elfin child of our imagination appeared to be doing the human child in reality does. It drinks in the outer world; and it must do so, for upon this depend its life and its growth. Food and air and light must flow to it from their several sources. They are the material of its body and the stuff of its increase. The faculties must exercise themselves upon the many objects of perception. They must transmit to the brain their corresponding sensations. These are the material of thought and the food which nourishes intelligence. Who the alchemist is—the subtle inner self which transmutes the seemingly dead elements into a living organism and the accumulated sensations into coherent thought—we do not know. Let us call it the human spirit, the sum of human faculty; or, to be brief, the soul. This is, I think, a legitimate use of the word. But the point I want to emphasize is this, that the soul, whatever it may be, whether the cause of the life process or its result, is no creator. It is a living fabric, woven on the warp and woof of cause and effect. It depends for its growth upon the materials of growth. The spinning must cease when there are no more strands to be woven. And so it comes about that souls differ from one another in magnitude. They are stunted, if the material of growth be limited. They are generous, if the material of growth be plentiful. And by material of growth I mean available material. A dyspeptic organism in the presence of food which it can not assimilate; a feeble brain structure face to face with possible sensations which for it are impossible—these are the victims of a fatal stint. We can set no limit to the power of assimilation. We can see no boundaries to the possibilities of sensation. The unfolding spirit finds itself at the beginning of a road, the end of which lies in infinity.

The distance between the mother and child is very great. Yet it may be traversed, and by one path, that of experience. This is only another way of saying that the child drinks in the outer world. The avidity with which it drinks, the completeness with which it assimilates, these condition its growth. What the one is, the other *may* become. What the one is, the other does not necessarily become. The process of education, conscious and unconscious, formal and informal, the education of daily contact with life, determines the resemblance or divergence.

It would be a serious matter if we allowed the education of the child to proceed without guidance. This would be to lose the profit of our own experience. It is a still more serious matter when we attempt to guide it. I am afraid that with our sophisticated ways we often do things which make life, acting unconsciously, a far better schoolmaster than we, with all our conscious methods.

Have I made myself clear? Have I pointed out with sufficient plainness and sufficient emphasis that men are the children of their own experience; that education is a process by which we enlarge this experience; that the art of teaching lies in the discrimination with which we decide upon the desirability of any possible experience, and the skill with which we bring the selected experience within reach of the child? I have meant to do so, and for a special reason. What to do?—that is one question. How to do it?—that is another. These two lie at the basis of manual training, as they do at the basis of every other scheme of education. The different answers give rise to the different schemes.

In adding manual training to current education, we are called upon to justify both the end and the means. The end must be rational; the means must be adequate. This is a reasonable demand. I am glad to answer for manual training, and to try to tell why we do it. I hope that others will be minded to correct and to complete the answer that I am about to give.

We did it in the first place for a quiet good.

In the face of matter, man seemed so helpless. In taking boys from the home and field and farm, and packing them into school-houses, we robbed them of much of their natural physical activity, and lessened the education that comes through the senses. There were some compensations. We brought about a certain amount of self-control. We made the boys acquainted with certain facts. We bespoke an interest in the things of the spirit. The humanities made some progress. But the fact remained that in all this we were dealing with the symbols of things rather than with the things themselves. It was observed that our children dwelt in a curious and a somewhat unwholesome world of unreality. It was startling to find, as I once did, a boy of fourteen who had been so persistently taught that the moon shone by reflected light, that he believed the moon to be nothing more than an image of the sun cast on the celestial sphere, much as we throw a sunbeam on the wall. He was greatly surprised at the time of an eclipse to find that the moon was a solid body. It reflected somewhat on the usefulness of geography to find children whose main impression, after a considerable study of the map, was that Pennsylvania was yellow and New Jersey pink, while for some unexplained reason New York was green. Doubtless things have improved since those days, but even now, in the year of grace 1895, the study of child psychology is revealing the fact that large percentages of our school children are ignorant of the most everyday realities of life. These same children can out-talk and out-name their less-schooled elders. They can make a quiet country boy silent and abashed in the presence of their wordy knowledge. But in spite of it all they leave an impression of undesirable helplessness. Now, we are all agreed that, as things stand at present, the school can not be dispensed with. Its benefits are much too substantial. But it can be supplemented, and some at least of these deficiencies corrected. The early motive for the introduction of manual training was precisely this. It was a desire to bring boyhood back into a world of reality through an acquaintance with things. Dexterity in the use of tools, and in the handling of such stubborn facts as wood and clay and metal, was held to be important as a part of this reality. The work went on with earnest singleness of purpose and commands the respect of even those who see in manual training something much deeper than this mere convenience.

This first end was objective. It must always remain valid. An intelligent regard for the conditions imposed by a world of matter is a large element in successful living. No one appreciates this more keenly than your out-and-out transcendentalist. After all, he is our truly practical man. But this quiet good began to expand into something larger when men came to cherish it for a wider motive. To do certain things was useful—to saw and plane and chisel and turn and chip and file. To do them well was more useful. It was recognized as a part of virtue. It meant not only an ability to accomplish certain practical operations successfully, but it also meant much more than this. It meant the cultivation of character. It meant the growth of patience, of perseverance, and of judgment. It meant the development of the sturdy virtues of self-reliance and self-poise. Manual training came to have an ethical value. I can not do better here than to quote with cordial approval a passage from Mr. Edward Carpenter's Essay on Desirable Mansions:

"Man is made to work with his hands. This is a fact which can not be got over. From this central fact he can not travel far. I don't care whether it be an individual or a class, the life which is far removed from this becomes corrupt, shriveled, and diseased. You may explain it how you like, but it is so. Administrative work has to be done in a nation as well as productive work; but it must be done by men accustomed to manual labor, who have the healthy decision and primitive, authentic judgment which comes of that, else it can not be done well. In the new form of society which is slowly advancing upon us, this will be felt more than now. The higher the position of trust a man occupies, the more will it be thought important that at some period of his life he should have been thoroughly inured to manual work; this not only on account of the physical and moral robustness implied by it, but equally because it will be seen to be impossible for any one without this experience of what is the very flesh and blood of the national life to promote the good health of the nation, or to understand the conditions under which the people live whom he has to serve."

Manual training has thus shown two aspects. It presents itself as a convenience, and as an agent of moral culture. To-day it is entering a new phase, and is expanding into a kingdom. It is doing so through the recognition of its psychological import.

Consider the structure of the human body. It is an organism made up of many complex tissues, of bones, muscles, and nerves. The whole is nourished by blood, manufactured within its own precincts. Special organs and ducts provide a system of sewerage for the prompt disposal of waste. In health, the blood supply is ample, its aëration complete, the renewal of tissue is prompt, the removal of waste is without interruption. Each organ performs its function. We have a healthy human animal—a rare sight. We value it for what it is and for what it can do. The indicated strength must be turned to some account. The well-poised head must display intelligence. A failure in these expectations, and our seemingly perfect human mechanism is a sad disappointment. It is the informing spirit and the disciplined will that make the Apollo admirable. These do not spring like Venus from the forehead of Jove. They are the children of a slower evolution. Each organ performs its function so perfectly because of the discipline of use, because of the slow discipline of long-continued use. We recognize this in the matter of the actions called physical. We build gymnasiums on this principle, and lay out our athletic grounds accordingly. The runner wants well-developed nerve and muscle, and he wants the habit of rapid action. The champion in every sport needs the human apparatus, the nerve and sinew, and he also needs the habit of prompt exercise. It is the same with the bodily organs and functions. Strong lungs come from deep breathing and the pumping of maximum quantities of air. If we want a strong stomach we must give it work to do. We must eat cheese and nuts and other foods that are hard to digest. It will never do to live on peptones. All this is very obvious. But it is less obvious when we come to speak of the operations of the spirit. Yet the case is quite the same. We need the organ and, through exercise, the well-developed function. Our thinking is connected with molecular changes in the brain and spinal column. It will depend upon these and upon the degree of their organization. But thinking is a complex operation. It may be resolved into simpler elements, into sensations. But even here it no longer suffices to say that these sensations are transmitted to the brain. This language is entirely too general. Their destination may be specifically stated. They go to a particular part of the brain, depending on their nature.

With respect to the outer world, we have but one sense, and that is the sense of touch. All our impressions are tactile. The outer world has for us but one mode of operation, and that is through motion. The organs of sense are attuned to different degrees of motion, and unerringly pick out their own notes. The ear, sensitive enough to the coarse air waves which constitute sound, is utterly deaf to the minute light waves which so easily affect the eye. The ego touches the outer world only at its own bodily extremities. What it comes in contact with is motion. For us, then, the outer world is coextensive with motion, and with only so much motion as we can perceive. The outer world has different dimensions according to the sensitiveness of this power of perception. The motion to which we do not respond is an unseen and unknown world—an undiscovered country. The motion to which we do respond makes up our entire world. It is our universe.

The impressions gathered by the several senses are transmitted to the brain over their appropriate nerve routes. Here at this central station the same exquisite division of labor prevails as at the outlying stations on the circumference. In receiving sensations, the brain does not act as a whole. It is rather a series of resonance boxes, each box responding to vibrations of particular pitch. The reports of the several senses are all duly pigeon-holed. In the same way every outgoing nerve impulse comes from a special center. It is not by a general action of the brain that we carry on our several activities, but by the action of a special part of the brain, depending on the nature of the activity. Any injury to this center, and the activities connected with it are as completely paralyzed as if the whole tissue were destroyed. By so much is a man dead; by so much is his universe curtailed. On the other hand, any increase in the power of these centers, and there comes an increase of life, an expansion of the realized universe.

Power, that is what we are after. Let us keep it always in mind. Let us not be turned off from the main quest, however alluring the side issues. We want the increased power of the human spirit.

Now, power is a result as well as a cause. Intellectual power is the result of a developed brain organism. This development comes through use. Any activity at the circumference means a corresponding activity at the center. The exercise of any one of the senses means the development of its corresponding brain center. The sum of this development is intelligence. This is what I mean by the psychological import of manual training. This it is which makes the lovers of power value manual training. Each movement of a motor nerve, whether it be in the fashioning of wood or metal or clay, involves a corresponding brain movement. These movements stimulate growth, and growth is what we are after. Intellect is a function of brain surface.

I believe, then, that the very strongest argument for manual training is not the practical value of the skill which it develops, not even the moral significance of the sturdiness which it inculcates, but that it is something which includes these and the other ends of culture, that it is the increased intellectual power which is the necessary physiological result of such training. This is a large claim, and one that has never been urged before, I believe, on precisely these grounds. But it is a claim which can be fully substantiated.

Perceiving, as we must if these considerations are well taken, that manual training means power—because it leads to the development of the brain as an organ, and to increase of function as a result of this growth—it becomes very evident that manual training is by no means the only method of securing this development. It is far from being the end of the purpose which it involves. It is only one out of a group of possible methods which have a common purpose, the development of human faculty. To accomplish this full purpose we shall need the cultivation of all the senses. What we want, then, is not only manual training; it is something larger than this—tactile training, the training of the eye, the ear, the hand—in a word, the cultivation of all the senses. And this, bear in mind once and always, not alone because the development of these senses means a large addition to the practical art of living, but still more because such a development means increased brain power, and the consequent generation of men and women of greater worth.

We hold manual training, then, not as the last word in education, but rather as a mere preliminary word—a preface which is to lead to that fuller unfolding of human faculty which will eventually be the meaning and purpose of education. We are engaged in a process, the unfolding and perfecting of the human spirit. We can accomplish this process intelligently only by keeping in mind the ideal we wish to realize. It is well to stop from time to time and examine this ideal—to state clearly to ourselves just what it is—and then, in the light of this knowledge, to examine into the efficacy of our chosen means. What do I mean when I say "a man"? Why do I feel a thrill quite different in kind and degree from the feeling aroused by such words as "wealth," "knowledge," "country"? What is this creature who is thus able to arouse in me the deepest reverence of which I am capable? Certainly it is not the average man of the streets, whose main study is bread and butter, with a casual thought to the rearing of progeny. Certainly not the petty trader who barters the glories of a universe for a few trinkets he calls wealth. One can not seriously cherish as an ideal any of the million of dead souls who daily walk our streets and with their small activities pester the beauty out of the days. To discard these types is not pessimism. It is rather a loyal optimism which insists upon the essential dignity and worth of manhood. When I say "a man" I mean a creature very different from these ghosts of the market and factory. I mean a radiant man, one who is the center of an abounding life and in whom is fulfilled the promise of the days. It is quite possible that by holding men so dear we should make certain material enterprises, now much esteemed, entirely out of the question; but, if so, we can better afford to lose the enterprise than the men. It is a devil's price which is paid in men. Education must look beyond boyhood and ask itself for what type of manhood it is planning. What sort of boys will evolve into this type of glorious, radiant manhood? Prigs will not do. No winged creature ever hatched from such a chrysalis. Neither will dullards nor bullies. Nor can we hope for much from the most current type of all, the pale-faced, anæmic boys, with their dull ears, near sight, short wind, bad breath, and a measure of life too large to permit dying and too small to permit living. What we need for such an evolution is radiant boys, breathing the full breath of life and health, thinking clearly, feeling deeply, rich in the fine riches of the human spirit, the riches that come from the expanding and unfolding of the human faculties.

This is an ideal boy, but it is not an impossible boy. He is a boy of flesh and blood—firm flesh and pure blood—and he shall not be driven out by any cry of Utopian!

It is the sort of boy I have in mind when I pronounce that word which should be a magician's word, the Open Sesame to many a human wonder, the word Education. It is by this standard that I must try all methods of education, manual training among the rest. It is not so much whether they produce this type of boy—we live in a world of the imperfect, one whose beauties are daily sung by the minor poets—but whether they have it in mind to produce them, and do actually tend that way.

Now, I have tried to show that manual training has its face turned toward this perfection, and that it does realize a first step toward its attainment. It is this feeling that urges upon us the necessity of other steps. I see very clearly where we should begin. We should begin with the naked boy. It is not enough to impress his head. It is not enough to impress his hands. Life is a question of the whole body. I am trying at the present moment to introduce physical examination into our own school, and to place our work upon a sound physiological basis. It is an innovation. I do not know whether I shall succeed. Society at present furnishes us with a supply of very imperfect boys, furnishes to us who are a set of very imperfect teachers. Between us, imperfect units on both sides, the process of education is to be realized. It is very evident that the remedy for all this is the generation of a more perfect race. And this dream should be the ever-present dream of education. By entertaining it, it will become less and less Utopian, and more and more American. There is no reason why we should not realize it. There is every reason why we should. We have only to believe more in men and less in things.

But, meanwhile, the imperfection is here, and the problem is how to deal with it.

It has struck me for some time past that the friends of darkness are more successful than we, the friends of light, because they so persistently address themselves to the means of accomplishing their purpose, and only gloat occasionally over the end; while we, with better purpose and nobler end, we, with education and the universe on our side, are so constantly failing because we set our eyes on the end, and its glories blind us to the means.

What reformer so unimaginative that he does not thrill at his own mind-pictures of a perfected humanity! But, alas! how few reformers, however earnest, who are patient enough to build from the mudsills up! For the most part we are a set of idle dreamers. Science has reclaimed from the unknown much more than we teachers have utilized. The laboratory is far ahead of the class-room. To our shame be it said. We know better than we do. The time has come to stop this trifling. I, a man, cry to myself, Halt! And I ask myself what I would do if I did the best I knew. The answer comes clear and unmistakable. I would stop trying to educate boys by the hundred—an impossible task—and devotedly try to educate a little group. I would begin at the beginning. One must know the sort of material one has to work upon. This is the beginning. Education must take in the whole day, and not a mere fragment of it. Knowing the condition of the whole organism, the powers and defects of each organ, our first business is to set about making this organism healthy and adequate for the life of a man. This is a matter of daily *régime* and not of intermittent treatment. It is a matter of food, baths, clothing, rest, and exercise. It can not be divorced from school life any more than it can from home life. This is the first and great requirement. No boy, unless heavily handicapped at birth or by subsequent accident, will fail to respond to such treatment and come out a relatively healthy organism.

Meanwhile, we are not forgetting that power resides in the head. But neither are we forgetting that the head is only made possible by the rest of the body; that the supply of blood depends on that pumping engine down below, the heart; that the condition of the vast system of nerves of which the head is the center depends upon the health of the entire network; in short, that not the least and meanest function of the organism is without influence upon the crown of it all. Education begins by a bodily renovation. And while this renovation is in progress, much else is being done. Each organ of sense is not only to be in health through its own health and the general health of the entire organism, but it is to be gaining power through exercise, for it is the office of the senses to supply the brain with raw material—that is, with sensations. There are many opportunities for such exercise. To begin with, let us consider the eye. Incidentally, all life contributes to its culture, and yet for lack of adequate training it remains a very inaccurate instrument. Its function is to appreciate distance, color, tone, light and shade, proportion. Put in the most general terms, it is to apprehend relations. Many wholesome exercises could be devised to develop these several phases—judgments of distances, discrimination between different colors and different shades of the same color, the evaluation of light and shadow, the study of the æsthetic principles underlying the sense of proportion. An eye trained in this way would be a source of endless delight, a constant finder of new beauties. And back of the eye is the seeing brain whose growth would be in proportion.

The ear is an equally promising field for training. Think of the world of harmony and music closed forever to those who, like poor Trilby, are tone deaf! Think of the thousand sounds in Nature which are full of meaning to those who have ears and hear; of the countless shades of meaning conveyed by the human voice to those who are sensitive enough to apprehend! At present this realm of sound is to most of us a coarse convenience, a quick way of ordering our dinner, and little more. It might be a garden of delight; and the time to open this garden is in youth, when the tissues are flexible and the life plastic. It is a tragedy that when we might be opening such treasures as these to our boys, we teach them, instead, bookkeeping and interest! And back of the ear is the hearing brain whose growth would be in proportion.

There is no sense organ which might not be stimulated by some well-directed training and made to yield its corresponding brain reaction. Even taste need not be omitted. It would be an exercise of serious value to have a boy learn to detect the percentage of sugar or salt or lemon juice in the glass of water he is drinking, for it would mean the exercise of attention and discrimination. Something might even be done with the nose. Its judgments might be refined and made analytic as well as æsthetic. And, again, back of the tongue and the nose is the tasting and smelling brain, and it is this always that we have in mind.

In manual training we appeal to touch, and incidentally to sight. But we have scarcely broken ground. The hand could be cultivated to a thousand delicacies of touch which are merely foreshadowed in our present clumsy exercises. Both hand and foot are capable of many movements which would add not only to health and convenience, but also furnish nerve and muscle reactions of large value. To sum up the present gains, I would say that manual training gives us increased dexterity and greater keenness of observation. Of still greater value is its higher gift, an increased development of the corresponding nerve centers in the brain, and the consequent increase in general intellectual power.

Here, as the lawyers say, we rest our case.

If manual training has, as I fully believe that it has, this vastly important psychological import, it is the herald of a coming education. If it has not, then its only value is industrial and utilitarian. It is an artisan movement, useful and in its way valuable, but nothing more.

And here let me say very explicitly that the matter is not one to be disposed of, for or against, by mere opinion. In view of its seriousness such disposal would be simply cavalier. It is a matter for scientific inquiry and decision. I am not an advocate of manual training any more than I am an advocate of the vortex theory of atoms. Such a position is not defensible. I stand toward the problem, as I do toward other problems of science, simply as a student weighing the evidence. I would ask for a similar attitude on the part of other teachers, and for nothing more. The final judgment will come, bear in mind, not from schoolmasters and school committees, but from the men who are patiently and experimentally studying the brain as the organ of human intelligence, and mind as a function of brain.

I have here tried to tell the main ground for the faith that is in us—the *raison d'être* of the manual-training cult. One other question remains: What does this training lead to? It is the question of a practical world, of a world which pays the bills, and very properly looks into the quality of its purchase. The question may be answered in two ways: one is the very cold and matter-of-fact way of telling just what the graduates of a manual-training school are doing at the present moment; the other is the more rosy method of setting forth what we think these same graduates, in view of their education, ought to be doing, and what, when manual training shall have done its perfect work, they undoubtedly will be doing. I shall combine these methods by giving the statistics of our own school and then criticising them.

