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THE

POPULAR SCIENCE MONTHLY.

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STUDIES OF CHILDHOOD.

VIII.—FEAR.

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IN passing from a study of children's ideas to an investigation of their feelings we seem to encounter quite a new kind of problem. A child has the germs of ideas long before he can give them clear articulate expression; and, as we have seen, he has at first to tax his ingenuity in order to convey by intelligible signs the thoughts which arise in his mind. For the manifestation of his feelings of pleasure and pain, on the other hand, Nature has endowed him with adequate expression. The states of infantile discontent and content, misery and gladness, pronounce themselves with a clearness, with an emphasis, which leave no room for misunderstanding.

This full, frank manifestation of feeling holds good more especially of those states of bodily comfort and discomfort which make up the first rude experiences of life. It is necessary for the child's preservation that he should be able to announce by clear signals the oncoming of his cravings and of his sufferings, and we all know how well Nature has provided for this necessity. Hence the facility with which infant psychology has dealt with this first chapter of the life of feeling. Preyer, for example, gives a full and almost exhaustive epitome of the various shades of infantile pleasure and pain growing out of this life of sense and appetite, and has carefully described their physiological accompaniments and their signatures.*

* *Op. cit.*, cap. 6 and 13.

When we pass from these elementary forms of pleasure and pain to the rudiments of emotion proper—as the miseries of fear, the sorrows and joys of the affections—we have still, no doubt, to do with a mode of manifestation which, on the whole, is direct and unreserved to a gratifying extent. A child of three is delightfully incapable of the skillful repressions and the yet more skillful simulations of emotion which are easy to the adult. Yet, frank and transparent as is the first instinctive utterance of feeling, it is apt to get checked at an early date, giving place to a certain reserve. So that, as we know from published reminiscences of childhood, a child of six will have learned to hide some of his deepest feelings from unsympathetic eyes.

This shyness of the young heart, face to face with old and strange ways of feeling, exposed to ridicule if not to something worse, makes the problem of registering its pulsations of emotion more difficult than it at first seems. As a matter of fact, we are still far from knowing the precise range and depth of children's feelings. This is seen plainly enough in the quite opposite views which are entertained of childish sensibility, some describing it as restricted and obtuse, others as morbidly excessive. Such diversity of view may, no doubt, arise from differences in the fields of observation, since, as we know, children differ hardly less than adults, perhaps, in breadth and fineness of emotional susceptibility. Yet I think that such contrariety of view points further to the conclusion that we are still far from sounding with finely measuring scientific apparatus the currents of childish emotion.

It seems, then, to be worth while to look further into the matter in the hope of gaining a deeper and fuller insight; and as a step in this direction I propose to inquire into the various forms and the causes of one of the best-marked and most characteristic of children's feelings—namely, fear.

That fear is one of the characteristic feelings of the child needs no proving. It seems to belong to these wee, weakly things, brought face to face with a new, strange world, to tremble. They are naturally timid, as all that is weak and ignorant in Nature is apt to be timid.

I have said that fear is well marked in the child. Yet, though it is true that fully developed fear or terror shows itself by unmistakable signs, there are many cases where it is difficult to say whether the child is the subject of fear. Thus the reflex movement of a start on hearing a sound does not amount to fear, though it is akin to fear.* Again, a child may show a sort of æsthetic dislike for an ugly form or sound, turning away in evident aversion, and yet not be afraid in the full sense. Fear proper betrays

* For an account of this reflex, see Preyer, *op. cit.*, cap. 10, S. 176.

itself in the stare, the grave look, and in such movements as turning away and hiding the face against the nurse's or mother's shoulder. In severer forms it leads to trembling and to wild shrieking. Changes of color also occur. It is commonly said that great fear produces paleness; but, according to one of my correspondents, a child may show fear by his face turning scarlet. Fear, if not very intense, leads to voluntary movements—as turning away, putting the object away, or going away. In its more violent forms, however, it paralyzes the child. It is desirable that parents should carefully observe and describe the first signs of fear in their children.