It has become a custom for some of the principal manual-training schools to publish in their catalogues a list of graduates with their occupations. These lists form very instructive reading, for they tell in the most practical way just what the training does lead to. The Northeast School has graduated but two classes, or one hundred and twelve boys in all. An examination of their record shows the following results:

Students:	Electrical engineering	7	
	Civil engineering	6	
	Economics	5	
	Mechanical engineering	4	
	Medicine	4	
	Biology	3	
	Art	2	
	Science	2	
	Arts and sciences	1	
	Dentistry	1	
	Theology	1	
	Mechanical drawing	1	
	Trade school (plumbing)	1—	38

Students (brought forward)		38
Technical positions: Electricity	12	
Architectural draughting	6	
Machine work	5	
Pattern-making	3	
Draughting	3	
Iron inspection	2	
Surveying	1	
Engineering	1	
Steel engraving	1	
Wharf-building	1—	35
Reporters		2
Farmer		1
Collector		1
In business for themselves		4
In business with father		5
Mercantile positions		19
Without occupation, or occupation unknown		7
Dead		1
Total		112

The first thing to strike one about this list is the large number of boys who continue their education in higher institutions. One third of this particular company of graduates are now at work in the several departments of the University of Pennsylvania, Cornell, and Drexel Institute, and in other medical, art, theological, and trade schools. The percentage is, I believe, considerably lower than in the four-year classical high schools of New England; but taking all the high schools throughout the country, and the percentage is much above the average. The result is gratifying, for it shows at least that the school has cultivated an appreciation of wisdom if it has not always succeeded in imparting it. Several factors have combined in turning the faces of so many boys toward college. In the first place, a manual-training school is a very practical school, and it does teach and illustrate the fact that if one wants to do good work one must learn how. Many of these boys have a distinct purpose in life, and they are at college in order to prepare themselves for carrying it out. Further, it so happens that a majority of the faculty are college-bred men, and have a sympathetic appreciation of college advantages. We have indeed made a special effort in this direction, and have tried to turn the most promising of our material collegeward, for we do feel that between the man who goes to college and the man who does not there is a difference of mental outlook which makes them the inhabitants of different worlds—a larger and a smaller universe. These influences within the school have been greatly strengthened by the friendly attitude of our university—an attitude constantly manifesting itself in cordial generosity and sympathy.

Almost another third of the boys find their career in technical work, made possible in large measure by the school training. They do not always get on very well with the "practical" men of the shops. A common criticism is that the boys know too much. But this is a criticism which may be interpreted in two ways. At any rate, they have a habit of coming out on top with a speed which indicates that any over-confidence at the start is soon cured. Our own graduates are still quite young, but the records of the Central School and of other training schools throughout the country show a goodly number of manual boys in positions of large responsibility, as teachers, fellows, inspectors, foremen, head draughtsmen, managers, and in other posts not awarded the incompetent.

The remaining third are distributed among a number of callings. It is a matter of regret to me that so many should have been willing to accept mercantile positions. In a number of cases, however, they are held only temporarily until something better can be found. With so many interesting possibilities in the world, it seems, to say the least, a very commonplace disposal of one's self to go into any trading operation. The influence of a manual-training school is decidedly against this sort of thing. I think I may say that it is somewhat aristocratic in its tendencies. It proposes that a man shall gain his living by some useful performance rather than by clever manipulation of stocks and markets. The tendency of manual training is distinctly away from commercial enterprises of a speculative character.

Of last year's class of fifty-nine boys but two are without regular occupation at the present time. This year's class has been less fortunate, for the depression in all manufacturing activities has made it more difficult to secure satisfactory posts.

On the whole, the record is gratifying. It shows that the training has somewhat of that catholic character which has been claimed for it by its advocates. If any judgment may be founded upon the destiny of this particular group of boys, it is clear that the training does lead to a variety of vocations rather than to one particular set. This seems to me a great advantage. The boys in a high school are much too young to elect their future. The training should be of such a general character as to present life in its entirety, and to open the doors of destiny in all desirable directions.

And now one word in conclusion as to what I personally would like to have manual training lead to, for in such a matter I may not so far involve my colleagues in the movement as to use the plural pronoun and say "we." There is discernible some tendency to give the movement a socialistic turn, and to urge manual training on the ground that society needs for its many activities the skill imparted by such schools. The boys are regarded, if I may so phrase it, as social tools in the making, and a process which turns out useful, workaday tools commends itself to the majority. In a word, the movement is looked at from the point of view of the whole, and notably from that aspect of it which has to do with social convenience. The graduates in manual training are socially useful, because they can do something. Economically they are good products. Now, for my own part, I much deplore this view. I want the social welfare and the social health quite as earnestly as those of my brothers who call themselves socialists, but this social good is a mere phantasmagoria, unless it means the sum of individual good, and it is attained only by attention to the factors in this sum—that is to say, to the individual. As I see life, individual good is the means and the end, and social good but the sign and symbol that this has been accomplished. Looking at the matter in this way, I can not build backward from the whole to the parts. I am forced to build in the other direction. And so I want manual training to lead to no such social illusion. I want it to lead in precisely the opposite direction. I want it to lead to the one great reality in the drama of life—to the unfolding and perfecting of the individual human spirit. I would have it intensely individualistic, leading never to self-sacrifice—which has for its necessary corollary other-sacrifice—but leading always to self-realization, a self-realization so glorious as to quicken neighboring dead souls into renewed life. So I say in effect to each of my boys: "I recommend manual training to *you*—not to society, but to you, the individual soul—that your faculties may unfold and that you may come into the full stature of a man. And I recommend it without reservation, recommend it whatever the trend of your genius, for it means increased power for every performance."

The end, then, in manual training which commends itself to me is not utilitarian or socialistic. It is human, personal, individualistic. I would have it lead first and foremost to complete manhood. There are many social necessities, so called, which lead the other way. There are hundreds and thousands of activities which destroy manhood, but which are urged in the name of society. What crimes are committed in this name! There are the grim fortresses of commercialism, twenty-three stories high, whose dismal, sunless cells are to be filled with young life, and to be its tomb. There are rows and rows of vulgar shops, with their poor wares and bad air, where there can be no thought of human perfection. There are industrial processes whose known cost is human life. There are many-storied factories full of human misery. There are hideous aspects of life called into being, enlarged, and, worst of all, *justified* by this same cry of social necessity.

Now, I do not believe in this. I believe in wholeness, in health, in vitality, in integrity, in goodness, in happiness. And I believe that manual training should lead to these, should lead to them inexorably. The same motive which makes me cherish manual training—the love of power, the love of perfection—makes me deny as its proper outcome any activity which disallows complete manhood. So manual training opens the doors of activity in all directions, only to declare that many of these doors are impossible. It consents only to those activities which, humanly speaking, are worthy; and the test of worthiness is not measured in the economic terms of productiveness; it is measured in the terms of the spirit, in its effect upon the worker. I do not succeed in impressing this view of life upon all of our graduates. I do not succeed in impressing it even upon a majority. But each year it does claim a small company, a company who believe with me that the most sacred thing about life is life, and who decline to violate this sacredness by any petty spoliation of the days. It does seem to us a tragedy that any young man, and particularly any young man in America, where the opportunities for rational living are so abundant, should deliberately elect a suicidal scheme of life, some dull routine which is to curtail experience and limit the universe to a daily round of sordid cares. Perhaps I should not have said deliberately. They do not do it deliberately; they do it because they do not see. They do it because culture and the ideal of life for which it stands have not taken hold of them; because we who represent this view of life have not been sufficiently active, insistent, loving, to win them over to our side. In any case it is a tragedy, and one that I much deplore. When education shall have done its perfect work, our boys and our men will declare with Walt Whitman, in his Song of the Open Road:

"Henceforth I ask not good fortune, I myself am good fortune."

And it is this to which I would have manual training lead, to the rare good fortune of a rich and full existence.

On account of the absence or loss, in fossilizing, of characteristic features, it has hitherto not been possible to give trilobites a fixed place in the zoölogical system; they by turns have been classed with isopods, phyllopods, and arachnids. Mr. H. M. Bernard, in his work upon The Apodidæ, placed them in that family; but he confesses that, however weighty the argument in favor of that relationship, the inability actually to demonstrate the existence of antennæ was a felt weakness. Recently some sixty specimens of the species *Triarthrus Beckii* were found by Mr. Valiant in the Hudson River shales, near Rome, N. Y., with antennæ, and have been described by Mr. W. D. Matthews in the American Journal of Science. Mr. Bernard regards the presence, structure, and position of the antennæ as justifying and confirming his classification.

ANIMALS THAT LIVE IN CAVES.

By E. A. MARTEL.

THE study of paleontology and prehistoric archæology and the exhumation of the life of the past in caverns have been pursued in France during the last twenty years at the expense of the investigation of the present life, while the fauna and flora of their black recesses and dark waters have nevertheless flourished quite as vigorously as in the subsoils of Austria and America. The naturalists of those countries have, however, carried their investigations in that domain considerably further than those of France. Still, numerous cave-dwelling species new to us have been found in the Pyrenees and the south and east of France.

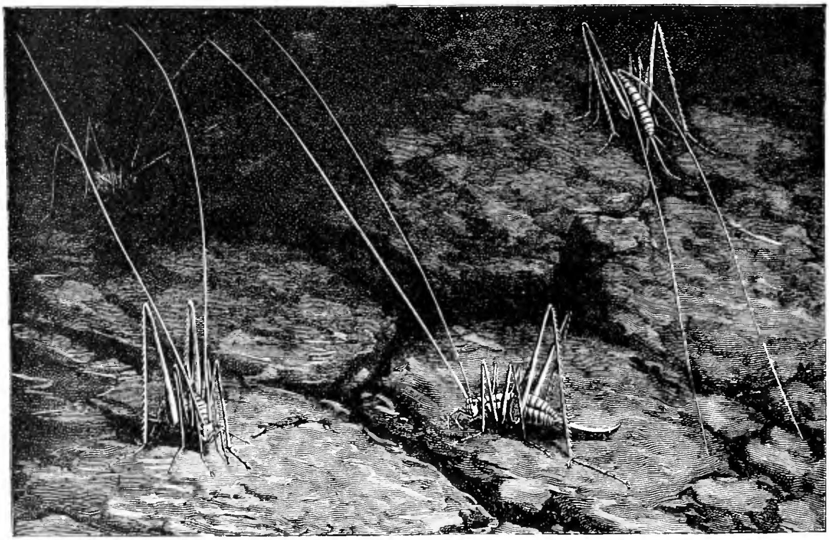
The zoölogical study of subterranean waters is eminently useful to hygienists, to whom it discloses the presence of noxious organisms capable of developing in the water supplies of cities, and thence finding their way into the human economy.

Animals of all classes may be found in caverns. Some, which do not pass all their existence there, but seek shelter in them, have been called by the Austrian Schiner *troglophiles* (or cave lovers), and others, which never leave their dark abodes, are designated by him as *troglobiens* (or cave dwellers). I can not present here even a simple picture of the subterranean fauna actually known; I can hardly even sketch the outlines of the subject and insist on its importance.

The higher vertebrates—mammals, birds, and reptiles—found in caves seem to be chiefly troglophiles. There are, however, real troglobiens among the lower vertebrates—batrachians and fishes. The articulates, in particular, and especially the arthropods—insects, myriapods, arachnids, and crustaceans—have revealed many species previously unknown. The *Dolichopoda palpata*, represented in the figure, was discovered by M. E. Simon, in 1879, in the grottoes of Belvès and Espezel, in the Aube. Worms, mollusks, etc., are not rare.

The list of the fauna of the Mammoth Cave in Kentucky comprises no less than a hundred species, without counting those that come in casually from without. Blind spiders set their nets for eyeless flies. Fish eat crawfish, which feed upon smaller crustaceans pulled with their pincers from beneath the flat rocks, while the crustaceans prey upon defenseless mollusks, and these forage upon microscopic fungi.

The important question of the origin of the subterranean fauna is still invested with a degree of mystery. It was at one time believed and maintained by Agassiz that they were specially created for the medium in which they live. It was afterward recognized that they are derived from species that have simply undergone external modification. A careful comparative study of the modifications they have undergone, and of their phases, would be necessary to clear up the doubtful points. The doctrine of the evolution of species is concerned in this investigation. The introduction underground of the ancestors of these fauna may have taken place and may be taking place in two ways: through perfect individuals carried by streams into wide-mouth pits, whence they can not escape to the light, or through eggs or larvæ borne into narrow fissures by simple infiltration of water. It is a matter of question whether or not creatures hatched from these germs, which have never lived on the surface, and their descendants,



Blind Insect of Caves (*Dolichopoda palpata*).

would be affected by more rapid changes than those which have come underground by accident, but have not been born there. The principal changes undergone are usually albinism, or more or less complete loss of color, and atrophy of the eyes. The organs of vision become, of course, useless in the underground darkness. It is found, on the other hand, that cave-inhabiting animals have the other senses developed to excess; they guide themselves by means of long cirri or long antennæ, which are very sensitive; they are put on their guard by means of their hearing, which informs them of distant perils; and by their smell, telling them of invisible game, helps them to their food. Albinism is accounted for as the result of failure to absorb the light-rays. It is generally agreed that cave-dwelling animals have lost through adaptation to the medium the visual organ their ancestors enjoyed.

Schioldte, of Copenhagen, and Dr. Gustave Joseph, of Breslau, have made curious studies of the transitions in gradual atrophy of vision from aërial animals to their cave-inhabiting congeners. M. Joseph believes that when the light is diminished in the animal's habitat, dislocation of the eyes takes place, and that the intermediate species are especially domiciled in caves where a twilight prevails, or where a little light enters at noon or in summer. While the *Proteus* and the *Amblyopsis* of the Mammoth Cave have the eyes simply covered by a membrane, some mollusks appear not to have even a place for the most rudimentary ocular globe. We might, however, ask if these different degrees of blindness do not proceed in a measure from differences in the length of time that has elapsed since the species were buried. On the one side, some animals have been found in caves having their eyes preserved in full vigor; on the other side, artesian wells have thrown to the surface, and some subterranean lakes have yielded to the collector, living beings in no wise modified from those living above ground. It has been reasonably concluded from this that these beings have been drawn in by the water that feeds the lakes coming from unknown distant points, and that their abode underground has not been long enough continued to make them blind. It would be interesting to compare atrophy of vision in cave-inhabiting animals or in those of subterranean waters with those remarkable creatures specially adapted to enormous sea depths which have been collected in the expeditions of the Challenger, Talisman, and others of like purpose.

It is perhaps possible to attach too much importance to the blindness of subterranean animals as a peculiarity. A considerable number of species living in surface waters are destitute of vision.*

M. Joseph is of the opinion that "the presence or absence of organs of vision always corresponds with the conditions of existence of the animals." So far as concerns the heredity of atrophies, Hovey says, in his Celebrated American Caverns, that Dr. Hayden witnessed the birth of eight little blind amblyopses.

What we have said is only the present indication of some of the questions raised by underground zoölogy. An ample harvest of facts heretofore not observed may be anticipated from the exploration of the numerous caves of the Causses in France—such as have been made in the caves of Carniola and the United States—or of any caves as yet virgin to scientific examination. The subject is full of interest, and all the more attractive because so much still remains to be found out about it.

The outfit for hunting cave-inhabiting animals includes an

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* R. Moniez, Faune des Eaux souterraines.

entomologist's pincers, a fine, strong, close-meshed net, a brush for applying alcohol to the creatures to stupefy them, and vials or bottles of different sizes and shapes for holding the collections, either dry or in spirit. Of special importance are practical experiments on the physical modifications which animals of the outer world may undergo when shut up for a long time in the depths of caverns.—*Translated for The Popular Science Monthly from La Nature.*

THE SHAD'S ANNUAL PILGRIMAGE.

By A. H. GOURAUD.

As the sun, at the close of his winter's recession, marches into higher latitudes, he awakens in successive zones both animal and vegetable worlds to the full activities of their being, and exerts, even in their remote and hidden seclusion, his influence upon the finny inhabitants of the deep. With the northward advance of the vivifying orb, the shad (*Alosa sapidilla*), the alewife, the menhaden, and other migratory fish wheel into line, and, massed in solid column, approach our coasts, welcome heralds of the spring. Beginning in Florida in January, the various colonies have quitted their ocean abode, and in consecutive order are entering our rivers from the St. John's of Florida to the St. John of New Brunswick. Burdened with the myriad germs of a coming generation, it is the reproductive instinct that impels the shad to quit the security of the deep sea that it may cradle its precious freight in the rocking waters of a clear, running stream.

In common with alewives and menhaden, shad are members of the herring family, which fish they so far resemble that one of the British species is called by the Scotch fisher folk "king of the herrings," an appellation, however, more likely suggested by the commonly entertained belief that the herring shoals are led by one of enormous size, styled the king, and whose capture or destruction is presumed to occasion ill luck to the fishermen. The herring family are in their retirement deep-sea fish, and it is likely that the shad and menhaden winter off our coasts in depths of hundreds of fathoms. At an average of perhaps a hundred miles from the New Jersey and Long Island shore lies the edge of the great continental plateau, beyond which the water deepens rapidly, and there, at no great distance from its border, is probably the abiding place of many of our finny migrants. The fish frequenting each river are probably restricted to neighboring portions of the ocean, it being very unlikely that the different colonies are grouped together, as is generally supposed, in one gathering place. Denizens of the shallows, as well as of the remote profound, they are therefore subjected to great variations of pressure, not unlikely at times approaching half a ton to the square inch. At its migratory period the shad rises to the surface from the deep, and the sudden change of pressure thereby occasioned would do great violence to its bodily structure but for an apparent special provision of Nature, to be later explained.

In the marine profound there are fishes in abundant variety that exist at depths of several miles, and perhaps also in its nethermost and as yet unknown deeps. Many of these fish seem to be limited to certain oceanic strata to which their organization may be specially adapted and to no other. From time immemorial finny creatures of soft and fluffy substance and distorted shape have been found floating, sometimes dead, sometimes barely living, upon the surface of the sea; but, until the explorations of the Challenger afforded the solution, their nature and origin remained a mystery. The fish then drawn up from the far deep presented upon emergence the same bloated and unsubstantial appearance, which, by the scientists of that famous expedition, was ascribed to the expansion of the contained gases incident to the sudden release of enormous pressure. This expansion had so ruptured or puffed out the tissues of the creature that its entire semblance was without doubt radically altered, the puffy and loosely coherent mass of flesh having originally been a firm and compact substance. Fish of such localized habitat, if venturing too far above their proper stratum, would, despite their utmost effort, be buoyed to the surface by the constantly enlarging volume of the imprisoned gases, dilating measurably with the diminution of the weight or depth of the overlying water, and to such mischances is due the occasional appearance of these forlorn castaways upon the wide bosom of the deep.

Against such injury or inconvenience the shad, in common with its congeners, is seemingly secured by an anatomical peculiarity not as yet fully understood, but believed to be a distinctive adaptation of Nature. In the shad's head there appear a number of tubes presumed to exist for the introduction into the blood and system generally of a sufficiency of water, which fluid may be absorbed or extruded with increase or with diminution of pressure, and the tissues become thus adjusted to the varying strain. This presumptive function does not, of course, admit of experimental observation, and in the absence of such demonstration the mode of operation and, indeed, even the purpose of the singular tubes must to some extent remain a subject of speculation.

Of all our marine food fish shad may be said to be the most popular; as an edible and as a delicacy it appears upon the table of both the poor and the rich, being equally esteemed by the epicurean as well as by the unpampered palate. The Chinese have a species of shad, *sam-lai* (*Alosa Reevesii*), alleged to be as savory as our own, but larger and less bony. It ascends the Yang-tse-Kiang, a river three thousand miles in length, to spawn in its upper waters, but at the end of its long journey becomes worthless through emaciation. As with ourselves, the first fish of the season command an extravagant price. The Chinese gourmet, however, differing from his Christian brother, maintains that it needs to be neither baked, boiled, nor fried, but only steamed; such treatment, in his opinion, best developing the flavor. In most of the European streams shad are found, but do not equal the American or Chinese variety in flavor or in nutritious value. We have sent a number of shipments of fry to various parts of Europe with the object of stocking its rivers with our superior fish, but the effort has not been remarkably successful.

Very different, however, has been the result upon the Pacific coast, where the greatest and most brilliant feat of marine acclimatization has been successfully accomplished. Little more than a score of years ago the fry were borne across the continent, and assiduous care and attention during their long journey of over three thousand miles assured the survival of a due portion, which were placed in the Sacramento River. From this and a few later shipments has resulted their present abundance along a coast line of twenty-five hundred miles, extending from southern California to Alaska, being in their season so plentiful in some streams that barrels of them are pitchforked out of the water. It was only two or three years after the first planting that a few more or less mature specimens were obtained from the Sacramento. Gradually the number of marketable fish increased until now they almost equal in some of their localities the salmon in abundance, the price having declined from the initial figure of a dollar a pound, obtained while the fish were yet scarce, to an average of ten cents a pound in 1889, and four cents in 1892. From the slender colonies originally transported, forming less than one per cent of the number annually placed in Atlantic waters, and involving the expenditure of a comparative trifle, the inhabitants of a long stretch of coast now derive a valuable and important food supply.

Until the Pacific coast plantings it was assumed that the shad invariably returned to the stream that gave them birth, and this, as a rule, is perhaps correct. The conditions of the California coast evidently operate, however, to the diffusion of the fish, they having in many instances established themselves in rivers far from the Sacramento. This movement may be due to the balmy Japanese current, the Gulf Stream of the Pacific, which laves its northeastern shore and agreeably tempers its climate. Influenced by its genial flow and pursuing its track, the shad have wandered northward, and, if they maintain their advance, as they probably will, their ultimate establishment in the river system of Asia may be regarded as assured. Owing to various favorable conditions, the shad not only multiplies rapidly in its new abode, but in some localities has modified its habits, being found in varying abundance throughout the year. Moreover, it attains an exceptional size; seven and eight pound fish are common in California, but are almost unknown with us, and there have been exposed for sale in the San Francisco market shad of a weight as high as twelve and thirteen pounds. This superiority in size is not unlikely due mainly to a less actively prosecuted fishery, for shad of equal weight were known to our fathers. The heaviest fish are probably the growth of a number of years, and an exhaustive fishery that each season leaves but few survivors necessarily tends to eliminate the larger individuals.