It may be well to begin our study of fear by a reference to startling effects. As is well known, sudden and loud sounds, as that of a door banging, will give a shock to an infant in the first weeks of life, which, though not amounting to fear, is its progenitor. A clearer manifestation occurs when a new and unfamiliar sound calls forth the grave look, the trembling lip, and possibly the fit of crying. Darwin gives an excellent example of this. He had, he tells us, been accustomed to make all sorts of sudden noises with his boy, aged four months and a half, which were well received; but one day, having introduced a new sound—that of a loud snoring—he found that the child was quite upset, bursting out into a fit of crying.*

As this incident suggests, it is not every new sound which is thus disconcerting to the little stranger. Sudden sharp sounds seem to be especially disliked, as those of a dog's bark. Loud and voluminous sounds, too, have a terrifying effect. The big noise of a factory, of a steamship, of a passing train, are among the causes alleged by my correspondents of this early startling and terrifying effect. My little girl when taken into the country at the age of nine months, though she liked the animals she saw on the whole, showed signs of fear on hearing the bleating of the sheep, by seeking shelter against the nurse's shoulder. So strong is this effect of suddenness and volume of sound that even musical sounds often excite some alarm at first. "He (a boy of four months) cried when he first heard the piano," writes one lady, and this is but a sample of many observations. A child of five months and a half showed such a horror of a banjo that it would scream if it were played or only touched. Preyer's boy, at sixteen months, was apparently alarmed when his father, in order to entertain him, produced a pure musical tone by rubbing a drinking-glass. He remarks that this same sound had been produced when the child was four months old without any ill effects.†

This last fact suggests that such shrinkings from sound may

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* Mind, vol. ii, p. 288.

† *Op. cit.*, p. 131.

be developed at a comparatively late date. This idea is supported by other observations. "From about two years four months (writes a mother) to the present time (two years and eleven months) he has shown signs of fear of music. At two years five months he liked some singing of rounds, but when a fresh person with a stronger voice than the rest joined, he begged the singer to stop. Presently he tolerated the singing as long as he might stand at the farthest corner of the room." This child was also about the same time afraid of the piano, and of the organ, when played by his mother in a church.

It is sometimes supposed that this startling effect of loud sounds is wholly an affair of nervous disturbance.* But the late development of the repugnance in certain cases seems to show that this is not the only cause at work. Of course, a child's nervous organization may, through ill health, become more sensitive to this disturbing effect. But I suspect that vague alarm at the unexpected and unknown takes part here. There is something uncanny to the child in the very production of sound from a usually silent thing. A banjo lying now inert, harmless, and then suddenly firing out a whole gamut of sound may well shock a small child's preconceptions of things. The second time that fear was observed in our child at the age of ten months it was excited by a new toy which squeaked on being pressed.† This seems to be another example of the disconcerting effect of the unexpected. In other cases the alarming effect of the mystery is increased by the absence of all visible cause. One little boy of two years used to get sadly frightened at the sound of the water rushing into the cistern which was near his nursery. The child was afraid at the same time of thunder, calling it "water coming."

I am far from saying that all children manifest this fear of sounds. Miss Shinn points out that her niece was from the first pleased with the piano, and this is no doubt true of many children. Children behave very differently toward thunder, some being greatly disturbed by it, others being rather delighted. Thus Preyer's boy, who was so ignominiously upset by the tone of the drinking-glass, laughed at the thunderstorm; and we know that the little Walter Scott was once found during a thunderstorm lying on his back in the open air clapping his hands and shouting "Bonnie, bonnie!" at the flashes of lightning. It is possible that in such cases the exhilarating effect of the brightness counteracts the uncanny effect of the thunder. More observations are needed on this point.

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* This seems to be the view of Perez: The First Three Years of Childhood (English translation), p. 64.

† Observation of F. H. Champneys. Mind, vol. vi, p. 106.

A complete explanation of these early vague alarms of the ear may as yet not be possible. Children show in the matter of sound capricious repugnances which it is exceedingly difficult to account for. They seem sometimes to have their pet aversions like older folk. But I think a general explanation is possible.

To begin with, then, it is probable that in many of these cases, especially those occurring in the first six months, we have to do with an organic phenomenon, with a sort of jar to the nervous system. To understand this we have to remember that the ear is, in the case of man at least, the sense-organ through which the nervous system is most powerfully and profoundly acted on. Sounds seem to go through us, to pierce us, to shake us, to pound and crush us. A child of four or six months has a nervous organization still weak and unstable, and we should naturally expect loud sounds to produce a disturbing effect on it.

To this it is to be added that sounds have a way of taking us by surprise, of seeming to start out of nothing; and this aspect of them, as I have pointed out above, may well excite vague alarm in the small creatures to whom all that is new and exceptional is apt to seem uncanny. The fact that most children soon lose their fear by getting used to the sounds seems to show how much the new and the mysterious has to do with the effect.

Whether heredity plays any part here in the fear of the dog's barking and other sounds of animals seems to me exceedingly doubtful. This point will, however, come up for closer consideration presently, when we deal with children's fear of animals.

Before considering the manifold outgoings of fear produced by impressions of the eye, we may glance at another form of early disturbance which has some analogy with the shocklike effects of certain sounds. I refer here to the feeling of bodily insecurity which appears very early when the child is awkwardly carried, or let down back foremost, and later when it begins to walk. One child in her fifth month was observed, when carried, to hold on to the nurse's dress as if for safety. And it has been noticed by more than one observer that on dandling a baby up and down on one's arms, it will on descending—that is, when the support of the arms is being withdrawn—show signs of discontent in struggling movements.* Bell, Preyer, and others regard this as an instinctive form of fear. Such manifestations may, however, be merely the result of sudden and rude disturbances of the sense of bodily ease which attends the habitual condition of adequate support. A child accustomed to lie in a cradle, on the floor, or in somebody's lap, might be expected to be put out when the supporting mass is greatly reduced, as in bad carrying, or wholly removed, as

* See the quotation from Sir Charles Bell, Perez, First Three Years of Childhood, p. 63.

in quickly lowering the child backward. The fear of falling, which shows itself on the child's first attempting to stand, comes, it must be remembered, as an accompaniment of a new and highly strange situation. The first experience of using the legs for support must, one supposes, involve a profound change in the child's whole bodily consciousness—a change which may well be accompanied with a sense of disturbance. Not only so, it comes after a considerable experience of partial failings, as in trying to turn over when lying, half climbing the sides of the cradle, etc., and still ruder bumpings when the crawling stage is reached. These would, I suspect, be quite sufficient to produce the timidity which is observable on making the bolder venture of standing.*

Fears excited by visual impressions come later than those excited by sounds. The reason of this seems pretty obvious. Visual sensations do not produce the strong effect of nervous shock which auditory ones produce. Let a person compare the violent and profound jar which he experiences on suddenly hearing a loud sound with the slight surface agitation produced by a sudden movement of an object across the field of vision. The latter has less of the effect of nervous jar and more of the characteristics of fear proper—that is, vague apprehension of evil. We should accordingly expect that eye-fears would only begin to show themselves in the child after experience had begun its educative work.†

At the outset it is well, as in the case of ear-fear, to keep before us the distinction between mere dislike to a sensation and a true reaction of fear. We shall find that children's quasi-æsthetic dislikes to certain colors may readily simulate the appearance of fears.

Among the earliest manifestations of fear excited by visual impressions we have those called forth by the presentation of something new and strange, especially when it involves a rupture of customary arrangement. Although children love and delight in what is new, their disposition to fear is apt to give to new and strange objects a disquieting if not distinctly alarming character. This apprehension shows itself as soon as the child has begun to be used or accustomed to a particular state of things.

Among the more disconcerting effects of the ruder departure from the customary we have that of change of place. At first the infant betrays no sign of disturbance on being carried into a

* Preyer seems to regard this as instinctive. *Op. cit.*, p. 131.

† M. Perez (*op. cit.*, p. 65) calls in the evolution hypothesis here, suggesting that the child, unlike the young animal, is so organized as to be more on the alert for dangers which are near at hand (auditory impressions) than for those at a distance (visual impressions). I confess, however, that I find this ingenious writer not quite convincing here.

new room. But when once it has grown accustomed to certain rooms it will feel a new room to be strange, and eye its features with a perceptibly anxious look. My little girl at the age of seven months and a third gave unmistakable signs of such vague apprehension on changing her abode—a change which involved that of human surroundings also. She looked about her half wonderingly, half timidly, struck by the strangeness of the scenery, of the faces, and of the voices. Later, when experience and imagination are added, a child will show a still more marked shrinking from strange rooms. Thus a boy retained up to the age of three years and eight months the fear of being left alone in strange hotels or lodgings. Yet entrance on a strange abode does not by any means always excite this reaction. A child may have his curiosity excited, or may be amused by the odd look of things. Thus one boy, on being taken at the age of fifteen months to a fresh house and given a small plain room, looked round and laughed at the odd carpet. Children even of the same age appear in such circumstances to vary greatly with respect to the relative strength of the impulses of fear and curiosity.

How different children's mental attitude may be toward the new and unfamiliar is illustrated by some notes on a boy sent me by his mother. This child, "though hardly ever afraid of strange people or places, was very much frightened as a baby *of familiar things seen after an interval.*" Thus "at ten months he was excessively frightened on returning to his nursery after a month's absence. On this occasion he screamed violently if his nurse left his side for a moment for some hours after he got home, whereas he had not in the least objected to being installed in a strange nursery." The mother adds that "at thirteen months, his memory having grown stronger, he was very much pleased at coming to his home after being away a fortnight." This case looks puzzling enough at first and seems to contradict the laws of infant psychology. Perhaps the child's partial recognition was accompanied by a sense of the uncanny, like that which we experience when a place seems familiar to us, though we have no clear recollection of having seen it before.