Upon the Atlantic coast the utmost effort of the Fish Commissioners, supported by ample State and national expenditure, seems powerless to effect a renewal of the abundance of old. No more saddening exhibitions of man's improvidence are afforded than by the noble rivers that have been depleted or exhausted of their finny treasures, and of such perhaps the most striking are those presented by the larger affluents of Chesapeake Bay, the Potomac and the Susquehanna. Sixty years ago, through the greater course of these long streams, both the shad and the alewife, or fresh-water herring, existed in almost incredible numbers. In the Potomac the two species would often ascend the river together, and it was not an uncommon draught to secure several hundred thousand herring and several thousand shad at a single haul. The fishermen, in drawing the seine on shore, would pile the herring knee-deep for twelve or fifteen feet landward, and then walk or wade through the mass, thrusting in their arms and picking out the shad. The herring so stacked would be sometimes sold for a mere trifle, sometimes be given away; often, although an edible fish, and perhaps superior in that respect to the common herring, would be carted off for manure; and sometimes, for lack of even that demand, would be allowed to float away upon the rising tide. In 1832 nine hundred and fifty thousand, accurately counted, were taken out at one draught; the number of shad seined was often four thousand and upward, and the selling price as low as a dollar and a half per hundred fish. Of such destructive fishing a constant decline in the annual catch was the inevitable result, and thus it happened that for some years prior to the war practical exhaustion had been attained. The abatement of the fishery during that period so far restocked the river that it was renewed with profit upon the restoration of peace, but improvidence again resulted in impoverishment. In the early seventies government aid was invoked and extended; many millions of shad fry were artificially hatched and placed in the river, and thus, by constant reparative effort, a scant measure of plenty is at present with difficulty maintained.

In the golden days of their former abundance no shad were so highly prized as those captured in the upper reaches of the Susquehanna, whose clear, running waters only the better conditioned could attain, and which in their long journey against a fresh and swiftly flowing stream were presumed to acquire a flavor and excellence peculiarly their own. When the first settlers of the Wyoming Valley found their abiding place in the glades of its forested river that beneath the budding leafage of the spring rippled cheerily to the far-distant sea, they were amazed and confounded at the sudden revelation of its wondrous treasure of fish. The dreary winter of seclusion and solitude, of cold and privation, of coarse and scanty food had passed and gone, and the gladdening rays of the returning sun had quickened the face of Nature into joyous life. In their long deprivation the isolated community hungered for the coming fruits of the earth—of fresh food there was little or none—and toil and hardship, unsustained by proper nutrition, told heavily upon the weaker members of the lone and distant settlement. Then it was, in the time of their stress and suffering, that the ocean's bounteous harvest was borne against the fierce current of the swollen river, to diffuse joy and gladness in remote and difficult wilds. It was the assured possession of its fluvial crop that peopled the valley, for not only did this manna of the wilderness tide over the waiting interval between seed time and harvest, but, salted or smoked, afforded a winter supply of nourishing food that during the felling of the forest and the clearing of the land sustained the strength of the industrious pioneer. It, moreover, formed the subject of commerce, or rather, in those rude days, of barter, for the salted product was teamed through the primeval forest to the settlements upon the upper Mohawk and to the infant colonies that struggled for existence where are now the flourishing communities of Syracuse, Oneida, and others of that populous and prosperous section. It has been maintained that the first commercial routes established by mankind were probably those for the acquisition of salt; and the early existence of the ill-defined and perilous way that led to the Onondaga salt springs and to other sources of saline supply instances the assertion. A hundred shad, not unlikely over a quarter of a ton in weight, was the exchangeable value of a bushel of salt, weighing perhaps one fifth as much. Every farmer had an ample store of barreled shad, running from thirty to forty to the pork barrel, a measure that would probably require twice the number of the comparatively immature catch of to-day.

In the van of the ascending shoal that extended from bank to bank of the eddying stream were massed the largest and the strongest fish, the steady, even approach of their densely compacted ranks being betrayed by a nearing ripple, visible at a distance of several hundred yards. From beyond the submerged borders of the continent, whence it had taken its departure, an advance of six or seven hundred miles had been accomplished, with orderly movement and close formation, by this vanguard of the finny host. Day after day, in ocean's gloom and river's light, through billowy forest and far-rolling meadow, unseen and unmolested of man, the column had struggled onward. Battling with a madly contending current, sometimes halting, sometimes retreating,* and again advancing as the swirling waters became colder or warmer, many of the weaker and smaller fell out of the serried ranks, but the larger and stronger pushed unflaggingly forward to the difficult goal. The upper valley, apparently the bourn of their long and toilsome endeavor, was generally attained about the first of April, the males preceding the roe-burdened fish, successive shoals of each prolonging the fishery for some weeks, the best running eight or nine, and in exceptional instances reaching a weight of eleven and even of twelve pounds.

After the desolation of the lovely valley by the memorable Indian massacre of 1778, its widowed and fatherless were the objects of much kindly solicitude, and among the thoughtful administrations of the rugged frontiersmen was what became known as the widow's haul. The first Sunday after the season began the entire catch of the seine, whether much or little, was set apart for their exclusive benefit, and in 1790 one of these hauls, near Wilkesbarre, resulted in an authenticated total catch of ten thousand shad, and even larger draughts were reported from Nanticoke and Bloomsburg. The damming of the river, conjoined with wasteful methods of capture, utterly extinguished these magnificent fisheries, of which former abundance a partial renewal is hoped for from the labors of the Pennsylvania Fish Commission.

The lavish generosity of Nature has everywhere been abused, and the finny treasures of the Delaware have been wasted with the same reckless prodigality and unconcern for the future that have elsewhere marked the fishery. In 1891 the joint action of the commissions of New York and Pennsylvania, in establishing an effective fishway at Lackawaxen dam upon the Delaware, opened an additional hundred miles of that splendid stream to the shad.

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* The chilling of the water, occasioning the retreat of the fish, may be the result of a lowering of the aërial temperature, or of the sudden irruption into the main stream of the ice-bound waters of an upper tributary. In the Hudson shad have been known to retreat fifty and even sixty miles.

Since the erection of the obstruction in 1823 the spawning grounds of the upper river had been inaccessible to the fish; but now, after an absence of nearly seventy years, they are caught at Downsville, N. Y., upon the Popacton Branch, and at Deposit, upon the West Branch, being at their farthest three hundred miles from the sea. Where for two generations they have been unknown exists a promising fishery, which, with provident and careful administration, would doubtless become as bountiful as of yore. It was above this newly opened fishway that the season's largest shad was caught in 1891. As with the Susquehanna, the long journey seems to insure the presence of fish of superior size and flavor, and "Delaware River shad" is now a conspicuous sign in the markets of the West.

In our noble Hudson the construction of dams has not been so disastrous to its fishery, and although the shad formerly ascended to Glens Falls, and even to Saratoga Lake, their spawning grounds are now confined to beds in the river's course between Hudson and the Troy dam. Despite the multiplicity of gill nets, its annual stocking with millions of fry affords a substantial supply, that, however, falls far short of the requirement and is but a poor fraction of the yield of aforetime. Our catch under proper regulations and due access to the upper river could doubtless be greatly enlarged, the last season's product being estimated by the Fish Commission at about eight hundred thousand fish.

In colonial times shad were so extraordinarily cheap and abundant in the Connecticut Valley that a measure of discredit was attached to their appearance on the table. The possession of the salted fish, to the exclusion of the orthodox and more luxurious pork, argued the poverty of the host, and, even when fresh, it was considered vulgar fare, inasmuch as shad sold for years as low as a cent apiece. The denser peopling of the valley and the consequent decline of the catch naturally occasioned a higher appreciation of the once-despised fish, especially among those with whom cheapness is synonymous with worthlessness. The Connecticut is a river of smaller volume than the streams already discussed, and its banks are thickly populated—circumstances tending to aggravate the difficulties of restocking, the principal obstacle probably being, there as elsewhere, the rapacity and improvidence of the fishermen. About 1870, when the effort of the commissioners was begun, they derided their undertaking, but a few years later the whilom scorners begged them to desist, alleging that the abundance was so great that they could get no due remuneration for their catch. The New York wholesale price, they complained, was reduced to three dollars per hundred fish, and they argued that it was useless and a scandalous waste of the people's money to hatch fish beyond the absorptive capacity of the markets. The general introduction of speedier and of increased transportation facilities, of refrigerator cars, and of cold storage warehouses soon greatly extended, not only the area but also the period, of consumption. Thus it happened that a wider and more enduring market speedily abated the surplus that the fishermen bewailed—a surplus which, under an ever-increasing demand, ere long dwindled to a deficiency. The existence in a densely populated territory of a remunerative fishery, free and open to all comers, conjoined with the adoption of improved devices of wholesale capture, created a lamentable dearth that the utmost effort availed little to relieve.

The river at its mouth discharges its current to the westward, so that along the Connecticut shore of the sound a strip of fresh water extends a dozen miles before mingling with the salt sea. This belt is practically a portion of the river, and the fish, approaching, probably, from the eastern entrance of the sound, enter the strip at its terminus; then, retracing their course, pursue their way through the fresh water to the actual mouth of the river, within which the law prohibits the construction of pound nets. These formidable engines of finny destruction were ranged at short intervals, across the route of the fish, in the fresh-water belt, some of them extending over a mile into the sound. In constant operation, ingulfing fish every hour of the day and night without intermission or cessation, the natural result was the capture, in the sound waters, of the larger portion of the run of shad. When the sorely harried fish finally entered the river, they were beset with scores of gill nets, such as we are familiar with in the Hudson, and which were stretched at short distances as far as Essex, beyond which the poor remnant encountered the sweep nets, which one after another were dragged across the river as fast as possible. In a few years the annual catch declined from nearly half a million to a mere fraction, and at present will average but little more than thirty thousand, the commissioners of late having found it useless to stock with liberality. The State of Massachusetts procured the erection at Holyoke dam of a thoroughly serviceable fishway, thereby opening the upper river to the shad, and, besides, freely colonized with fry the portion that she controlled. The effort was vain, the expenditure useless, and the complaints of her Fish Commission to that of Connecticut that the shad are debarred from her waters have failed to effect material redress. The offending fishermen, however, contend that the lack of shad is due to river pollution, to the diversion of the current by the construction of the Government breakwater at its mouth, and to other causes not subject to their influence or control.

The early settlers in Massachusetts found immense numbers of shad in the various rivers of the colony, and, following the Indian practice, were accustomed to use their surplus catch as manure, placing a thousand fish to the acre. The Towsers of that day evidently gave trouble, as would appear from the following quaint and amusing town law of Ipswich passed in May, 1644:

"It is ordered that all Doggs for the space of three weeks after the publishing hereof shall have one Legg Tyed up. If such a Dogg should break loose and be founde in any Cornefielde doing any harme, the Owner of the Dogg shall pay the Damage. If a man refuse to tye up his Doggs legg and he be found scraping up Fish in the Cornefielde, the Owner shall pay 12*s.*, besides whatever Damage the Dogg doth."

Of the shad, man, without doubt, is the greatest agent of destruction, although his wasting effort is exerted only within the borders of his own domain; but beyond, in the open sea, the ranks of the migrating horde are thinned by the shark, porpoise, and dogfish, the seal, otter, and salmon, and, most destructive of all, the bluefish. This dread sea butcher works terrible havoc among all neighboring fish not larger than himself, and in the shoals of shad, like those of the menhaden, he revels in slaughter. His opportunity, however, is brief, and perhaps not frequently exercised upon the incoming fish, his earliest appearance in our latitude being usually later than that of the shad. Along New Jersey, however, there have been instances of shoals of shad being driven upon the shore by his murderous onslaughts, the bluefish being a creature that often seems to chop, maim, and destroy for mere amusement.

The shad, after its entrance into our rivers, eats nothing, the one all-dominating impulse being that of the maintenance of its species; for that it braves every danger and endures every hardship. It presses on, sparing no exertion to attain its goal; if it halts or retreats, it is because the temperature of the river current has fallen too low for the development of its ova. It manifests an acute discrimination of gradations of heat, recognizing promptly differences of a degree or even less. In spawning it seeks a temperature of about 60°, and usually deposits its eggs near sunset, when the water is warmest, the place chosen being often the down-stream edge of wide flats, over which the gently flowing current becomes heated to the requisite point. That current thenceforward becomes the foster mother of the deposited ova, its suspended oxygen ever vivifying the slowly developing germ, and, thus cared for, the abandoned and apparently neglected waif waxes apace. As soon as capable of independent movement, the tiny fish, scarce half an inch long, with its yolk sac as yet unabsorbed, strikes out for the deeper portions of the river, its instinct possibly teaching it that to tarry is destruction, for there it would become the assured prey of the minnows, killifish, and other small fry that abide in the shallows. Inasmuch, however, as the young shad possess the continuous dorsal fin along the body incident to the earliest and lowest fishes, the so-called instinct is most likely a reversion to the ancestral habit, such forms being characteristic of deep waters.

Their burden laid down, their object accomplished, the parent fish, worn with privation and spent with effort, turn at last seaward. Emaciated and exhausted, they have become worthless to the fisherman, who frequently observes them dead or apparently dying, drifting down the stream. It is likely, however, that they recuperate rapidly upon reaching the sea, having then access to their customary food, and, if escaping marine carnivora and surviving until the following spring, they renew their arduous voyage, stronger and larger fish, once more to strenuously strive and suffer, but not probably again to return. For the mass of our migratory fish may be likened to some of our familiar wayside plants, that devote their vital energies to the fructification of their seed: with its ripening they wither, with its complete formation they die.

Of the voided eggs, but a very small fraction develop, many are unfertilized, many are devoured by various depredators, many perish by changes in temperature, by floods, or by disturbances of the place of deposit. Of the scanty remnant that become fry, there again results a trifling fraction that mature; many fall victims to innumerable enemies, to lack of sustenance, and to other fatalities. Surviving all these, the young shad in a few months descends the river; then, quitting the fresh water that has nurtured and sustained it, launches boldly out for its distant and unknown home in the obscurity of the great salt sea. Still in its new and strange element does it run the gantlet of danger and death, but instinct guides it to its ancestral abode, whence two or three years later it emerges one of a host of adult fish burdened with a sense of unaccomplished parentage.

Leaving their home in the far deep, the shad, in beginning their annual pilgrimage, rise to the surface and then direct their course landward, the earliest migrants being those in which the propagative function is most advanced. Pursuing their way over the comparative shallows that widely fringe our continent, and joined by other communities bent upon the same devoted errand, they gather in our estuaries and about the mouths of our rivers, and there they linger until the effluent waters are warmer than those of the sea. With the manifestation of this sign the waiting multitude, freighted with a dawning generation that engages their overmastering solicitude, form into rank and column, and with a common impulse set out to conclude their mission of self-immolation and sacrifice for the maintenance of their race.

COMMUNICATED INSANITY.

By CHARLES W. PILGRIM, M.D.

FOR several weeks past it has been scarcely possible to take up a paper without seeing such startling headlines as "Triplets, and all Crazy," "Three Daughters become Maniacs," etc. In fact, so much publicity has been given to the rather unusual number of cases of communicated insanity that have recently occurred in New York, Buffalo, and Philadelphia that the subject has become one of general interest and one upon which accurate information should be given.

The fact that an insane person can, under certain conditions, produce the same form of insanity in another previously sane, or infect him as it were, is indisputable. The French were the first to recognize this fact, and several cases have been reported in L'Encéphale, and other journals, under the term *folie à deux*. It has also been called *folie simultanée* by Régis, and *folie imposée* by Falret.

Although *folie à deux* is not an unusual occurrence, *folie à trois* is quite uncommon, and still rarer, although not unknown, is the evolution of insanity with like symptoms in whole families. Dr. Cramer, in the Allgemeine Zeitschrift für Psychiatrie, reports a most interesting example of the latter kind where a mother and daughter becoming insane, and possessed with delusions of persecution, impressed the same delusions upon the father and five grown-up children. Thus the same form of insanity was imposed upon a family of eight.

Dr. Ireland, in his interesting book The Blot upon the Brain, shows how powerful an influence the insane mind has had upon the sane in the history of religious imposture. He calls attention to the fact that there are people still living who remember Joanna Southcott, who claimed that when sixty years of age she would give birth to the Messiah, and who succeeded in making nearly a hundred thousand people in England believe in her statements.

Brothers, of whose insanity there is no doubt, infected many, and even some among the educated, with his claims to inspiration; and John Thoms, of Canterbury, as late as 1838 collected quite a number of followers whose faith was great enough to make them believe that they would be invulnerable against the attacks of the militia. As a result, Thoms and nine of his credulous followers fell victims to the bullets of the soldiers. But even then all faith was not lost, for many believed that he would rise again within a month. Such psychical epidemics, Kirchhoff believes, are gradually evolved by a sort of "waking suggestion" like the process of suggestion during hypnosis.

An interesting discussion upon the subject of communicated insanity was brought out at the meeting of the Association of Asylum Superintendents in 1887 by the reading of the history of the Pocasset letter-carrier, Freeman, who, with the consent of his wife, who had become possessed of his same fanatical ideas, offered up their son as a sacrifice, in the manner of Abraham. The insanity of the mother was not detected at the time, but in a month she became manifestly insane. As will be seen, this case can not be considered a typical one of communicated insanity, for the remorse and grief which necessarily followed the participation in her husband's fanatical act were sufficient to account for her insanity aside from any influence which he might have had over her. The discussion, however, brought out the interesting fact that several of the superintendents present had had experience with cases which would appear to justify the use of the term "communicated insanity," although others objected to its adoption. One particularly interesting instance was related by Dr. Fletcher, of Indiana, where two brothers and a sister, living on a farm isolated from the rest of the community, became, one after the other, controlled by the same insane delusion. They were Germans, industrious and thrifty, but uneducated and superstitious. The elder brother conceived the idea that the devil had taken possession of their farm and was secreted under a certain bowlder in the barnyard. He imagined that no good crops could be raised until his Satanic majesty had been unearthed. He began searching, and worked for several days rolling up great bowlders until the younger brother, and finally the sister also, became possessed of the same idea, and lent their assistance. They all worked for about six weeks, making an excavation about twenty feet square and fifteen feet deep. They worked so hard and became so emaciated that the neighbors interfered and had them sent to an asylum, where, happily, under the influence of treatment, change of surroundings, and good diet, they ultimately recovered.

Within the past year two sisters have come under my observation whose histories support more fully than any cases with which my reading or observation have made me acquainted the theory that under certain conditions the insane mind may mold the sane mind just as is common with those that are working normally. These two sisters were aged respectively forty-three and thirty; both were unmarried, and, unlike the cases reported by Dr. Fletcher, they were quite well educated and possessed of some literary taste, and were more than ordinarily accomplished in music, both instrumental and vocal. The elder was large, somewhat masculine in appearance, rather aggressive, and possessed of considerable personality. The younger, on the contrary, was quiet, retiring, and more inclined to follow than to lead. Their father was nervous and eccentric, but had never been declared insane. The mother, while living, with the assistance of the sons, maintained a comfortable home, but after her death the home was broken up and it became necessary for the sisters to earn their own livelihood. The younger was particularly fond of music and was ambitious to obtain a musical education. In order to accomplish her desire they decided to go to Boston, where they hoped by sewing and dressmaking to earn sufficient to support themselves, and also enough to give the younger an opportunity to pursue her musical studies. The result was, of course, disappointing, and they were at last obliged to return to the town which they had left, and there begin what proved to be the bitterest struggle of all. Having previously lived in comparative comfort, their surroundings were altogether different when they found themselves alone, struggling to earn their bread by the use of the needle in their native town. It was difficult to obtain the necessary work, and the elder sister after a time began to think that their lack of success must be due to the work of enemies. From this idea systematic delusions of persecution were gradually evolved which influenced her to such an extent that she could not go into the street without thinking she was being followed, watched, and annoyed. These ideas she communicated to the younger sister, who for some time endeavored to persuade her of their falsity. About this time the elder sister developed the delusion that all her acts were due to the influence of the Holy Spirit, and that she and her sister were to be henceforth inseparable, and that they were to act together under all circumstances and in regard to all things. This idea she also communicated to the younger sister, and at last the oft-repeated delusions had their effect and the passive subject became as clay in the potter's hands. The subjectivity of the younger sister was from that time complete, and soon she developed delusions of exactly the same character and of equal strength, until finally neither could go outside the house with any feeling of safety. They became so suspicious that the most ordinary acts on the part of friends or strangers were misinterpreted, and the finding of an ordinary red necktie which had once belonged to one of the brothers led them to believe that he had become an anarchist. From this suggestion the elder sister conceived the idea that three red stars had been placed on the front door to indicate that it was under the anarchistic ban, and in that way warn and drive away any one who might desire to enter for the purpose of offering them work. This idea was, of course, imparted to the younger sister, and immediately the stars appeared as a reality to her. Thus the active agent not only communicated her delusions to the passive subject but actually transferred her visual hallucinations. From this state it was easy to get into a condition where anything red exerted a very disturbing influence over them.* As the insanity progressed aural disturbances manifested themselves, and they were made still more unhappy by hearing noises in the rooms above, which convinced them that their enemies were not content to annoy them only when they went into the street, but that they had actually taken possession of the house in order to keep up their torment. One night the elder sister awakened the younger saying that she heard some one walking in the room above them, and that she was sure that it was some one who had come to do them injury. The younger listened and became convinced that they were in great danger, and both claimed that they could feel the presence of the stranger, although they could not see him, and they both smelled the kerosene oil with which he was to burn the house. Believing that they were in great danger, they began throwing furniture out of the house, deeming that the best way of attracting the attention of the police. While in the act of throwing the furniture out they both screamed: "We can not help it. We are not to blame!" They were, of course, taken in charge, and the next day they came under my care. They were separated at once and placed upon different wards in the hospital. In about four months from the time of admission the younger sister had given up all her delusions and had reached her normal condition. The course of the disease in the elder sister was not so satisfactory, however, and, though much improved, she is still influenced by the ideas which controlled her before admission. From frequent conversations with the younger sister after her recovery the fact was made plain that for several weeks she realized that her sister was insane and fought hard to remain uninfluenced herself. At last, however, the sane mind succumbed to the overpowering influence of the insane one, and she became her sister's second self in word, thought, and act. Of course, this would not have occurred had the condition of things been reversed and had the younger sister been the first to become insane. Neither would it have followed had it not been for the neurotic tendencies of the passive subject coupled with the debilitation due to worry, overwork, and

* This interesting peculiarity reminds us of the dancing mania so graphically described by Hecker in his Epidemics of the Middle Ages. This remarkable epidemic, which began in 1374 in Aix-la-Chapelle and lasted until 1418, when its scene was transferred to Strasburg, was characterized by dancing of the wildest and most abandoned character, which lasted until those who participated in it fell to the ground from sheer exhaustion. Thousands upon thousands were affected by it. Its victims became furious whenever they saw anything red, while on the contrary the same color exerted a remarkable fascination over those who were affected by another form of dancing mania known as Tarantism, which existed later and lasted several centuries.

insufficient food. The close association of the two and the solitary life which they led were also important factors in the case.

I would not for a moment subscribe to the doctrine that insanity is contagious and communicated from one to another, as, for instance, smallpox is, and I altogether repudiate the common idea that it is easy to become a lunatic when compelled to associate with and listen constantly to the ravings of madmen. The immunity of doctors and nurses who live among the insane and associate with them constantly is sufficient proof that under ordinary circumstances, when there is neither hereditary tendency nor neurotic temperament, there is but little danger of being affected by association with the insane. Of course, no medical superintendent would knowingly engage as a nurse one who was ignorant and superstitious, or one who was unduly nervous or inclined to insanity from hereditary influences, and that is probably the chief reason why so few cases of mental trouble occur among those whose lives are passed in the midst of the melancholy wrecks of human minds. This brings to mind the popular fallacy that an insane person is apt to be made worse by being sent to an asylum where he must associate with others who are insane. Experience proves this belief to be entirely unfounded, for as a general thing the insane, being occupied entirely by their delusions, take little notice of their surroundings, and hence the appropriateness of the French term *aliéné*—a stranger to the world in which he lives. Of course, when recovery begins, the situation is different, but even then the associations are not generally injurious, for the convalescing patient often takes an interest in his less fortunate fellow, which does much to promote his recovery, as well as to make him realize that he himself has been insane.

But, notwithstanding my lack of belief in the contagiousness of insanity, I believe, as stated at the beginning of this article, that under certain conditions insanity may be communicated or developed by association, and this paper is written with the hope that some practical hints may be gathered from the observation of cases similar to the ones I have described. It is obvious that when insanity exists in a family it is highly injudicious to subject other members of the family, especially those who are neurotic, to the influence of the insane member. The danger is much greater when the delusions are of a persecutory character, and women are much more liable to be affected than men. Acute mania or dementia are not likely to communicate themselves, but not infrequently a mental breakdown occurs in other members of the family, due to the loss of sleep, confinement, and irregular habits which the home care of such cases involves. When insanity has spread, or communicated itself to another, as it were, the course is plain. Separation must take place at once, and it is not at all unlikely that under new surroundings and appropriate treatment the passive subject will soon be restored to the normal state. But even admitting that under ordinary circumstances the danger of communicating insanity from the insane to the sane is slight, I shall think that this paper has fulfilled its purpose if it does aught to encourage the early treatment of the insane in hospitals especially designed for the care of such cases. Only those who are familiar with the fact appreciate the danger from delayed treatment, and realize how the chances for recovery diminish as the months pass by without hospital aid. From a careful analysis of the cases with which I have had to do during the last decade, the incontrovertible fact is shown that from six to eight persons recover when placed under treatment within the first three months from the beginning of the attack, where only one recovers when hospital treatment is delayed a year. This fact alone suggests in no uncertain tone the early removal of the patient from the influence of home and friends, even though "communicated insanity" should be considered merely a figment of the alienist's brain.

SKETCH OF PROF. LARDNER VANUXEM.

LARDNER VANUXEM was born in Philadelphia, July 23, 1792, and died at his home near Bristol, Pa., January 25, 1848. His father was James Vanuxem, a shipping merchant of Philadelphia, formerly of Dunkirk, France—a man eminent in business and highly esteemed as a citizen and in social and domestic life. His name was originally written Van Uxem; the form was changed by him partly for convenience in writing, but largely because he had become a great admirer of his adopted country and wished to remove the foreign stamp from his cognomen. James Vanuxem's wife, Rebecca, was a daughter of Colonel Elijah Clark, of New Jersey. Of their fifteen children Lardner was the eighth. Seven of these lived to long past middle life, and two of them to ninety and over. His maternal grandmother's name was Lardner.

Of the early educational course of the subject of this sketch there is no record, and no one living has any knowledge. It is thought that he was for a time a student in the Pennsylvania University, but this can not be verified. He entered his father's counting-house as a young man, but business proved very distasteful to him, his mind having been drawn previously to the cultivation of chemistry and mineralogy. He soon determined to give up all connection with business and devote himself to science. Accordingly, his father gave him the advantage of a three years' residence in Paris, at the School of Mines, where he became the associate of Prof. Alexandre Brongniart, the Abbé Haüy, and other distinguished men then prominent as professors in the schools of that great scientific metropolis. There he formed an intimate acquaintance with the late Prof. Keating, of Philadelphia, who in the same walks was drinking from the same fountain of knowledge. Being graduated in 1819, after a short tour through some districts of France, investigating the rock formations, collecting specimens, etc., he returned to this country and his native city, "charged with all the improvements of recent chemical discoveries, and the advancement in all its kindred arts." But he preferred the more abstract pursuit of his studies to the application of his knowledge to the practical arts.

Almost immediately after his return home, he was invited by President Cooper, of Columbia College, in South Carolina, to take the chair of Chemistry and Mineralogy in that institution. Becoming a member of the president's family, a warm friendship was formed between him and each member thereof, which ended only with their lives.

In 1826 he retired from the college and devoted his attention exclusively to geology as a profession. During that year he published in the newspapers and in Robert Mill's Statistics of South Carolina reports on the geology of the State, of which he made a survey or assisted in making one, having previously made one of North Carolina. "He also made quite a collection of minerals and rocks of the State, which were deposited in the University of South Carolina."

He then visited Mexico to examine gold-mining property, of which he had been solicited to take charge. His inspection soon convinced him that no profitable results could accrue to the owners, and he advised that it be abandoned.

In 1827–'28 he studied the geological features of the States of New York, Ohio, Kentucky, Tennessee, and Virginia, under the auspices of the State of New York, and made his report to its Legislature.

It was either at this time or immediately after his return from France that he spent much time in geological investigations in the vicinity of Philadelphia in company with Dr. Isaac Lea, who was his chosen and most intimate friend and associate from his early days to the end of his life. Subsequently Dr. Lea honored him by naming after him a class of fresh-water shells which he had been the first to discover and make known. It is from Dr. Isaac Lea's record of him that much of the information in connection with science, contained in the first part of this sketch, is derived. He also made at times extensive and careful investigations in the franklinite districts and marl beds of New Jersey.

In 1830, having returned to Philadelphia, he purchased a farm near Bristol, Pa., and soon after married a daughter of his neighbor, John Newbold, Esq., of Bloomsdale. His farm remained the home of himself and family for the remainder of his life, about seventeen years. "While he often assisted with his own hands," says Dr. Lea, "in the cultivation of the farm, he never at any moment ceased to cultivate his already extensive acquirements in geology, mineralogy, and chemistry, nor to add to a collection of specimens of great extent and rareness."

In 1836, at the solicitation of Governor Marcy, he entered upon what has been pronounced "one of the most magnificent investigations ever made in the geological developments of any country or by any government"—the geological survey of the State of New York. The results are given in Geology of New York, Third District, Albany, 1842. The Third District, of which Prof. Vanuxem had charge, comprised fourteen counties in the central part of the State. The scope of the work performed by Prof. Vanuxem and his colleagues is thus indicated by Prof. James Hall: * "During the few years of field work the New York geologists had harmonized the conflicting views before entertained regarding the relations of the geology of the eastern and western parts of the State; they had traced the boundaries of the successive geological formations, had shown the extent and limits of the iron-bearing strata, and had rectified the erroneous views which had been held till some time after the commencement of the survey regarding the boundaries and distribution of the salt-bearing formation of the State. They had also shown the limits of the granitic formations and their associated mineral products, the thickness and extent of all the limestone, sandstone, and shale formations of the State, and had definitely settled the relations of the rocks of New York to the coal measures of Pennsylvania and the geological formations of the Western States."

The important service rendered to geological science in the matter of nomenclature by the members of this survey is also described by Prof. Hall, as follows: "Since there was no possibility of identifying the individual rocks and groups of strata with those of Europe, as described, the New York geologists were compelled to give names to the different members of the series; and since the sandstones, limestones, slates, and shales are so similar in different and successive groups, it was impossible to give descriptive names which would discriminate the one from the other. Therefore local names were proposed and adopted—as, for example, Potsdam sandstone, Trenton limestone, Niagara limestone, and Niagara shale (the two latter, with subordinate beds,

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* In The Public Service of the State of New York.

making the Niagara group), the Medina sandstone, the Onondaga salt group, the Hamilton, Portage, and Chemung groups, thus giving typical localities of the rock instead of descriptive names. This method or system of nomenclature leaves no possibility of mistake or confusion which might arise from a different appreciation of descriptive terms. The typical locality always remains for study, comparison, and reference, and there need be no difference of opinion or discussion as to what was intended by the use of any one of the terms. The progress of geological science in the country is greatly indebted to this system of nomenclature, and to the absolute working out of the succession of the groups, and the members of the same, to which this system of nomenclature has been applied."

At the close of the survey he spent some months in Albany (associated with Prof. James Hall) in arranging the State geological cabinet, the specimens of which he had assisted in collecting, and out of which has grown the New York State Museum. His name was given by his colleagues to several species of the fossils discovered in the course of the survey, and in 1858 Mr. Elkenah Billings named a genus (discovered in Canada) in his honor.

Prof. Vanuxem's private collection of minerals and geological specimens was considered at the time of his death as "the largest, best arranged, and most valuable private collection in this country." The shell and mineral specimens were fine and many of them very beautiful, but it was the geological department, with its numerous specimens of rock and fossil and the perfect arrangement of the whole, giving to the investigator, in the best manner possible, the information sought, and all arranged by his own hands and methods, that constituted its chief value. It was constantly visited by eminent scientists both of this country and from abroad. Prof. Agassiz, Sir Charles Lyell, and Dr. Nicolay were drawn to it on more than one occasion. Those who were in the habit of visiting it most frequently, both from interest in it and its possessor, seemed to be filled with enthusiasm, of whom were Dr. Emmons, Dr. Beck, Prof. Timothy Conrad, Dr. Locke, of Cincinnati, and many others. On one occasion, while engaged on the United States Coast Survey, Dr. Locke brought all his paraphernalia of work and his assistants, pitching his tents in a field on the Vanuxem farm near the house; there he remained for some weeks, continuing his work, at the same time availing himself of the opportunity of study in and examination of the cabinet, making numerous casts of the specimens, especially the rare fossils.

After his death, Prof. Vanuxem's collection was purchased by W. M. Stewart, President of Masonic College at Clarksville, Tenn. It was reported that during the civil war the collection was dissipated and destroyed, but this rumor could not have been wholly true, for part if not all of the specimens are still there. In May, 1892, one of Prof. Vanuxem's daughters was applied to for information as to the whereabouts of this collection, by a geologist, as it contained, he said, the only known specimen of a certain South Carolina fossil, which he very much desired to examine.

Prof. Vanuxem was a member of and assisted in the organization and establishment of the Philadelphia Academy of Natural Sciences and other scientific associations.

"It was the habit of those connected with the New York survey to meet at Albany at the end of each field season, for the purpose of comparing observations and becoming acquainted with each other. In the autumn of 1838 Prof. Vanuxem suggested that an invitation be extended to the geologists of Pennsylvania and Virginia for the purpose of devising and adopting a geological nomenclature that might be acceptable to all those who were then engaged in the State surveys, and thus become the nomenclature of American geology. This meeting was finally held in 1840, and then the Association of American Geologists was organized, which is now succeeded by the American Association for the Advancement of Science, one of the largest scientific bodies in the world."

Some few years after the close of the New York survey, Prof. Vanuxem was solicited by Prof. Henry, of the Smithsonian Institution, at Washington, to become his associate in charge of that institution. Although it would have been a work in many ways congenial, the offer was declined, for various reasons that he deemed good ones.

In addition to the report that has been mentioned, and numerous papers on scientific subjects published in the American Journal of Science, he published An Essay on the Ultimate Principles of Chemistry, Natural Philosophy, and Physiology (Philadelphia, 1827); but it is his Report of the New York Survey which it is said "will remain his monument, and on which the reputation of his scientific attainments is based."

It would seem as though a man as devoted to science as the subject of this sketch would have his time and thoughts completely absorbed thereby, but not so in this case. The investigating turn of his mind prompted the examination of abstruse subjects, and to him the Scriptures presented an unlimited field. His careful scrutiny of the sacred writings and close study of all the extant commentators upon them resulted in an immense pile of manuscript books which he left as a monument of his interest in the subject, untiring industry, perseverance, and love of research, if nothing more. Although trained in the Presbyterian faith by his mother, Prof. Vanuxem had adopted, and expressed in these writings, views which were too broad and too far in advance of the time to be considered "orthodox."

Every attempt to extend the bounds of human knowledge or to give the benefit of enlightened direction to the activities of mankind aroused his interest. His attention was thus drawn to the so-called new religions, Mormonism and Millerism, as they arose; to the religious teachings of Channing and Emerson; and to the study of Egyptian antiquities. He studied phrenology, and became a believer in its theories. At a time when the subject had hardly been thought of he was a strong advocate of the emancipation of woman from the narrow sphere of activity to which she had been confined. General literature did not have the absorbing interest for him that scientific subjects did. As for music, it appeared to have no charms in his eyes; he declared that far too much time was wasted over it. This fact seems rather unaccountable, as all his brothers and sisters were devoted to the art, and some of them proficient in it.

For Benjamin Franklin's character and achievements he had the highest admiration; honoring himself and his place by naming it after him "Franklin Farm," and the entrance hall of the house was adorned for many years by a bust of the great man; attention often being called to it as "the presiding genius of the place."

To complete the picture, even of a man of science, the social and domestic side of his character and life as well as daily occupations must not be omitted. He was kind and gentle in manner and speech, his somewhat quick temper being under complete control. Though his children stood rather in awe of him, as did many others (of his subordinates), he ruled them by affection and "treated them as intelligent beings," as he said, the result being the most implicit obedience.

His active mind was engaged frequently upon subjects requiring deep thought while his hands were executing works of minor importance. On being asked why he did not plow his own fields, he would reply that he never liked to engage in any manual labor that absorbed the whole attention, as he desired to keep his mind free for other matters. His knowledge of chemistry was brought into use in the cultivation of his farm—much to the amusement of his less enlightened neighbors, who did not believe in "book farming." He had learned the use of carpenter's tools when a boy, for his father, in order to keep his sons off the street, had wisely provided them interesting occupation at home by fitting up a shop for their use. Prof. Vanuxem turned his skill to account in making the cases and chests of drawers in his cabinet—a room measuring about fifteen by twenty-five or thirty feet—and otherwise as occasion required.

"Always cheerful, intelligent, bright, and full of anecdote," it has been said of him, "he was gladly welcomed into every social circle." Both frugality and generosity were prominent traits of his character. More than once did he take into his household, for indefinite periods, young relatives who needed assistance. His table was abundantly supplied and his house was well furnished with comforts, but extravagance in anything he strongly deprecated, especially in dress. "Love of dress," he used to say, "had caused more sin than anything else in the world."

Careful and neat to an extreme himself in his habits and arrangements, he exacted the same from those around him as far as possible. Of the courtesies and conventionalities he was most scrupulously observant, and was greatly annoyed by any breach thereof, as when any of his Quaker neighbors, coming in, would sit with hat on in the house. Obedience to the "golden rule" appeared to be the guide of his life, as he was wont frequently to hold it up to his children, that they should make it theirs.

He had the reputation of being visionary and full of untenable theories. This may have been true to some extent, and it would certainly have appeared to be the case even if not so, for it was often said by his scientific contemporaries that "he lived too soon, being many years in advance of his times; people were not prepared for his discoveries and theories, and therefore not able to appreciate them, even the scientific world." He was considered also "a very peculiar man," which was not surprising, in view of his independence of general opinion, in following out what he considered the right or best course in any matter. As an illustration might be given a description of his equipment for the New York survey. It consisted of a four-wheeled wagon with buggy top, covered with white canvas for coolness, with a box at the back large enough to hold his requirements for the season, and working implements. This was drawn by a large, rusty-brown mule, very far from handsome, but strong, trusty, faithful, with powers of endurance much beyond those of a horse. He was often not a little amused at the comments and ridicule that this equipage provoked, but it was the thing that best answered his purpose, so he went on his way and let them laugh.

Finding it necessary to turn his acquirements to some pecuniary advantage, was one of the inducements of Prof. Vanuxem to engage in the New York survey. The working for "pay" was one of the things for which he had a great aversion, "a feeling," as he writes, "he never could conquer." He wanted to be able to work for the public without charge and not feel that his time belonged to some one who had a right to its control; he was too conscientious to feel any freedom when under bonds of this sort.

Physically Prof. Vanuxem was below the average in height, rather slightly built, active, energetic, with great powers of endurance, and persevering in whatever he undertook. He was always in good health, being "temperate in all things," and, though often furnishing wine for his guests, declining the use of it himself, as he said he wished to keep his head always perfectly clear. To tobacco in all its forms he had a great aversion. One of his theories was that human life was much too short, either because of too much luxury and self-indulgence on the one hand, or lack of proper sustenance on the other. By striking the happy medium, he believed life might be indefinitely prolonged. His last illness was of about three weeks' duration, and caused by a carbuncle on the upper lip. After a time the brain became affected and unconsciousness ensued, which continued uninterruptedly until he passed away, having seen but fifty-five and a half years. This early ending of his life seems like the irony of Fate! The many letters received by the family after his death, from those with whom he had been associated in his scientific career, filled with such heartfelt expressions of sorrow and regret for the personal loss and the loss to science, attest to the estimation in which he was held by them all.

The original of the likeness accompanying this sketch was a daguerreotype—the only portrait of any kind ever made of Prof. Vanuxem. This was taken in a group in 1846, in the early days of the art, when the arrangement of dress and pose was not understood so well as afterward. Hence the eyes, said to have been his best feature, are unfortunately cast down, as he was told to look at the child seated on his knee. The portrait is like him, but has not the pleasing aspect his countenance always wore.

It appears from a discussion by Prof. Holden, of the Lick Observatory, of the smallest object on the moon that can be registered on the photographic plate by the three-foot refractor, that a crater on that star less than one tenth of a mile in diameter will form an image that is about the same size as the grains of silver in the photographic film, and can not in general be distinguished. Craters not more than three tenths and fifteen hundredths of an English mile in diameter, however, have been detected already. Prof. Holden concludes that for further advances in lunar photography it will be necessary to employ plates of greater sensitiveness so as to shorten exposure, and also plates in which the grain is finer.

The "southerly bursters" of Australia are storms that occur very suddenly, and mostly between November and February. A fresh northeasterly wind may change in ten minutes to a gale from the south, doing much damage to vessels that may be unprepared. The storms are always accompanied or preceded with great electrical excitement, and cause a considerable drop in the temperature. The wind velocity used to reach from sixty to eighty miles an hour, and on one occasion attained the rate of more than a hundred and fifty miles an hour, in a gust. Latterly, however, the wind seldom exceeds fifty miles, and generally ranges between thirty and forty miles an hour. The average annual number of storms is thirty-two.

EDITOR'S TABLE.

WIDENING THOUGHT.