What applies to places applies also to persons; a sudden change of customary human surroundings by the arrival of a stranger on the scene is apt to trouble the child.

At first all faces seem alike to the child. Later, unfamiliar faces excite something like a grave inquisitorial scrutiny. Yet for the first three months there is no distinct manifestation of fear of strangers. It is only later, when attachment to human belongings has been developed, that the intrusion of strangers, and especially the proposal of a stranger to take the child, calls forth clear signs of displeasure and the shrinking away of fear.

Preyer gives the sixth and seventh month as the date at which his boy began to cry at the sight of a strange face. In one set of notes sent me it was remarked that a child four months and a half old would cry on being nursed by a stranger. To be nursed by a stranger, however, is to have the whole baby world revolutionized: little wonder, then, that it should bring the feeling of strangeness and homelessness (*unheimlichkeit*).

Here, too, curious differences soon begin to disclose themselves, some children being decidedly more sociable toward strangers than others. It would be curious to compare the age at which children begin to take kindly to strangers. Preyer gives nineteen months as the date at which his boy surmounted his timidity; but it is probable that the transition occurs at very different dates in the case of different children.

I should like to add that the little boy to whom I referred just now displayed the same signs of uneasiness at seeing old friends after an interval, as at returning to old scenes. When eight months old "he moaned in a curious way when his nurse (of whom he was very fond) came home after a fortnight's holiday." Here, however, the signs of fear seem to be less pronounced than in the case of returning to the old room. It would be difficult to give the right name to this curious moan.

Partial alteration of the surroundings frequently brings about a measure of this same mental uneasiness. C——'s disturbance at the age of twelve weeks at finding his mother in a new dress is paralleled by the apprehensions of Preyer's boy when one year and five months old on seeing his mother in a black dress. The second observation, read in the light of the first, seems to suggest that a change from the customary rather than anything appalling-looking in the black color itself was here the source of the boy's trouble.* This is borne out by another observation sent me. A child manifested between the ages of six or eight months and two years and a half the most marked repugnance to new clothes, so that the authorities found it very difficult to get them on. It is presumable that the donning of new apparel disturbed too rudely the child's sense of his proper self, and begot an uncanny feeling of another put in place of the old familiar child.

In certain cases the introduction of new natural objects of great extent and impressiveness will produce a similar effect of childish anxiety, as though they made too violent a change in the surroundings. One of the best illustrations of this obtainable from the life of an average well-to-do child is the impression produced by a first visit to the sea. Preyer's boy, at the age of

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* *Op. cit.*, p. 131. Compare the alarming effect of the father's putting on a big hat, p. 117.

twenty-one months, showed all the signs of fear when his nurse carried him on her arm close to the sea.* The boy C——, on being first taken near the sea at the age of two, was disturbed by its noise. While, however, I have a number of well-authenticated cases of such an instinctive repugnance to and something like dread of the sea, I find that there is by no means uniformity in children's behavior in this particular. A little boy who first saw the sea at the age of thirteen months, exhibited signs not of fear but of wondering delight, prettily stretching out his tiny hands toward it as if wanting to go to it. Another child, who also first saw the sea at the age of thirteen months, began to crawl toward the waves. And yet another boy at the age of twenty-one months, on first seeing the sea, spread his arms as if to embrace it.

These observations show that the strange big thing affects children very differently. C—— had a particular dislike to noises, which was, I think, early strengthened by finding out that his father had the same prejudice. Hence, perhaps, his hostile attitude toward the sea.

Probably, too, imaginative children, whose minds take in something of the bigness of the sea, will be more disposed to this variety of fear. A mother writes me that her elder child, an imaginative girl, has not, even now at the age of six, got over her fear of going into the sea; whereas her sister, fifteen months younger and not of an imaginative temperament, is perfectly fearless. She adds that it is the bigness of the sea which evidently impresses the imagination of the elder.

Imaginative children, too, are apt to give life and purpose to the big, moving, noisy thing. This is illustrated in M. Pierre Loti's graphic account of his first childish impressions of the sea, seen one evening in the twilight. "It was of a dark, almost black-green; it seemed restless, treacherous, ready to swallow; it was stirring and swaying everywhere at the same time, with the look of sinister wickedness." †

There seems enough in the vast waste of unresting waters to excite the imagination of a child to awe and terror. Hence it is needless to follow M. Loti in his speculations as to an inherited fear of the sea. He seems to base this supposition on the fact that at this first view he distinctly recognized the sea. But such recognition may have meant merely the objective realization of what had, no doubt, been before pretty fully described by his mother and aunt, and imaginatively pictured by himself.