WE do not know a more encouraging sign of the times than the vastly improved *entente* now existing between those two forces, which only a generation ago seemed to many to be irreconcilable enemies—science and religion. There were not wanting, at the time we speak of, wise men who asserted that the conflict between these two must be the result of misunderstanding; but, in general, the partisans of religion were convinced that any science, so called, which threatened their special beliefs must be absolutely false, while some at least of the partisans of science were disposed to hold that, because some specific theological tenets had been proved unsound, the whole basis of religion had been shattered and destroyed. Of course, remnants of these errors may be found lingering here and there even now; but in centers of thought and culture very different ideas have begun to prevail. We noticed some time ago, in another department of the Monthly, an excellent work by the esteemed President of Rochester University—Genetic Philosophy—which was thoroughly in line with all that is best in the modern scientific spirit; yet Rochester University, if we mistake not, is an institution under the control of the Baptist denomination. More lately still we called attention to the liberal and hopeful utterances of the Presbyterian clergymen who were celebrating the jubilee of Knox College at Toronto, Canada. We now find an admirable article in the December number of The New World, bearing the title Science a Natural Ally of Religion, which again we may credit to the Baptist denomination, as it proceeds from the pen of Prof. E. Benjamin Andrews, of Brown University, Rhode Island.

According to Prof. Andrews, who states his case very well, it has come to this, that science, which bigots and fanatics on one side or the other once accounted the natural foe of religion, can and must now be claimed as its natural ally. Science, Prof. Andrews tells us, has done the work of religion in unifying human knowledge, and thus leading our thought by necessary stages to the recognition of one First Cause of all things. We have been led to see that there are not *forces* in the world—that there is but one *force;* and we have been set free from the crude materialism which unintelligently deified matter as the one self-existent reality. The doctrine of evolution, far from being an impediment to religious faith, "opens the way for an apprehension of the Divine Being and his modes of procedure far more rational, helpful, and uplifting than the time-honored creationist view." Or, as he otherwise expresses it, we see in evolution "simply the slow march of creative energy." The old idea represented the Deity as forming a plan, just as an architect might design a house, and then, when all the details had been worked out, proceeding to realize it. According to the evolutionist view, "we can not think of the Divine Being as ever having been without a world. He creates from all eternity, and the product each instant is a brand-new work entire, which, though God's creature, is yet not external to him, but rather the sign of his own living, throbbing presence."

Science, Prof. Andrews further claims, has rendered philosophic skepticism henceforth impossible—such skepticism, for example, as that of Pyrrho of Elis and the later Academics. How far this is true, as a matter of exact logic, we are not prepared at this moment to say; but what science undoubtedly has done is to render the tone of mind of the ancient skeptics almost impossible in the present day. With so vast an amount of truth demonstrated for all practical purposes, so that it daily serves as the basis of action in the present and prediction for the future, no one not a born sophist would care to take up the Pyrrhonic parable that knowledge is an impossibility. By increasing to so vast an extent the compass of human knowledge and revealing the mutual interdependence of phenomena, science has made for every one of us an intellectual system vastly surpassing in solidity anything that was possible for Plato and his contemporaries.

We are not concerned, however, to indorse all the expressions used by Prof. Andrews; what we wish to call attention to is his cordial acceptance of the methods and conclusions of science, and his emphatic assertion that not only does he find nothing therein to impair religious faith, but that, on the contrary, he regards science as rendering an indispensable assistance to such faith. We have ourselves, on more than one occasion, put on record our belief that the religious instinct in man is an essential part of his nature; so that, closely as it may seem to be connected at any time with particular dogmas, it will not perish if those dogmas should be overthrown, but will appropriate to itself other intellectual forms that will serve its purpose as well as or better than the old. The article we have been considering is an example and proof of this. The doctrine of evolution has become to Prof. Andrews and to those who think with him—and they are many—almost a religious symbol. It has certainly become to them a means of expressing religious as well as scientific thought. Religion, after all, is simply the overflow of the human heart toward a transcendent power which reveals itself in us, if not at all times, at least in our best and highest moments. We find it nobly exemplified in a passage of the heathen sage Epictetus: "If we had understanding," he says, "ought we to do anything else both jointly and severally than to sing hymns and bless the Deity, and to tell of his benefits? Ought we not, when we are digging and plowing and eating, to sing this hymn to God? 'Great is God, who has given us such implements with which we shall cultivate the earth; great is God, who has given us hands, the power of swallowing, a stomach, imperceptible growth, and the power of breathing while we sleep.' This is what we ought to sing on every occasion, and to sing the greatest and most divine hymn for giving us the faculty of comprehending these things." Coming down to our own century, the poet Coleridge expresses in a few pregnant words, but from another point of view, the essential nature of religion when he says in one of his translations from Schiller:

> "For the stricken heart of love
> This visible universe and this common world
> Is all too narrow."

In Epictetus we see the overflow of the glad heart, while Coleridge tells us of the overflow of the sorrowful heart. The aspiration and exultation of the one and the yearnings and pleadings of the other meet in the common thought of God. This is religion divorced from dogma, religion which no scientific investigation, no development of knowledge, can ever shake or annul. Science henceforth is free to work in its own sphere, by its own methods, and religion is free to comfort, to elevate, and purify human nature by bringing it into contact and relation with the thought of that which is highest and best and most enduring in the universe, with the thought of a Justice that is above human justice, a Love that is above human love, and a Sympathy that is denied to none. When we think of science and religion in this way we see how natural it is that they should act in unison, the first revealing more and more of the beauty and order of the world, the second giving its sanction and aid to what we may call the transcendent effort and impulse of the human mind. In view of this common ministry of blessing how petty seem all the disputes of the past! Let us hope that we have heard nearly the last of them, and that, henceforth, as the poet says:

> "Mind and heart, according well,
> May make one music as before,
> But vaster."

A DISEASE OF MODERN LIFE.

In a recent number of the Contemporary Review Prof. T. Clifford Allbutt discusses in a very interesting and instructive manner the question whether, as commonly alleged, nervous diseases are much more prevalent in the present day than they were a generation or two ago. His conclusion is that such is not the case. He disputes, in the first place, the statistics which seem to show that insanity is greatly on the increase; and, in the second place, maintains that in a great many cases in which the nervous system is affected the trouble is not primarily nervous at all: the nerves have been implicated through disorder in other regions of the body. He believes that some of the conditions of city life are unfavorable to the health and vigor of the so-called laboring classes; but he thinks that, on the whole, there is a marked increase of vitality and power in the more favored classes. "I do not hesitate to say"—we take pleasure in quoting this encouraging statement—"that when I look back upon the young men and women ot forty and thirty years ago, I am amazed rather at the physical splendor and dashing energy of our young friends of to-day. The world seems to have filled with Apollos and Dianas; cheap food and clothing, improved sani tation, athletics that bring temperance with them, frequent changes of air and scene, and a more scientific regulation of all habits, seem since my adolescence to have transformed middle-class youth, and the change is rapidly spreading downward." Women, the professor says further, seem especially to be changed for the better. "Freedom to live their own lives and the enfranchisement of their faculties in a liberal education, which, physically put, means the development of their brains and nerves, seem not only to have given them new charms and fresher and wider interests in life, but also to have promoted in them a more rapid and continuous flow of nervous spirits, and to have warmed and animated them with a new vitality both of body and mind." The professor is eloquent, but no one will affirm that on such a theme eloquence is misplaced. The question may now be asked, If there is so much cause for congratulation in the physical and mental condition of the present generation, where do we find the darker lines of the picture? Our headline speaks of A Disease of Modern Life. What is it?

The disease of modern life which Prof. Allbutt recognizes is lack of self-control. It is not that nerves are too excitable—their business is to be excitable, he remarks—but that a certain power of what may be called inhibition is largely lacking. What is wanted is not that there should be less sensibility, but that sensibility should not be confined so much as it is to the external parts of our nature. Let sensibility be more profound, and the whole man will be a gainer. We can not do better, however, than quote the professor's own words: "As we become more and more able to subordinate the impressions of the moment, and compare them with our stores of previous impressions, we learn that momentary realities, keen as they are, must take their places in the larger sequences of that beautiful instrument which harmonizes our joys and resolves our discords; we learn anew that happiness lies in the pleasures which abide and in the selection of permanent beauty and truth from the bitter-sweet of passing delights. . . . As the common mind of successive generations, by sifting and sublimating its experiences and conceptions, discovers its classic thinkers and its classic artists, so, in the life of the individual man, should experience be refined and conceptions enlarged until our desires and pleasures are purged of their grosser and more transient accidents." This is well put, and so is the following: "The discipline which leads us to avoid the eddies of the current and to move in the larger periods of human life and thought, which reveals to us the fugitive and deceitful nature of selfish gratifications, and the abiding joy of devotion to higher ideas, is medicine for neuroses. We preach no self-denial for its own sake, but renunciation of the harlotries and enchantments which minister to transient joys in oblivion of the future."

This is wholesome reading for those who, because they weakly yield to superficial impressions and momentary gusts of feeling, think themselves the victims of an extraordinary refinement of nervous organization. What such persons have, judging merely by the outcome in action, is an inferior nervous organization, one which is all activity on the surface and all inertness below the surface. Professor Allbutt seems to think, however, that in many if not in most cases the deeper regions of the nature might be stirred if a proper discipline were employed. He does not compare the too facile nervous responses which so many exhibit to the imperfect physical habits of breathing, eating, walking, etc.—which are also widely prevalent; but he evidently regards the former as a phenomenon quite akin to these, and therefore more or less remediable by proper measures. The only remedy that unaided Nature knows is suffering, which long centuries ago the sages of the human race saw and proclaimed to be the great teacher of virtue and wisdom; and possibly the function of suffering in this respect will never become wholly obsolete. Prof. Allbutt, however, thinks that proper educational influences might do a great deal to redeem human life from the sway of the momentary. One's heart does fail just a little at the thought of combating by educational effort anything like a general tendency—of trying to induce forces to take a line of greater rather than one of less resistance; and yet the duty of making the attempt seems to be plain. The evil with which we have to contend is in full sight. We see it in all the devices now existing in such profusion for reducing intellectual labor and the strain of attention to a minimum. We see it in flashy newspapers, in idle illustrations, in chopped-up articles, in manufactured witticisms of irredeemable and inexpressible inanity, in shows fit only for children offered for the entertainment of men and women, in vapid social amusements, in a general impatience of whatever is serious and solid, in the levity with which attacks on fundamental institutions of society and established rules of morality are regarded, and in numberless other signs of a prevalent disposition to treat sensuous pleasure, however fleeting and however unworthy—so long as it fills a vacant moment—as the one intelligible end of existence. The teaching, if we understand Prof. Allbutt aright, which he thinks might be greatly influential in mending this state of things, is the teaching of social duty. "I speak as a physiologist," he says, "when I say that, in the growth of higher and more penetrating conceptions of national life, and in the increasing sense of security, efficiency, and vigor which result from organization, we shall find the cure for the irregular nervous outbursts, moods of despondency, and waste of effort which we certainly have continual cause to lament." At present, he adds, while we "minister to impressions that are skin-deep and transitory, we leave vast inner tracts of the nervous system uncultivated." One great cause of the evil may lie in the fact that to-day a certain superficial education is all but universal—an education which favors a superficial life—and that the education which reaches those deeper tracts that the professor speaks of is, through the spread of the other, becoming increasingly scarce. The true note of a high education is generous enthusiasm; the equally true and authentic note of an inferior education, even though conducted within the walls of a famous university, is the spirit of selfish competition. The world never had so many teachers by profession as it has to-day; but possibly it never lacked teachers in the highest sense more than it does to-day—teachers who are fountains of inspiration to all who come within their influence, because, in their teaching, deep calls to deep, and the nature of the pupil is inwardly molded into the image of a true humanity; not merely fashioned from without into fitness for a struggle in which the hindmost is piously consigned to — the best help he can get.

LITERARY NOTICES.

From the Greeks to Darwin. An Outline of the Development of the Evolution Idea. Columbia University Biological Series. I. By Henry Fairfield Osborn, Sc. D. New York: Macmillan & Co. Price, $2.

Prof. Osborn has undertaken in this work the interesting and useful task of tracing from the earliest times down to the present day the course of speculation and discovery which resulted in the establishment of the Darwinian theory of the origin of species by natural selection. This being his specific task, we could wish that the author had drawn more clearly the distinction between the discovery and enunciation of the law of natural selection and the discovery and enunciation of the law of evolution in its most comprehensive sense. We do not, indeed, find this distinction drawn anywhere throughout the work; on the contrary, we find in many places a somewhat loose application of the wider term evolution to the narrower theory of natural selection, with a certain amount of resulting confusion. "The evolution law," he tells us, "was reached not by any decided leap, but by the progressive development of every subordinate idea connected with it, until it was recognized as a whole by Lamarck and later by Darwin." Compare this with Prof. Huxley's statement of the case: "In the Origin of Species, and in his other numerous and important contributions to the solution of the problem of biological evolutions Mr. Darwin confines himself to the discussion of the causes which have brought about the present condition of living matter, assuming such matter to have once come into existence. On the other hand, Mr. Spencer and Prof. Haeckel have dealt with *the whole problem of evolution* (Italics ours). The profound and vigorous writings of Mr. Spencer embody the spirit of Descartes in knowledge of our own day and may be regarded as the Principes de Philosophie of the nineteenth century." (See Collected Essays, Vol. II; also Encyclopædia Britannica.) Prof. Osborn tells us, referring to Darwin, that "in the middle of this century came the man who ranks as the great central thinker." This was certainly not Darwin's estimate of himself. His strong point, as he often remarked, was observation. He looked at his facts hard and long until they seemed to teach him something, but he expressly disclaimed any special talent for generalization. This he recognized as belonging to Mr. Spencer in an altogether eminent degree. "I suspect," he wrote to Prof. Ray Lankester, "that hereafter he will be looked at as by far the greatest living philosopher in England; perhaps equal to any that have lived."

Nothing could be further from the wish of any one connected with this journal than to belittle in any way the work of Charles Darwin. That he was the author of a great and fertile idea which has worked almost a complete revolution in biological method all the world is aware. It is only a month or so since we quoted in these very columns the testimony borne by Prof. Huxley to the value and importance of the Darwinian theory as formulated and understood by Darwin himself. We desire, however, that justice should be done to others as well as to Darwin; and if there is not in the work before us a deliberate attempt to ignore the claims of Herbert Spencer as an exponent of the theory of evolution we are greatly deceived. Turning to the index, we find the following entry: "Spencer, early publications, 215"—that and nothing more. Turning to page 215, we find it mentioned that Spencer was "one of the few out-and-out evolutionists before the publication of the Origin of Species." A reference is made to two of his early essays as bearing this out, and the following quotation is given from one of them: "Any existing species, animal or vegetable, when placed under conditions different from its previous ones, immediately begins to undergo certain changes of structure fitting it for new conditions." In all (including the quotation), sixteen lines of large type are allotted to Mr. Spencer; and this is his share in the volume. In the bibliography at the end of the book there is *no mention of his name;* not even the two early essays referred to in the index are allowed a place. Yet one of the headings in the bibliography is, "The Natural Philosophers and Speculative Evolutionists." Mr. Morley is there, on the strength of his work on Diderot and the Encyclopædists; and G. H. Lewes, on the strength of an article published in Fraser's Magazine in 1857; Mr. Fiske is there, very properly, on the strength of his Cosmic Philosophy; but Mr. Spencer's works, on which Cosmic Philosophy is professedly based, are absolutely ignored. How is this to be explained? It would be ridiculous on our part to enter upon a serious argument to prove that, as a "speculative evolutionist," Mr. Spencer occupies simply the foremost position in the world to-day. Darwin fully recognized the fact; Huxley recognizes it; Mr. Sully, who has gone over very much the same ground as Prof. Osborn, says that "the philosopher who has done more than any one else to elaborate a consistent philosophy of evolution on a scientific basis is Mr. Herbert Spencer"; Mr. Leslie Stephen, in the introduction to his Science of Ethics, speaks of Mr. Spencer as "the leading exponent of the philosophy of evolution," and of his having "worked out an encyclopedic system of which his ethical doctrine is the crown and completion"; Geddes and Thomson, in their very able work on The Evolution of Sex (Contemporary Science Series), refer repeatedly to Spencer, and say pointedly that to him is due "the first adequate discussion of growth." But why multiply opinions? Mr. Spencer is not beyond disparagement, or attempted disparagement, by smaller minds; but in the judgment of the foremost men of the present day his position as an original, powerful, and most fertile thinker, in regard to the problems of evolution in general and of biology in particular, is decisively established. The omission, however, of Mr. Spencer's name is not the only peculiarity of Prof. Osborn's bibliography. We look in vain for the names of Romanes, Grant Allen, Patrick Geddes, J. Arthur Thomson, and Andrew Wilson, not to mention any others. It can not be urged in explanation that the bibliography only comes down to the date of Darwin's Origin of Species, because it contains dates as recent as 1892. We can only conclude, therefore, that a partisan effort is being made to keep as much as possible from the knowledge of Columbia students in biology not only Mr. Spencer's work in biology and the general theory of evolution, but that of other writers who recognize the commanding position which he occupies.

The historical sketch, which the work before us purports to give, is in general well done, and the student who masters it will have a tolerably correct and complete idea of the work of Darwin's predecessors. To many doubtless the information given will come as a surprise, so widespread is the idea that evolution sprang in full armor from the brain of Darwin. Darwin himself was surprised when he took to reading Buffon. "I have read Buffon," he says in a letter to Huxley; "whole pages are laughably like mine. It is surprising to see how candid it makes one to see one's views in another man's words." Darwin was a man who was candid at all times, and not only candid but generous. Were he still living he would be foremost in regretting that a book written, as we may say, in his honor should have done so much less than justice to one whom he honored and esteemed so highly.

Fundamental Problems. By Dr. Paul Carus. Second edition, enlarged and revised. Chicago: The Open Court Publishing Company. Pp. 373. Price, $1.50, cloth; 50 cents, paper.

This attempt to present the method of philosophy as a systematic arrangement of knowledge is a collection of essays that appeared originally as editorial articles in The Open Court, revised in the light of the criticisms they then drew out. The author has endeavored to avoid originality; that is, to introduce as little as possible of his personality and his private sympathies with, or antipathies against, other solutions. Philosophy is presented as the most practical and most important science, because its problems lie at the bottom of all the single sciences; and as furthermore the foundation of the rules of our conduct. In this book is proposed a philosophy of most radical free thought, unincumbered by the excrescences of negativism and hedonism, "that is, no negativism, no agnosticism, and no metaphysical mysticism, but a systematic arrangement of positive facts"; and religion and modern science, ethics and politics, industry, mercantile enterprise, and socialism, in their present existence, are regarded as alike based upon the teaching of the positive school. In this second edition of the work are inserted an introductory chapter on Ontology and Positivism, and an appendix containing the author's replies to his critics.

Electricity at the Columbian Exposition. By J. P. Barret, Chief of Department. Chicago: R. R. Donnelley & Sons' Company. 1894. Pp. 501.

The author modestly disavows claims to originality in the composition of this work, and characterizes it as nearly resembling a compilation. He deserves credit for the excellent manner in which he has done his work. The general introduction gives a brief account of the electrical expositions previous to 1893. The introductions to the several chapters present a scientific though cursory survey of the various applications of electricity and their bearing upon the exposition. The great extent of the department made it impossible to describe all the exhibits; only the unimportant ones, however, were omitted, and the book as a whole presents a good general view of the electrical exposition, together with a large amount of detailed information concerning the various branches of electric art as represented at the fair. Arts and industries in general are dwelt upon where they have any bearing on electricity. Everything is up to date, even Moisson's process for the preparation of artificial diamonds being brought in in connection with electric furnaces. The various branches of electric industry are so closely allied to each other that it is often pretty nigh impossible to draw a line of separation between them; and, though the matter is is well arranged and classified, the specialist will have to consult most, if not all, the chapters in order to obtain full information in any connection. The typographical appearance of the book and the numerous illustrations deserve high commendation.

The Psychic Factor. By Charles Van Norden, D. D., LL. D. New York: D. Appleton & Co. Pp. 223. Price, $1.25.

This volume, although intended as a manual for students, gives in a very readable form what is known of the working of mind experimentally and physiologically, as well as by introspection.

Matter, life, and mind are stated to be three ultimates which psychology can not explain. The hypotheses which philosophers hold in regard to them are classified as materialism, idealism, ideal realism, monism, and the popular one of matter and mind. The author considers that "there is no beginning place for mind anywhere" in the evolution of life, therefore the original cell must be psychic. The unfolding of the mental process is traced from the oxygen sense of bacteria and the sunshine quest of Desmids through plant life and animal life to the human brain. In this progress there are three marked steps—the appearance of protoplasm, the specialization of cells, and the co-ordinating of function. A study of the nervous system generally, and of its development in the various orders of life according to increasing complexity, complete the comparative view of the psychic factor.

In man we come upon the fact of consciousness. This is defined not as a name for a series of mental states, but as a recognition by mind of itself. It is held that even in the lower forms of life there may be "a dim awareness of their psychic acts." Attention and the unchaining of mental states are given as the two functions of consciousness.

The author revels, however, in the realm of subconsciousness. Sleep, dreaming, somnambulism, hypnosis, thought-transference, lucidity, and hallucinations are so many doors by which knowledge may enter unhampered by sense. The consideration of criminality is given in the psychology of disease. Newspapers and novelists are justly arraigned for their responsibility in spreading the contagion of vice, and wholesome suggestions in regard to education are given.

Mind in detail is taken up in part second and begun by an outline of the evolution and action of the sensory and motor end organs. In the thirty first chapter an analysis of the cognitive powers is first reached. The old-time division of the mental processes is retained as useful, though the mind is not endowed with any faculties, these being only different phases of psychic action.

It is a little to be wondered at that the author of this work merely enumerates the name of Comte in a list of materialistic philosophers whose theories are annihilated, yet employs the well-known Comtian law to describe the progress of the sciences, including psychology. Blank ignorance is made to precede the theological, metaphysical, and positive stages, which are euphoniously called periods of superstition, speculation, and exactness.

The spirit of the book is claimed to be "strictly scientific" and its purpose "to embody the trustworthy results of safe thought." This aim appears to have suffered an eclipse in the following statements: "When mind and life depart in death, the matter remains, so far as science can discover, chemically and physically the same." What about the coagulation of the blood and the whole process of disintegration? Is organized and unorganized matter identical? Thought-transference is also declared to be "a subconscious gift" whose *demonstration* is recent; "correlated" with this is "the no less amazing *fact* of lucidity or second-sight" due to a supersensuous vision which discerns beyond the reach of any known organ. The clew to this rash advocacy seems to be that "this discovery removes from the theological doctrine of a divine inspiration the stigma of violating probabilities."

Accuracy is pronounced impossible; "all sciences have to be regularly readjusted every few years."

Barring the questionable science of these passages, the book is brimful of information and good advice. It is well arranged, clearly written, and can hardly fail to benefit as well as to attain popularity.

Practical Work in General Physics. By W. G. Woollcombe, M. A., B. Sc. New York: Macmillan & Co. Pp. 83. Price, 75 cents.

A course of fifty experiments is provided in this little manual, comprising measurements of lengths, areas, and volumes, determinations of the density of solids, liquids, and a gas, the use of hydrometers and barometers, and a few relating to the pendulum and capillarity. Considerable attention is given to careful measurement, the sliding callipers, micrometer screw-gauge, the chemical balance, and the opisometer being used, with a vernier attachment wherever it is applicable.

Lectures on the Darwinian Theory. Delivered by the late Arthur Milnes Marshall. Edited by C. F. Marshall. New York: Macmillan & Co. Pp. 236. Price, $2.25.

This volume consists of a series of lectures delivered by the late Prof. Marshall in connection with the extension lectures of Victoria University during 1893. The author having failed to elaborate them and prepare them for publication himself, not all the parts are written out in detail, and there is a consequent variability in the fullness of the text; nevertheless, having been delivered by one of Darwin's most earnest disciples, they are believed to form a useful introduction to the literature of Darwinism. They present the History of the Theory of Evolution; Artificial and Natural Selection; The Argument from Palæontology; The Argument from Embryology; The Colors of Animals and Plants; a review of the objections to the Darwinian theory; the origin of vertebrate animals and the descent of man; and a summary of the life and work of Darwin. The author, summarizing his own work, defines as the position which he has endeavored to establish, that there are causes which have been in existence since life began that will account for the structure, life, and habits of man, and that have tended in this direction; but "whether there is anything further than this; whether man has other attributes, either peculiar to himself, or held by him in common with other animals; whether there are attributes that can not be explained by these laws, are questions with which science has nothing to do."

Physical Laboratory Manual. By H. N. Chute, M. S. Boston: D. C. Heath & Co. Pp. 213. Price, 80 cents.

The author of this manual is not one of those who would teach physics through laboratory work exclusively. The pupil, he says, "should come to the laboratory well grounded in the first principles of physics as presented in some elementary treatise on the subject, and well read, especially, on the subject that he is to investigate, both as to mode of conducting the work, and manner of observing." Leaving the laws and principles of the science to be presented in a separate volume, this manual gives only directions for experiments. These directions consist regularly of a brief statement of the problem, a list of the apparatus required, the details of what is to be done, under the heading Method, and a tabular form of record. Sometimes the statement of method is supplemented by remarks. Cuts showing the proper arrangement of apparatus accompany the directions in many cases. Prefixed or appended are aids for both pupil and teacher relating to the management of the work, and making and manipulating apparatus, also many tables for reference. The book is adapted to pupils of high schools and academies.

School English. By George P. Butler. American Book Co. Pp. 272. Price, 75 cents.

The increased attention which is now given to the study of English in secondary schools has stimulated the production of rhetorical text-books as well as the republication of English classics.

Some knowledge of rhetoric is plainly a necessity, not only in order to analyze the beauties of the masterpieces of literature, but that the pupil may recognize the faults in his own composition. The newer manuals which have been prepared for this purpose give too many regulations and a superfluity of extraneous matter. The author of this work, an experienced teacher, considers that twenty rules are sufficient to fortify young writers against common mistakes in construction. He succeeds not only in simplifying these directions, but in the chapter on Clearness, Force, and Harmony, furnishes some excellent drill in a neglected quarter. The exercises suggested in reproduction, substitution, and condensation should also prove helpful in paving the way for essay writing.

We do not understand, however, why the student is directed to look up *indecided* in the International Dictionary and observe its use when the word is not to be found there. Possibly it is a colloquialism known to the author and unrecorded by the makers of the lexicon.

The aim of the book is given in a quotation from Herbert Spencer's Philosophy of Style, "to enable the student to present his ideas in such language that they may be apprehended with the least possible effort"; and it is not too much to say that he must be indeed a dull scholar who is not materially helped toward this end by a faithful following of the principles here inculcated.

A Laboratory Manual of Physics and Applied Electricity. Arranged and edited by Edward L. Nichols, Professor of Physics in Cornell University. Vol. II. Senior Courses and Outlines of Advanced Work. New York: Macmillan & Co. Pp. 444. Price, $3.25.

The student who has completed such a course of laboratory study in physics as is presented in the first volume of this work will be prepared to take up the problems for original research given in the volume now issued. The needs of students who intend to become electrical engineers have been especially consulted in those parts of Volume II dealing with applied electricity, heat, and photometry. There is also a fourth part, of a hundred and fifty pages, consisting of exercises in general physics. The student who essays this course of experiments "is supposed to be familiar with the general principles of electrical measurement, and to have had such experience in adjusting instruments and practice in manipulation that he is ready at the start to investigate the operation of electrical apparatus." The following titles of experiments will give an idea of the sort of problems proposed: Comparison of magnetization curves of dynamos, characteristics of the Waterhouse dynamo and study of third-brush regulation, calibrating a voltmeter, effects of speed variation with a series dynamo, photometry of the arc light, specific heat of a liquid, influence of temperature upon the color of pigments, spectrophotometry, exploration of the earth's magnetic field. In preparing this volume, Prof. Nichols has had the co-operation of Messrs. George S. Moler, Frederick Bedell, Homer J. Hotchkiss, and Charles P. Matthews.

An Introduction to Structural Botany. By Dukinfield Henry Scott, F. L. S., F. G. S. London: Adam and Charles Black. New York: Macmillan & Co. Pp. 281. Price, $1.

There is a touch of irony in the preface to this volume that is too good to be lost. The author observes, "If science is to be taken seriously, it rather seems desirable that those who study it should have to use their brains as much as in learning Euclid, algebra, or grammar."

Although it is often urged in behalf of scientific study that its disciplinary effect equals that of drill in the classics, the notion is wonderfully prevalent, even in this country, that a knowledge of science may be imbibed in a haphazard fashion without much application.

A little investigation of such a book as this will tend to convince the aspirant for mental exercise that as much of it is involved in becoming precisely acquainted with one flower as in mastering a chapter in Greek.

With the exception of a dissertation on the physiology of nutrition and an introduction explaining simple botanical terms and divisions, the whole volume is devoted to a consideration of three floral types, the Wallflower, the White Lily, and the Spruce Fir. These higher plants are chosen, not only because they are familiar forms, but also since they exemplify the division of labor and give an opportunity to become acquainted with the more specialized organs and their functions. The vegetative and reproductive organization of each, their external characters and internal structure, are minutely described. The phenomena of pollination, fertilization, the chemistry of the nutritive process and protoplasmic movements, are traced out in like fashion and the mysteries of plant life unfolded.

In method, arrangement, and language the book is altogether commendable. It is also well illustrated and contains an index. The addition of a glossary might be suggested, as likely to prove convenient to the young student.

Biological Lectures. Marine Biological Laboratory of Wood's Hole. Boston: Ginn & Co. Pp. 242. Price, $2.15.

This volume is the second of a series, the first of which appeared in 1890. Like its predecessor, it does not include the general course of lectures given at Wood's Hole pertaining to the work pursued, but indicates special lines of inquiry involving unsettled problems.

Necessarily different points of view are developed, and the reader can test whether he believes fully in the cellular theory as expounded in The Nature of Cell Organization or in its inadequacy as presented by Prof. Whitman, who quotes from Huxley's essay of 1853 that the cells are no more producers of vital phenomena than shells on the sea beach, marking only where vital tides have been.

A valuable and interesting paper also is that on physiological morphology, in which the author, Jacques Loeb, maintains that all life phenomena are determined by chemical processes.

On the other hand, in Dynamics in Evolution, we learn that natural selection is a mischievous metaphor; that morphologists and physiologists are on the wrong track and can not settle the greater questions in biology. Surface tension is the important factor in the shaping of the cell, and the changes in amœboid form are understood only by dynamical analysis. No progress can be made in regard to the meaning of life until speculation about germ plasm or a lot of biophores, plastidules, *et sic*, superintending the business of development is abandoned.

Two popular and attractive essays are

those on the external conditions of plant life and the marine biological stations of Europe. The book is well illustrated and contains an appendix upon the work of the laboratory.

Preparatory Physics. By William J. Hopkins. New York: Longmans, Green & Co. Pp. 147.

The author of this laboratory manual is Professor of Physics in the Drexel Institute, Philadelphia, and the course of experiments here presented has grown out of the needs of his classes in beginning their study of the science. The greater part of the experiments relate to mechanics, for the author regards this subject "as being fundamental, particularly susceptible of treatment in this manner, with comparatively simple apparatus; and because the student is very greatly aided in thoroughly comprehending its problems by investigating them experimentally." Besides mensuration, the matters investigated under the head of mechanics are the composition of forces and of motions, levers and pulleys, breaking strength of a wire, deflection of beams, the inclined plane, the pendulum, etc. The properties of liquids are quite fully illustrated, and the book includes also a few experiments on heat, sound, light, and magnetism. The author maintains that only quantitative work is of value to the beginner in physical experimentation and he prefers to avoid those subjects in which only discouragingly inaccurate results are obtainable with the methods and apparatus that the beginner can use.

Manual of Physico-chemical Measurements. By Wilhelm Ostwald. Translated by James Walker, Professor of Chemistry in University College, Dundee. New York: Macmillan & Co. Pp. 255. Price, $2.25.

Dr. Ostwald has now added to his valuable chemical works one on the border land between chemistry and physics. It deals with microscopic measurements of length, accurate weighing, the use of thermometers, thermostats, and calorimeters, of barometers and manometers, processes for determining volumes and densities, optical and electrical measurements, determinations of solubility, etc. The author confesses to "a special pleasure in 'pottering' and making things for myself," and urges his fellow-workers to adopt the practice of working with homemade apparatus. To facilitate their doing so he includes in this volume directions for making a logarithmic slide-rule, for marking scales on glass, and for soft and hard soldering, giving also a special chapter on glass-blowing. By these means he has "striven to combat that helplessness nowadays so prevalent among experimenters, who have to resort to the mechanic for every trifle." A section on weight-testing and several tables have been reprinted by permission from Kohlrausch's Physical Measurements. The tables in the volume comprise only those that are absolutely essential, the work of Landolt and Börnstein being referred to for all others.

A commendable feature in the *System of Physical Culture*, prepared expressly for public-school work by *Louise Preece* (C. W. Bardeen, Syracuse, N. Y.), is that every exercise can be taken by the pupils when standing in the aisles beside their seats. The conditions are prescribed for the exercises that the work should be such as will appeal to the sense of the beautiful, combining strength and freedom of movement; that it must be such as can be done by the pupils in the schoolroom within the usual limitations of space and time; that the movements shall be such as can be conducted in a systematic, orderly manner, without causing confusion; and that they must be such as do not demand a change of dress. The directions are analyzed and arranged by Louise Gilman Kiely, of the University of Minnesota, and illustrated by the author with 180 graceful half-tones and 50 cuts. (Price, $2.)

In his paper on the *Status of the Mind Problem*, selected from a course of lectures delivered before the Anthropological Society of Washington, *Lester F. Ward* compares the old metaphysical and the modern scientific methods of mind-study, and argues in favor of the latter. In this method mind is considered as an attribute of the physical structure. If the charge of materialism is applied to this view, the author answers that, using the word materialism in its only proper and legitimate sense as postulating the material nature of the mind itself, "the scientific conception of mind is the farthest possible remove from a materialistic conception. The antithesis between matter and property is absolute." But, if the other view is accepted, that there is an element—mind, thought, or spirit—"that can detach itself from the personality to whom it normally belongs, or remain in space performing mechanical operations upon material objects," it is difficult to see how the charge of materialism can be avoided.

The Political Ethics of Herbert Spencer is the substance of a paper submitted to the American Academy of Political and Social Science, in which the author, *Lester F. Ward*, presents the results of his careful examination of Mr. Spencer's works, in a review criticising and impugning the more prominent features of his ethical system. His sociological system is declared to "proceed from so low and so narrow a standpoint as to constitute a protest against all attempts to deal scientifically with the subject," and it is pronounced "astonishing that the great exponent of the law of evolution in other departments should so signally fail to grasp that law in this highest department"; and, instead of carrying his system up symmetrically and crowning it with the science of man, he is said to have "tapered it off and flattened it out at the summit."

The Magazine of Travel is a new monthly publication which will be devoted to articles and discussions relating to travel in its broadest sense. The publishers promise that each number will be an improvement upon its predecessor. The first number, January, 1895, has articles on American and Foreign Travel Compared, by Hon. Chauncey M. Depew; Mexico: its Attractions for the Tourist, by E. H. Talbott; The New Education, by Edwin Fowler; A Summer in Alaskan Waters, by W. G. Cutler, United States Navy; Christmas on the Limited, a story, by Frank Chaffee; The Mountain Paradise of Virginia, by Charles D. Lanier; Hunting in the Cattle Country, by the Hon. Theodore Roosevelt; and In Southern California, by G. M. Allen. (The Magazine of Travel Publishing Company, E. H. Talbott, President and Manager, 10 Astor Place, New York; 25 cents, $3 a year.)

The results of *M. H. Saville's* studies of the *Ceremonial Year of the Maya Codex Cortesianus*, as summarized by him in a paper read before the American Association, are that there was a time series of two hundred and sixty days, divided into thirteens, beginning with 1 Imix, and making a sacred ceremonial year; that the glyphs in the part of the codex relating to this series are to be read from left to right through a series of pages in an alternating manner; that the pictures and glyphs accompanying this time series explain ceremonies that were to take place at intervals during the ceremonial year; and that the coincidence of a sinistral circuit of glyphs perhaps indicates the quarter in which ceremonies were observed during the last four days of the year. The author hopes that his paper may accomplish at least so much as to indicate a fruitful source of investigation for students of the Maya codices in studying the pictures and glyphs associated with this time series.

A Practical System of Studying the German Language is designed by the author, Dr. *Albert Pick*, for the use of physicians and medical students in self-instruction. It is observed that while one can learn by the aid of the usual text-books to converse in German about everyday affairs or to read literary German, or may become acquainted with the details of the grammar, none of them are competent to assist him in reading medical books, conversing with patients, or listening to medical lectures. The present system is for teaching the German medical language, and accustoming him to the long, coherent sentences used in medical treatises, talks, etc. It consists of short essays on anatomy, physiology, pathology, medical and surgical diseases, examination of patients, etc. Each lesson is in two parts; one being a short essay on the subject in "medical German," and the other a conversation on practical everyday subjects. A few lessons are given in applied or practical grammar alone. A key to the pronunciation and a translation accompany every word, wherever it appears. The work is in twelve paper parts, convenient to be put in the pocket, so that it may be carried along and consulted at any time or place. (Published by Pick & Tanner, Newtonville, Mass.)

The *Sixth Annual Report on the Statistics of Railways in the United States* of the *Interstate Commerce Commission* represents the year ending June 30, 1893, and is distributed nearer the date to which it applies than any previous statistical report issued by the commission. It might be prepared still earlier, except for the fact that the railways are dilatory in handing in their returns. The railway mileage in the United States at the date of closing the report was 176,461 miles, showing an increase during the year of 4,897½ miles, or 2·80 per cent. This rate of increase as compared with the corresponding rates for previous years shows that the railway construction of the year stood below the average of construction for the six preceding years, but was in excess of the rate for the accounting year immediately preceding. The report is a solid mass of facts and figures tabulated to a very great extent, relating to all sides of railway construction, operation, service, and finance; equipment, men employed, capitalization and valuation of property, public service, earnings and expenses, and accidents. The commissioners close the report with recommendations that express companies, owners of rolling stock, depot property, stock yards, and the like, and carriers by water, connected with railway interstate traffic, be required to make reports to the commission.

With *The Play of the Planets*—a mechanical chart or revolving card, on which are depicted the phases of the moon, certain planetary elements, the zodiac, and the days of the month—by the aid of the *Book of the Play*, one may learn to cast his horoscope. The book of which, as well as of the game, F. E. Ormsby is the author, by way of illustration casts the horoscope of "Baby Esther," who was born September 9, 1893. The work is described as "a game, amusing and instructive," and in conformity with this a number of games are given which may be played in the social circle; and it is as much for purposes of amusement as of astrology that the "play" is constructed. (Planetary Publishing Company, Chicago. Price, $1.)

Mr. *Ormsby* is also editor of a new monthly periodical, *Planets and People*, "devoted to the science of occult forces, astronomy, vibration, magnetism, life, and the mystery of worlds, suns, and systems," which is published by Ormsby & Sprague, Chicago. It will give the first half of each number to articles and sayings of leading minds and thinkers in the occult realms of investigation, while the rest will embrace plain astronomy, occult astronomy or astrology, both the heliocentric and geocentric systems, physiology, anatomy, phrenology, physiognomy, etc.

The *Sixth Annual Report of the Agricultural Experiment Station of Cornell University*, besides the report of the director, *I. P. Roberts*, contains the reports of the treasurer and chemist, the botanist and arboriculturist, the cryptogamic botanist and plant pathologist, and the entomologist, agriculturist, and horticulturist, and an appendix of twelve bulletins, to which special attention is called as containing matter of prime importance. The year's investigations embraced a large amount of practical and scientific work; and the quality of the work is represented as steadily improving. A glance at the bulletins, without having time to examine them carefully, seems to confirm the director's estimate of them that they are of high scientific character, and will be exceedingly useful to the farmers.

The periodical *Our Animal Friends* is much more than the organ of the American Society for the Prevention of Cruelty to Animals, and publishes so much matter of varied interest relating to natural history and the ways and doings of animals, with anecdotes of animals and stories, with general information, and handsome illustrations as to make it a very attractive magazine for children and the family. The twenty-first volume—September, 1893, to August, 1894—comes to us handsomely bound and fitted to adorn equally the library shelves or the table.

PUBLICATIONS RECEIVED.

Abbott, Arthur Vaughan. The Evolution of a Switch Board. Madison, Wis.: University of Wisconsin. Pp. 32.

The Astrophysical Journal. An International Review of Spectroscopy and Astronomical Physics. Monthly. Vol. I, Nos. 1 and 2, January and February, 1895. Press of the University of Chicago. Pp. 100. 50 cents. $4 a year.

Atwater, W. O. Foods; Nutritive Value and Cost. Washington: United States Department of Agriculture. Pp. 32.

Aërial Navigation, Proceedings of the International Conference on, at Chicago, August, 1893. New York: American Engineer and Railroad Journal. Pp. 429. $2.50.

Ashland Collegiate Institute, Ashland, Ky. Catalogue. Pp. 16.

Baring-Gould, S. Noémi. New York: D. Appleton & Co. Pp. 263. 50 cents.

Bedell, Frederick. On Magnetic Potential. Reprint from the Physical Review. Pp. 6.

Bell, Clark, Editor. Bulletin of the Psychological Section of the Medico-Legal Society. Quarterly. New York: Clark Bell. Pp. 64. $1.50 a year.

Benedict, James E. Scientific Results of the Albatross Expedition. New Genera and Species of Crabs, etc. Washington: United States National Museum. Pp. 10.

Bigelow, Robert Payne. Scientific Results of the Albatross Expedition. Report on Crustacea of the Order Stomatopoda. Pp. 62.

Bolin, Jakob, 332 West Twenty-fifth Street, New York. On the Different Types of Respiration in Man and Woman. Pp. 4.

Brooklyn, City of. Report of the Board of Commissioners of Electric Subways. Pp. 24, with Map and Plates.

Catholic University Bulletin. Vol. I, No. 1, January, 1895. Quarterly. Washington: Catholic University of America. Pp. 146. 50 cents. $2 a year.

Cobbe, William Rosser. Dr. Judas. A Portrayal of the Opium Habit. Chicago: S. C. Griggs & Co. Pp. 320. $1.50.

Daily News, Chicago. Almanac and Political Register for 1895. Pp. 456. 25 cents.

Davis, Gualterio G. Anales de la Oficina Meteorologica Argentina. Tomo IX. (Annals of the Argentine Meteorological Office. Vol. IX.) Climate of Córdoba, Buenos Aires. Pp. 678.

Day, William C. Production of Stone in 1893. Washington: United States Geological Survey. Pp. 64.

Ethical Addresses. First Series. Lecturers of Ethical Societies. Philadelphia: S. Burns Weston. Pp. 194.

Emmons, S. F. Progress of the Precious Metal Industry in the United States. Washington: United States Geological Survey. Pp. 52.

Fitz, Prof. G. W. A Location Reaction Apparatus. Reprint from the Psychological Review. Pp. 6.

Foote, G. W. Salvation Syrup, or Light on Darkest England. London. Pp. 32. Twopence.

Gatchet, Albert S., Washington. Ethnographic Notes. Pp 11.—Specimens of Songs of the Modoc Indians. Pp. 6.

Geikie, James. The Great Ice Age, and its Relation to the Antiquity of Man. Third edition, largely rewritten. New York: D. Appleton & Co. Pp. 850, with Maps and Plates. $7.50

Geikie, Sir Archibald. Memoir of Sir Andrew Crombie Ramsey. With Portrait. New York: Macmillan & Co. Pp. 397. $4.

Goode, G. Brown, and Bean, Tarleton H. Scientific Results of the Albatross Explorations. Cetomemidæ and Rondeletidæ. Pp. 4, with Plate.—Revision of the Order Heteromi, and Description of Two New Generic Types. Pp. 16, with Plate.—Harriotta, a New Type of Chimæroid Fish. Pp. 3, with Plate.

Griswold, W. M., Cambridge, Mass. Index to St. Nicholas. Vols. 1 to XXI. Pp. 19.

Harvard University Summer School. Announcement of Courses of Instruction for 1895. Pp. 63.

Historical Society of Southern California. Annual Publication, 1894. Los Angeles: Curran & Bineley. Pp. 87.

Hodge, F. W. List of the Publications of the Bureau of Ethnology. Washington: Government Printing Office. Pp. 25.

Imperial University of Japan, Tokio. Journal of the College of Science. Vol. VII, Part II, The After Shocks of Earthquakes. Pp. 84, with Plates.—Vol. VII, Part III, Mesozoic Plants and Tertiary Fossils. Pp. 43, with Plates.

Income Tax Law, The, and Speech of David B. Hill in the United States Senate. New York: Brentano's. Pp. 90. 10 cents.

Jones, Richard. The Growth of the Idylls of the King. Philadelphia: J. B. Lippincott Co. Pp. 161.

Langley, S. P. Report of the Secretary of the Smithsonian Institution to June 30, 1894. Washington. Pp. 88, with Plates.

Langmuir, A. C. Index to the Literature of Didymium. Washington: Smithsonian Institution. Pp. 20.

Latch, Edward B. Application of the Mosaic System of Chronology in the Elucidation of Mysteries pertaining to the Great Pyramid. Philadelphia: J. B. Lippincott Co. Pp. 30.

Lewis, Virgil A., State Superintendent. Biennial Report on the Free Schools of West Virginia, 1893-'94. Charleston, W. Va. Pp. 300.

Libby, Orin Grant. The Geographical Distribution of the Vote of the Thirteen States on the Federal Constitution. University of Wisconsin. Pp. 116.

Linell, M. L. A New Species of Golden Beetle from Costa Rica. Pp. 2.

Lonee, L. F. Track. University of Wisconsin. Pp. 24.

McDonald, Marshall, Commissioner. Bulletin of the United States Fish Commission. Vol. XIII. Washington: Government Printing Office. Pp. 462, with Plates.—Report of the Commissioner of Fish and Fisheries to June 30, 1892. Pp. 528.

Mach, Ernst. Popular Scientific Lectures. Translated by T. J. McCormack. Chicago: Open Court Publishing Company. Pp. 313. $1.

Marsh, O. C. On the Pithecanthropus Erectus, Dubois, from Java. Pp. 4, with Plate.

Mason, Otis T. Overlaying with Copper by the American Aborigines. Pp. 3.

Merriam, C. Hart, United States Department of Agriculture. Report of the Ornithologist and Mammalogist for 1893. Pp. 10, with Maps. Monographic Revision of the Pocket Gophers—Family Geomidæ. Pp. 256, with Plates. Washington: Government Printing Office.

Orford, Henry. Lens Work for Amateurs. New York: Macmillan & Co. Pp. 231. 80 cents.

Peck, H. T., and Arrowsmith, Robert. Roman Life in Latin Prose and Verse. American Book Co. Pp. 256. $1.10.

Purdy, C. T. The Steel Construction of Buildings. University of Wisconsin. Pp. 30.

Quatrefage, A. D. The Pygmies. Translated by Frederick Starr. New York: D. Appleton & Co. Pp. 255.

Ridgway, Robert. Additional Notes on the Native Trees of the Lower Wabash Valley. United States National Museum. Pp. 12, with Plates.

Russell, Thomas. Meteorology, Weather, and Methods of Forecasting, etc. New York: Macmillan & Co. Pp. 274, with Plates. $4.

Saunders, Charles H. Handbook of Practical Mechanics. Hartford: Student Publishing Company. Pp. 116. $1.

Schlundt, Herman. On the Speed of the Liberation of Iodine in Certain Mixed Solutions. University of Wisconsin. Pp. 33.

Sheldon, W. S. What We Mean by Duty. Philadelphia: S. Burns Weston. Pp. 30. 12 cents.

Simpson, Charles H. Distribution of the Land and Fresh Water Mollusks of the West Indian Region, etc. United States National Museum. Pp. 26, with Plates.

Slingerland, M. N. The Cabbage-Root Maggot, with Notes on the Onion Maggot, etc. Cornell University. Pp. 96.

Smith, Eugene A., State Geologist. Report on the Geology of the Coastal Plain of Alabama. Montgomery. Pp. 759.

Smock, John C., State Geologist, New Jersey. Annual Report for 1893. Pp. 457, with Maps in separate sheets.

Stokes, Anson Phelps. Joint-Metallism. Third edition, enlarged. New York: G. P. Putnam's Sons. Pp. 240. $1.

Venezuela, United States of. Statistical Annuary to July 1, 1889. Pp. 9, with Map.

Wilkes, Gilbert. Some Practical Hints in Dynamo Design. University of Wisconsin. Pp. 14.

Winchell. Geological and Natural History Survey of Minnesota for 1893. Minneapolis. Pp. 210.

Woodward, R. S. Smithsonian Geographical Tables. Smithsonian Institution. Pp. 182.

Yeo, John. Steam and the Marine Steam Engine. New York: Macmillan & Co. Pp. 196. $2.50.

POPULAR MISCELLANY.

Meeting of the Geological Society in Baltimore.—The seventh annual meeting of the Geological Society of America was held at the Johns Hopkins University, Baltimore, Md., December 27th to the 29th. About sixty fellows of the society were present, and fifty papers were read. Prof. T. C. Chamberlin, in his address as the retiring president, spoke of his observations during the past summer on the glaciers and ice sheet of Greenland, especially of Inglefield Gulf and of Bowdoin Bay, a fiord extending from that gulf northward to Lieutenant Peary's winter station. A series of very instructive lantern views of these glaciers was exhibited after this address. The surface of Inglefield Gulf, at its far northern latitude of 78°, lying twelve hundred and fifty miles north of the southern end of Greenland and only about eight hundred and fifty miles from the pole, was mostly frozen during all last summer; and it was with much difficulty that the stanch steamer Falcon, bearing this Peary Relief Expedition, cut its way through the ice pack in August to reach Bowdoin Bay. Because the sun's rays there fall so slantingly, their effect to promote the flow of the glaciers is very slight, the maximum rate of the glacial currents being found to be only two and a half feet a day in midsummer; but the reflection of the solar heat from the ground at the ice margin causes the ends of the valley glaciers and the border of the great inland ice sheet to have a very steep slope, or even in many places a precipitous and sometimes overhanging front. In these ice cliffs, rising abruptly one hundred to two hundred feet or more, the lower half of the ice incloses much englacial drift and is very distinctly laminated, having obtained a nearly horizontal or often steeply inclined stratification through the shearing effect of its motion in the upper and central parts being faster than below. As the bowlders and smaller rock fragments are carried onward in the ice, they are thus subjected to much wearing upon each other. At some localities this englacial drift is being amassed beneath the ice border in low, rounded hillocks, nearly like the drumlins or oval hills of till so well developed about Boston, in central New York, and in some other districts of the northern United States and Canada, which have long puzzled glacialists to explain how they could be formed. Other glacial papers were presented at this meeting by Prof. G. Frederick Wright, on his observations last summer in a second expedition to Newfoundland, Labrador, and Greenland; by Prof. C. H. Hitchcock, on deposits regarded as deltas of a glacial or ice-dammed lake in the basin of Lake Memphremagog, the old water level having been about four hundred feet above that of to-day; by H. F. Reid, on the secular recessions and readvances of the present glaciers of the Alps and other regions; by Warren Upham, on the question whether the ice sheets of the Glacial period were formed chiefly by snowfall upon all their area or advanced far beyond their zone of predominant snow accumulation, and a second paper on the climatic conditions shown by North American interglacial deposits; and two papers by Prof. H. L. Fairchild, on the lakes held by the barrier of the waning ice sheet in the valleys of the Finger Lakes, the Genesee River, and other streams in central New York. Prof. Fairchild, from observations made principally during the past year, maps and names fifteen or more of these lakes. They range from ten to thirty miles in length and from two to five miles in width, with outlets across the southern watershed to the head-streams of the Susquehanna. In the long and deep valleys now occupied by Canandaigua, Keuka, Seneca, and Cayuga Lakes, the former glacial lakes stood four hundred to seven hundred feet above the present lake levels, as shown by the old deltas and shore lines. Papers on the crystalline rocks of Archæan or pre-Cambrian age were presented by C. W. Hall, F. D. Adams, J. F. Kemp, C. H. Smyth, Jr., W. S. Bayley, and others. The folded structure of the Appalachian mountain belt was discussed by Arthur Keith; and the same type of mountain-folding was described by C. D. Walcott in the White Mountain range of Inyo County, Cal. Other papers on the Paleozoic rock series, and on their fossils, were by N. S. Shaler, H. P. Cushing, C. R. Keyes, H. S. Williams, David White, and Dr. Robert Bell. Mesozoic formations in Arkansas were described by G. K. Gilbert and F. P. Gulliver; in Montana, by W. H. Weed and L. V. Pirsson; and in Maryland and New Jersey, by W. B. Clark and N. H. Darton. Coming down to the present time in the geologic record, the Tertiary and Quaternary formations of New Jersey were reviewed by R. D. Salisbury; and the history of the island of Cuba during these eras was traced by J. W. Spencer. About a dozen other papers were on observations in petrography and mineralogy. The officers elect for the year 1895 are Prof. N. S. Shaler, Cambridge, Mass., president; Prof. Joseph Le Conte, Berkeley, Cal., first vice-president; Prof. C. H. Hitchcock, Hanover, N. H., second vice-president; Prof. H. L. Fairchild, Rochester, N. Y., secretary; Prof. I. C. White, Morgantown, W. Va., treasurer; Mr. J. Stanley-Brown, Washington, D. C., editor; and Mr. R. W. Ells, Ottawa, Canada, and Prof. C. R. Van Hise, Madison, Wis., new members of the council.

Prof. Sully's Inquiries.—Prof. James Sully, being about to issue a new and revised edition of his Teacher's Handbook of Psychology, and desiring to make it as useful as possible to teachers, invites suggestions as to the directions in which the book might be improved. He would also be glad to receive striking observations of children's mental characteristics as they reveal themselves under the processes of education, and fresh illustrations of the effects on the young mind of methods of teaching which accord with the principles laid down, and still more of those which conflict with them. These observations may relate to the ignorances of children, their preconceptions and prejudices, the special directions of their observation and interest, their customary lines of mental association (sequence of ideas), their ways of interpreting language, their modes of judging and reasoning about things, their sensibility and insensibility, and their attitude toward moral discipline. Illustrations are also desired of the practical bearing of principles, and more especially of the evils resulting from the neglect of them. Mr. Sully's address is East Heath Road, Hampstead, London, N. W. Communications should be sent before the end of April, 1895.

Disinfection of Scarlet-Fever Patients.—Experiments by Dr. William Gibson, of Campbeltown, Scotland, in disinfecting scarlet-fever patients so as to free them from contagion before the process of desquamation is completed, have resulted successfully. His method was to give a succession of three or four comfortably warm baths, sometimes daily, at other times on alternate days, using freely carbolic-acid soap, and washing the patient thoroughly from top to toe. After each bath, except the last, the patient was put back to the bed on which he had lain with the disease. After the last bath he was taken into a clean room, dressed with clothes free from infection, and then allowed to mingle with the rest of the family. In most cases the body was anointed daily with olive oil mixed with some disinfectant. Patients with such complications as otitis or ulcerated or suppurating throat were not subjected to the process. No complications followed the cleansing process in any case; but convalescence seemed to be rather hastened than retarded.

The Elements of Speech in the Kindergarten.—Drill in the sounds that make up words is suggested by Mrs. E. B. Burnz as a proper and profitable exercise for the kindergarten. Her idea is set forth in three articles that appeared in the Kindergarten News in the course of 1894. Few pupils or teachers in the ordinary schools realize that every word is composed of sounds into which it may be divided. Practice in making the separate sounds, combining them to form words, and separating words into their phonetic elements would greatly facilitate correct and ready enunciation both in speaking and reading. Many parents are much distressed because their children, when of kindergarten age and older, can not speak plainly. Such phonetic drill would be of great benefit to these children. The idea by no means involves the introduction of reading into the kindergarten—the instruction should be wholly oral. The children should be led to grasp the idea that each sound is produced by a special shape of the mouth. In learning to put the mouth into the various required shapes they get a control of the muscles of the tongue and other vocal organs. Mrs. Burnz gives some further details and suggestions, including the words of a "Vowel Song."

An Aquatic Biological Station in Illinois.—The Aquatic Biological Station of the University of Illineis and the Illinois State Laboratory of Natural History, at Havana, on the Illinois River, is especially devoted to the study of the effect on the aquatic plant and animal life of a region produced by the periodical overflow and gradual recession of the waters of great rivers, and is believed to be, in some respects, the only station of its kind in the world. The station, with the river varying in width from five hundred feet to four or five miles, according to the stage of the water and the outlying lakes, is excellently adapted to this purpose. The results of the first season's work are only a beginning, but they dimly reveal a large number of problems for which solutions may be sought. Notable contrasts in kind and number appear between animals of the springy shore and lake and those of the muddy intervale, only a few rods away on the other side, between river and lake, and between different lakes—contrasts easily comprehensible, as in the first instance given, where the cool spring water flowing in abundantly is evidently favorable to the gammerids and aselli swarming there, and sometimes peculiarly puzzling, like that between Quiver Lake, on the one hand, whose waters were densely choked in midsummer with a thick growth of aquatic vegetation, but contained fewer of the smaller animal forms than the open current of the river, and Thompson's Lake, on the other hand, where the water was relatively clear of aquatic plants, but abounded in rotifers and entomostraca. Still more curious was the contrast between the similarly situated and very similar lakes, Quiver and Matanzas, the waters of one loaded and clogged with plants and swarming with small mollusks and insect larvæ, and those of the other with hardly a trace of even microscopic vegetation, and with a correspondingly insignificant quantity of animal life. The course of events in a body like one of the station's lakes, with its extreme seasonal vicissitudes, ranging from complete overflow and loss of identity to absolute drying away in now and then an exceptional year, is extremely interesting to the œcologist. "The extraordinary instability of the system, one predominant and excessively abundant from quickly following another almost to the suppression of its predecessor, and all finally overwhelmed in a common doom, gives to the student an impression of an unhealthy organism, caught in the trap of an unfavorable environment, and hurrying through the stages of a fatal disease. One of the surprises of the season was the abundance of life in the main stream, which, as already intimated, sometimes contained a greater abundance of animal forms than most of the lakes connected with it; and another was the relatively small difference between the animals frequenting widely unlike situations in the same body of water." The freshness and fruitfulness of the field were well illustrated by the large number of new forms found, especially among rotifers, worms, and insect larvæ.

The Valley of Hadramaut.—Mr. Theodore Bent lately gave the Royal Geographical Society an account of an expedition which he and his wife had made to Hadramaut, a broad valley running for a hundred miles or more parallel to the coast of Arabia, by which the valleys of the plateau discharge their water into the sea at Saihut. Because of the fanaticism of the inhabitants, this main valley had been reached by only one European before Mr. and Mrs. Bent—Herr Leo Hirsch, in 1893. Mr. and Mrs. Bent traveled without disguise, and with a large retinue of followers. The country is inhabited by several classes of people: wild tribes of Bedouins, who do all the carrying trade, possess large tracts of country, and are a terror; the Arabs proper, who live in the towns and cultivate the lands around them; the Seyyids and Sherifs, the Arabian aristocracy, being descendants of the Prophet and possessing enormous influence; and the slave population and freed slaves. There is no source of wealth in the country, but great luxury prevails among the aristocracy. It comes from India, where it was acquired. The architecture of the towns is decidedly monotonous. Most of the houses are exceedingly high, many of them reaching eleven stories. They are built of sun-dried bricks, and are externally decorated with chevrons and zigzag patterns. There is always a terrace on the roof, where the people sleep in the hot weather, and they are usually decorated with turrets, domes, machicolations, buttresses, etc., which give them quite a mediæval appearance. Outside in the courtyard the flocks and herds are kept, and the horses are stabled at night. The lower story is devoted to the storage of goods, the second story is inhabited by servants, the third by the guests, and above that come the harem and the family dwelling rooms. Excellent carvings are executed on the parts of the buildings convenient for them, and on the household utensils. Sultan Sallah was much taken with Mrs. Bent's accomplishments, because she could do other things besides paint herself with turmeric and antimony, and lead a listless life of seclusion and squabbles in the harem. The medical condition of the country is terribly deficient. Burning the part affected with a hot iron is a favorite remedy, called *kayys*, and was seen frequently applied. The doctors consider certain smells dangerous for certain wounds, and those afflicted are obliged to wear stoppers in their noses for fear of inhaling the odor. On to a wound they will tie iron or tin; and, as women are not allowed to see medical men, their husbands take a hair from their head, by which the doctors undertake to decide from what the lady is suffering. Sultan Sallah told a curious case which had come under his notice: A man, for a wager, ate all the fat of a goat, and when he was subsequently taken ill, the doctor ordered a fire of wood to be lighted all round him to melt the fat, which had congealed in his inside.

The Composition of the Primitive Atmosphere.—Contrary to the usual doctrine that the proportion of oxygen in the atmosphere is decreasing and that of carbonic acid is increasing, a theory was put forth by the late Prof. C. J. Koene, of the University of Brussels, that the proportion of carbonic acid was formerly vastly greater than it now is, while oxygen was absent from the primary atmosphere. Force was added to these conclusions by the luxuriance of the coal plants and by the frequent presence of combustible substances, such as pyrites, molybdenite, and copper pyrites, in the primitive rocks. Under this hypothesis the origin of the oxygen in the atmosphere should be sought in the activity of plant life, decomposing carbonic acid and evolving the life-giving element. In the examination of this theory, Dr. T. L. Phipson has made experiments to ascertain to what extent our modern plants can vegetate in atmospheres of carbonic acid, hydrogen, and nitrogen. Taking such plants as pea, myosotis, antirrhinum, and convolvulus, he found that they could exist for many days, and even weeks, in an atmosphere of pure carbonic acid, but did not thrive; that they appeared healthy in an atmosphere containing so much carbonic acid that an animal exposed to it would perish in a few minutes; and that they flourished remarkably well in an atmosphere containing one hundred times as much carbonic acid as in its normal condition. Convolvulus and antirrhinum in an atmosphere of pure hydrogen were healthy, while the hydrogen gradually disappeared, probably by uniting with the nascent oxygen, and the plants got covered with water. In an atmosphere of pure nitrogen vegetation was remarkably healthy for a lengthened period, and in one of carbonic acid and nitrogen mixed it was truly luxuriant. Dr. Phipson found, moreover, that the lowest orders of microscopic plants separate oxygen from its compounds—carbonic acid and water. He concludes that, primarily, when the heat was so intense that no compounds could exist, the earth was in the state of free elements, or of atoms all identical, which became differentiated as the cooling went on; that the primitive atmosphere consisted of nitrogen, into which volcanic action poured large quantities of carbonic acid and water; that free oxygen, not at first present, was supplied by the evolution from the first organic beings—plants—that appeared, they deriving it from the carbonic acid they found in the soil and the atmosphere. This oxygen, poured into the air for an incalculable series of ages, has gone on increasing in quantity from the earth's earliest history to the present time; and when it had attained to a certain amount, animal life became possible, and duly appeared (in its lowest forms). As the oxygen became more abundant, animal life of a higher order became possible. The development of the nervous system has coincided with the increase of oxygen in the air.

Place of the Free Academy.—Describing the place of academies in the State school system of New York, Principal William E. Bunten said at the University Convocation that the free academy is a democratic institution in the best sense of the word democratic. It is there that the great bulk of successful business men receive all the training and discipline they ever get in school above the elementary branches; and an increasingly large number pass directly from the academy to the study of law and medicine. The great majority of teachers get their only preparation in the academy, either with or without training classes. Again, "many a boy or girl receives in the academy an inspiration, a sort of mental momentum" that sends him to college—a thing he never would have thought of had not the free academy existed; and many a parent is able to give a son or a daughter a collegiate education because the same academy saves the expense of three or four years at the preparatory school, and at the same time keeps the child under the wholesome influences of home during these early formative years. The place of the academies is, then, "to prepare what may be called the great middle class to enter on their several vocations in life, and to place golden opportunities before the youth of all classes, rich and poor alike."

The "Hot Winds" of the Plains.—An instructive study of the summer "hot winds," with which the great plains are occasionally visited, has been published by I. M. Kline, based on a comparison of the recorded observations of about twenty years. These winds are likely to occur between May 15th and September 15th, but are most frequent during July and August; they are extremely dry; their direction corresponds with that of the general movement of the atmosphere at the surface of the earth at the time; the region of the atmosphere in which they occur has a progressive movement from west to east; and they occur mostly with low-pressure areas, which have moved slowly from the north of Montana southeasterly along the eastern slope for three or four days before they take up a decided movement eastward—although this condition is subject to variation. A striking characteristic of them is their effect on vegetation, which they always cause to wilt and droop, while the more intensely hot winds burn vegetation to a crisp in a few minutes, without relation to the amount of moisture present in the soil or general atmosphere. The opinion that there is a special class of these winds, that the heat and dryness are of dynamic origin like that of the foehn and chinook, has been advanced by some, and the present study of all the observations and correlated facts relating to the subject seems to confirm this view. Although the development of these hot winds is wholly independent of drought conditions, they will, of course, become much more intense, extend over more territory, and be more injurious to crops when they occur during the prevalence of a drought than when they occur with seasonable weather. The areas affected by them, while they make considerable show, are but a small amount when compared with the whole crop of a State. Occasionally one sixth or even one fourth of two or three counties are completely burned up, but such cases are rare. After a careful consideration of the subject, the author has come to the conclusion that while these winds are often very intense and striking in their nature and damage crops to a considerable extent, yet there are often parts of the United States where the farmer has as great drawbacks to contend with—such as overflows, excessive rains, etc. These winds are a feature of the climate of the eastern slope of the Rocky Mountains, and can not be expected to disappear or even become less frequent; neither are they likely to become more so. The best suggestion the author can make for lessening their injurious effects is to fence against them by hedges and plantations of timber.

Mechanical Work and Chemical Action.—Some very interesting experiments in the transforming of mechanical work into chemical action have been described by M. Carey Lea. Employing a shearing stress, he placed, in one series of experiments, a small quantity of a metallic salt in a mortar, spread it into a thin uniform sheet over the bottom, and rotated the pestle with the utmost force he could command. Two or three decigrammes of chloroaurate of sodium left 1·8 milligramme of metallic gold. Under the action of the pestle the yellow color of the salt gradually deepened to an olive shade. When water was poured on, the undecomposed salt dissolved, leaving the gold as a delicate purple powder. Half an hour's trituration of half a gramme of the salt resulted in the reduction of 9·2 milligrammes of gold. By a similar operation corrosive sublimate was reduced to metallic calomel. Salts of mercury, platinum, and silver gave results analogous to those obtained with gold.

Value of Tradition.—When Jacques Cartier visited the St. Lawrence River in 1535 he found, where Montreal now is, a strong city exercising an extensive sway, named Hochelaga. When Champlain sailed up the same river, seventy years later, Hochelaga had disappeared and left no trace. The story of the fall of its dominion has never been satisfactorily explained. Mr. Horatio Hale, visiting the Wyandotte Indians a few years ago, found among them coherent traditions of their former residence in the east, and their withdrawal thence to settle near Mackinaw. The interpretation of these traditions, of which the author gives two versions, divested of what is fanciful in them, combined with a few known incidents, points to the expulsion of the Huron tribes from their stronghold of Hochelaga as the result of a war with other tribes of the Iroquois stock. From this lesson Mr. Hale draws important conclusions regarding the value of traditional evidence. "It is plain," he says, "that until recently this evidence has been seriously undervalued. Our students of history have been too generally a book-worshiping race, unwilling to accept any testimony with regard to events that is not found in some contemporary page, either written or printed. It is not half a century since a distinguished English author pronounced the opinion that no tradition can be trusted which is more than a hundred years old. At the time when this opinion was put forth by Sir George C. Lewis, many voyagers and missionaries in the Pacific islands were accumulating traditional testimony of vast and varied origin, which is now admitted on all hands to prove the occurrence of events that must have taken place at successive periods extending over the last two thousand years. The Brief History of the Hawaiian People, by Prof. W. B. Alexander, of Honolulu, published in 1891, 'by order of the Board of Education of the Hawaiian Kingdom,' recounts as unquestionable facts many voyages, migrations, battles, royal and priestly accessions, marriages, and deaths which have occurred in the Sandwich Islands and other groups, from the eleventh century to our own time. At the other extremity of the great ocean the Polynesian Society, established at Wellington, New Zealand, has published in its excellent quarterly journal communications from able contributors relating to various histories, and carrying them back, with the aid of numerous mutually confirmatory genealogies, for many centuries, with unhesitating belief in their general truth. In this way the history of the peopling of the vast Polynesian region, extending over a space larger than North America, and covering at least twenty centuries, is gradually becoming known to us as surely, if not as minutely, as that of the countries of Europe during the same period. The question naturally arises whether we may not hope to recover the history of aboriginal America for at least the same length of time. . . . We have every reason to feel assured that in the three hundred Indian reservations and recognized bands of the United States and Canada, with populations varying from less than a hundred to more than twenty thousand, and comprising many men and women of good education and superior intelligence, there are mines of traditional lore ready to yield returns of inestimable value to well-qualified and sympathetic explorers."

Mashona Granaries.—Grain is stored by the natives of Mashonaland in circular granaries, which are miniature copies of their own huts. Near the source of the Ingazuri River the railroad surveying party unexpectedly came across a collection of fifty or sixty granaries, belonging to a neighboring village, and in charge of two watchmen. "The clean surface of the granite rock formed the floor of the granaries; they were perched on bowlders, without regard to order, where a flat surface offered a favorable location.

Their circular walls consisted of wattle and daub; three or four stout poles with forked ends protruded above the rest of the wall to receive the ribs of the umbrella-shaped roof, this roof being first covered with a plastering of mud, and then thatched with long grass. Some of the granaries measured six feet in height to the eaves and six feet in diameter, but they varied in size to suit the area of level rock available on the several bowlders. The interior is partitioned, by walls of wattle and daub, into three or sometimes four compartments, to separate the bulk of the grain. The building is covered with an inner roof of sticks plastered into mud before the outer roof is put on. A small door or manhole made from an oval or round slab of rock, and with a handle fitted to it, is let into the wall of the hut about four feet above the ground. The outside ornamentation of nearly all the huts consists of moldings representing the female breast—an emblem of plenty—and a longitudinal bar in relief above them, the significance of which is open to conjecture. In the aggregate these granaries were capable of storing upward of six thousand bushels of grain."

Height of Ocean Waves.—Dr. G. Schott, studying the form and height of the waves of the deep sea, found that under a moderate breeze their velocity was 24·6 feet per second, or 16·8 miles an hour, which is about the speed of a modern sailing vessel. As the wind rises, the size and speed of the waves increase. In a strong breeze their length rises to 260 feet, and their speed reaches 360 or 364 feet per second. Waves, the period of which is nine seconds, the length 400 or 425 feet, and the speed twenty-eight nautical miles per hour, are produced only in storms. During a southeast storm in the southern Atlantic Dr. Schott measured waves 690 feet long; and this was not a maximum; for in latitude 28° south and longitude 39° east he observed waves of fifteen seconds period which were 1,150 feet long, with a velocity of 78·7 feet per second, or $46\frac{1}{8}$ nautical miles an hour. Dr. Schott does not think that the maximum height of the waves is very great. Some observers have estimated it at 30 or 40 feet in a wind of the force represented by 11 on the Beaufort scale (the highest number on which is 12); and Dr. Schott's maximum is just 32 feet. He believes that in great tempests waves of more than 60 feet are rare, and that even those of 50 feet are exceptional. In the ordinary trade winds the height is five or six feet. The ratio of height to length is about 1 : 33 in a moderate wind, 1 : 18 in a strong wind, and 1 : 17 in a storm; from which it follows that the inclination of the waves is respectively about 6°, 10°, and 11°. The ratio of the height of the waves to the force of the wind varies greatly.

Climate of Galveston.—The advantages of the climate of Galveston, Tex., are well set forth in a paper by Dr. I. M. Cline. The city is situated on an island four miles from the mainland, in latitude 29° 17′ north, and has, therefore, a real insular climate. During twenty years the lowest temperature was below 20° only in two, while the highest recorded temperature is 98°. July is the only month in which the maximum temperature reaches 90° in every year. During August it has reached that point in eighteen years; during September, in eight years; during June, in four years; and during May, in three years. The highest monthly range is 58°, and the average diurnal range is 10° 5′. The amount of moisture in the atmosphere ranges between seventy and eighty per cent. There are on the average 133 clear, 140 partly cloudy, and 92 cloudy days in a year; and it is estimated approximately that the sun shines to some extent on 318 days in a year. The average annual death rate is about 15 per 1,000 inhabitants, consumption leading the list with one in fourteen deaths. No epidemic diseases, except a few cases of smallpox, have visited the region since 1870, and none of the more destructive epidemics have ever originated in Galveston.

Flameless Explosives.—A committee appointed in 1888 by the North of England Institute of Mechanical Engineers to investigate upon the subject of flameless explosives in relation to their degree of safety in mines, has only recently published the first part of its report upon experiments that were begun in 1892. They find that all the high explosives are less liable than blasting powder to ignite inflammable mixtures of air and fire damp. They can not, however, be relied upon as insuring absolute safety when used at places where inflammable mixtures of air and fire damp may be present. The variable results following upon the detonation of high explosives appear to be due in some measure to defective admixture of the ingredients or variation in the properties of them. It is also certain that these explosives alter in character with age. The same precautions should be observed when they are used as with blasting powder; and it should always be recollected that the risk of explosion is only lessened and not abolished by their use. All the high explosives upon detonation produce evident flame.

Science Endowments in the United States.—Of the endowments for post-graduate scientific study in our colleges, Mr. Addison Brown, in his address before the Scientific Alliance of New York, shows that Columbia College has two fellowships—the Tyndall, of $648 a year, and the Barnard, of about $300 a year—expressly restricted to science. Besides these, twenty-four general university fellowships of $500 for post-graduate study have been established, of which eighteen are in present operation; and, in addition, the Schermerhorn fellowship in architecture of $1,300, and the two McKim fellowships, to support study in foreign travel, and five prizes for proficiency in the medical department. The University of Pennsylvania has the Tyndall fellowship and the Lea Hygienic Laboratory with a fellowship of $10,000 endowed by Thomas A. Scott, and at present applied to original research in bacteriology. At Harvard, besides the three Bullard fellowships of $5,000 each, established in 1891 to promote original research in the medical school, there are two post-graduate fellowships devoted to science exclusively, the Tyndall fellowship of about $500, and the income of the recently established Joseph Lovering fund, the principal of which is now about $8,000. There are also eleven other general fellowships—the Parker, the Kirkland, and the Morgan—available for promising graduate students in any branch, of which about five have usually been assigned to science. These fellowships give an income of from $450 to $700 a year. Harvard has also forty-six scholarships available for graduate students, varying in income from $150 to $300 each, of which about seventeen are assigned to science. Princeton has a hundred undergraduate scholarships, and only one post-graduate fellowship for science. Yale has the Silliman and the Sloane fellowships in science. In all these colleges there are only about twenty-six adequately endowed post-graduate fellowships in science. As these should be continued for at least three years, there is provision altogether for only about nine per year—not one fourth the number required to supply the annual loss of trained teachers in the colleges of the country, to say nothing of the increasing demand through the growth and improvements in the colleges themselves. As it is from such specially trained students that the great professors of the future must be drawn, the need of much greater endowments for new recruits is apparent.

Animals in Sleep.—Delicate distinctions are made by a writer in the London Spectator on the Sleep of Animals between those animals which sleep soundly, those which sleep fitfully and always on the alert, as if "with one eye open," and real nocturnal animals which sleep in the daytime a dead sleep. Rabbits, deer, and other timid animals, sleeping largely in the daytime, when wakened, instantaneously pass into the action that is required—usually flight and escape—with full possession of their faculties. "A sleeping fox will rise, gallop off, and dodge the hounds with as much coolness and knowledge of the ground as if it had been surprised on the prowl with all its wits awake. . . . Hares seem never to sleep; however closely they may lie in their forms, the eye is ever alert and vigilant. . . . Deer stalkers have discovered by experiment that the sleeping senses of the stag (hearing and scent) are sensitive up to a distance of at least two hundred yards on the windward side." There are reasons for believing that the broken and timid form of animal sleep in the greater number of species is not such as they would naturally choose, but is the result of habits acquired and transmitted in centuries of danger and avoidance of their enemies; and that the same causes that have modified the hours of sleep—changing them from the night time to the daytime—have also modified its character. They are not daytime and alert sleepers by choice. Of such animals only a small fraction are night feeders by nature or choice. The real night feeders—bats, lemurs, lorises, etc.—are mostly insect-eaters, and their day sleep is sound, almost to lethargy—so that it is extemely difficult to disturb their slumber. Between these two kinds of sleep is the form enjoyed by the large carnivora and the domestic animals. Tigers and lions have no reason to be afraid of anything but man, and sleep soundly and carelessly. Yet they possess the power of vigilance in sleep, which they can use, if required. Domestic animals, under man's protection, sleep well, and usually wake deliberately. Dogs are drowsy or wakeful, and, according to their state of mind and circumstances, seem to sleep lightly or heavily at will. "Nothing can be more slow, reluctant, and leisurely than the enforced waking of a petted house-dog when it does not wish to be disturbed. It will remain deaf to a call, twitch its feet if tickled, but not unclose its eyes, and stretch and yawn like a sleepy child. But mention something interesting to the same dog when sleeping, such as the word 'walk,' or click the lock of a gun, and it is on its feet in an instant, and ready for enterprise." Even human sleep, this writer adds, "can be made vigilant by solicitude or previous resolve. It is a common experience that persons who are heavy sleepers can awaken at a certain hour by resolving to do so, or if roused by a sound previously agreed on recognize it as a call to awaken and do awaken instantly."

The Tanning School of Freiburg.—What is probably the only tanning school in the world—as distinguished from schools in which the chemistry of tanning is taught—was opened in 1889 at Freiburg, Saxony. Instruction is given in it in the theory and practice of the preparation of leather, in tanning, and in finishing. It is supported conjointly by the state, the city of Freiburg, and friends. It is attended by pupils from all parts of the world. It is completely fitted up with all the machinery and apparatus for tanning, and has rooms and machines for the unworked skins, lime baths, vats, cutting, rolling, and pressing. The machinery is all from the United States, and the director of the institution is an American tanner. Besides him, the teaching force includes a body of chemists, teachers, and a corps of practical tanners. The students give two hours a day—ten hours a week—in assisting at the operations of the tanners. Hides from all parts of the world are experimented upon every year, with all kinds of tanning processes, barks, and materials. The processes of the old and new schools are shown and compared; and it is said that the former give good and expensive, and the latter quick and cheap results. Lectures are given in the winter on subjects related to tanning; and excursions to tanneries, to the woods where the bark is collected, and to the yards where the bark is stored, are a part of the instruction.

NOTES.

The process of manufacturing calcium carbide by heating in an electric furnace a mixture of coal dust and lime is now well known. The appearance of this material, in masses, is like that of the mineral serpentine, it being greenish gray in color, with a luster like that of feldspar. If a few drops of water are thrown on this seeming rock, gas is given off, which, if ignited, burns with a brilliant flame, and will continue to blaze, if supplied with water, till the mineral is exhausted. It is proposed to use acetylene gas thus produced for local gas engines. A charge of the mineral is placed in a closed vessel in which a regulated supply of water is admitted. A little water entering evolves a quantity of gas, whose pressure shuts off the water, and, as the gas is exhausted, more water is admitted to renew the supply.

The fiftieth anniversary of the discovery of anæsthesia by Horace Wells was celebrated in Hartford, Conn., December 10th, by a meeting and banquet of about fifty dentists of the State. It was claimed by some of the speakers that there was now no question as to Dr. Wells's priority in the discovery; and the story of the early experiments was told by Dr. G. Q. Colton, whose administration of laughing gas fifty years ago suggested to Dr. Wells the idea of using it as an anæsthetic.

Mr. J. Gray read a paper in the British Association on the Distribution of the Picts in Britain, as indicated by Place Names. The Picti of North Britain and the Pictones or Pictavi of South Gaul are both mentioned by Roman writers. The evidence of place names shows that probably the whole intervening country was at an earlier date occupied by the same race. The language of the Picts was Basque. The name Pict is derived from a Basque word—*pikatu*, to cut. Place names in the British Isles involving all forms of the root Pakat have been classified under counties and their densities calculated. The Goidels, who followed the Picts, spread along the valleys of the Thames and Severn to the Mersey, where a part probably crossed to Meath and spread in two streams to the west coast of Ireland; the other part moved northward, and advanced into Scotland almost to the Forth. A second incursion entered Scotland by Argyll and spread along the west counties to the extreme north. The pre-Pictish inhabitants were probably Iberians, and prevailed mostly in Ireland, South Wales, Cumberland, and South Scotland.

Experiments made by different observers at different times and places, culminating with those of M. Kœchlin on the Eiffel Tower, indicate that the formulas used by meteorologists for the conversion of wind velocity into pressure give results about one third too high.

The Pilot Chart of the North Atlantic Ocean, published by the Hydrographic Bureau of our Navy Department, shows that from the 9th to the 23d of November there were only two days of good weather. The system adopted by this bureau for collecting and discussing observations made at sea enables it to present the chart of the results very quickly.

It has been found, after careful investigation, by Profs. A. Bartoli and E. Stracciati, of the absorption of solar radiation by fog and by cirrus clouds, that a veil of cirrus is able to intercept as much as thirty per cent of the sun's rays; while a slight fog, equally diffused in all directions, intercepted from fifty-eight to ninety-two per cent of the solar rays that would have been transmitted with a clear sky.

Prof. G. S. Brady, after an examination of British fish-cultural establishments, has recommended the foundation of a hatchery on the Northumberland coast to aid in keeping up and improving the supply of sea fish, and of a biological laboratory attached to it for the scientific study of the marine fauna of the neighborhood.

In a recent lecture before the English College of Preceptors on Science Teaching, Mr. H. G. Welles pointed out that a rational course of science should grow naturally out of the kindergarten. This should lead to object lessons proper, and demonstrations in physics and chemistry may be made to grow insensibly, without any formal beginning, out of such lessons. The best—about the only permanently valuable—preparation for a scientific calling that can be given to a boy in a secondary school is the broad basis of physics and chemistry led up to in this way.

OBITUARY NOTES.

The Marquis Louis Charles Joseph Gaston de la Saporta, the eminent fossil botanist, and author of many brilliant books on his specialty, died suddenly at Aix, France, in the last week in January. He was born at Saint Zacherie in 1825; was nominated correspondent of the Institute of France in 1876. In his special field he was one of the most industrious students and eminent authorities of the day. Between his first book, on the flora of the Quaternary period, in 1876, and his Paleontological Origin of Cultivated Trees, in 1888, he published at least twenty volumes containing important facts and new discoveries. His last work was on the fossil flora of Portugal. "No one," says M. Albert Gaudry, himself an eminent paleontologist, "has cast so clear light on the history of the formation and successive developments of the vegetable world." The Monthly has been often enriched with translations of his brilliant and suggestive essays.

Prof. Arthur Cayley, the greatest English mathematician, and one of the most eminent mathematicians of any country or time, died in Cambridge, England, January 26th. He was born in Richmond, England, in 1821, and showed a great aptitude and liking at an early age for arithmetical calculations—although it was said of him in later years that he could not count the change for a shilling. He was educated at Cambridge, where he excelled all in mathematics, coming out as senior wrangler and first prize man in 1842; practiced at the bar for several years, without losing his taste or ceasing his devotion to mathematics; and was appointed to the newly instituted Sadlerian Professorship of Mathematics at Cambridge, in 1863, after he had already contributed about three hundred papers to the Royal Society. As a mathematician he is perhaps most famous as the discoverer of the Theory of Invariants, which, according to Prof. Salmon, has given a new aspect to several departments of the science. The Royal Society's list contains the titles of seven hundred and twenty-four papers and memoirs by Cayley, down to 1883, while the number now would probably be about eight hundred. Prof. Cayley was active and efficient in many other spheres than that of mathematics. He was an early member of the Alpine Club. He was familiar with many European languges. He delivered a course of lectures at Johns Hopkins University in the winter of 1882–'83. He was President of the British Association at Southport in 1883. He received the Royal and the Copley medals of the Royal Society, was an officer of the French Legion of Honor, and was an honorary member of many learned societies at home and abroad. His mathematical papers are in course of publication in a series of ten quarto volumes, of which seven have appeared.

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