The opposite attitude—that of the thoroughly unimaginative

* *Op. cit.*, p. 131.

† Le Roman d'un Enfant.

child—in presence of the sea is well illustrated by the story of the little girl, aged two, who, on being first taken to see the watery wonder, exclaimed, "O mamma, look at the soapy water!" The awful mystery of all the stretch of ever-moving water was invisible to the child, being hidden behind the familiar detail of the "soapy" edge.

There is probably nothing in the natural world which makes on the childish imagination quite so awful an impression as the watery leviathan. Perhaps the fear which one of my correspondents tells me was excited in her when a child by the sudden appearance of a mountain may be akin to this dread of the sea.

We may now pass to another group of fear-excitants—the appearance of certain strange forms and movements of objects.

The close connection between æsthetic dislike and fear is seen in the well-marked recoil of a child of thirteen months at the sight of an ugly doll. The said doll is described as a black doll with woolly head, startled eyes, and red lips. Such an ogre of a doll might well call up a tremor in the bravest of children.

In another case, that of a little boy of two years and two months, the broken face of a doll proved to be highly disconcerting. The mother describes the effect as a mixture of fear, distress, and intellectual wonder. Nor did his anxiety depart when, some hours later, the doll, after sleeping in his mother's room, reappeared with a new face.

In such cases, it seems plain, it is the ugly transformation of something familiar and agreeable which excites the feeling of nervous apprehension. Making grimaces—that is, the spoiling of the typical familiar face—may disturb a child even at the early age of two months.* Such transformations are, moreover, not only ugly but bewildering, and where all is mysterious and uncanny the child is apt to fear.

Children, like animals, will sometimes show fear at the sight of what seem to us quite harmless objects. A shying horse is a puzzle to his rider, his terrors are so unpredictable. Similarly in the case of a timid child, almost anything unfamiliar and out of the way, whether in the color, the form, or the movement of an object, may provoke a measure of anxiety. Thus a little girl aged one year and ten months showed during a drive signs of fear at a row of gray ash trees placed along the road. This was just the kind of thing that a horse might be expected to shy at.

As with animals, so with children, any seemingly uncaused movement is apt to excite a feeling of alarm. Just as a dog will run away from a leaf whirled about by the wind, so chil-

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* Quoted by Tracey, *op. cit.*, p. 29. But this observation seems to me to need confirmation.

dren are apt to be terrified by the strange and quite irregular behavior of a feather as it glides along the floor or lifts itself into the air.*

In these cases we may suppose that we have to do with a germ of superstitious fear which seems commonly to have its starting point in the appearance of something exceptional and uncanny that is unintelligible, and so smacking of the supernatural. The fear of feathers as uncanny objects plays, I am told, a considerable part in the superstitions of folklore. Such apparently self-caused movement, so suggestive of life, might easily give rise to a vague sense of a mysterious presence or power possessing the object, and so lead to a crude form of a belief in supernatural agents.

In other cases of unexpected and mysterious movement the fear is slightly different. A little boy, when a year and eleven months, was frightened when visiting a lady's house by a toy elephant which shook its head. The same child, writes his mother, "at one year and seven months was very much scared by a toy cow which mooed realistically when its head was moved. This cow was subsequently given to him at about two years and three months. He was then still afraid of it, but became reconciled soon after, first allowing others to make it moo if he was at a safe distance, and at last making it moo himself."

There may possibly have been a germ of the fear of animals here; but I suspect that it was mainly a fear of the signs of life (movement and sound) appearing when they are not expected and have an uncanny aspect. The close simulation of a living thing by what is known to be not alive is disturbing to the child as to the adult. He will make his toys alive by his own fancy, but resent their taking on the full semblance of reality. In this sense he is a born idealist and not a realist. More careful observations on this curious group of child-fears are to be desired.

Concerning an African idea of the origin of monkeys or chimpanzees, Mr. Herbert Ward relates a fable of the natives of Balangi and adjacent tribes of the upper Congo, to the effect that many generations ago a tribe of natives who lived on the banks of the Congo River, near Bolobo, fell into a condition of debt and difficulties with their neighbors. In order to escape the persecutions of their wrathful creditors, they retired into the great forest. Time passed, but they still remained poor. Forest life degenerated them. Hair grew upon their bodies. They arranged to forego speech, lest they should be recognized. They are still in the forest, and are known as *Bakewa*, or monkey men. Upon being asked if they ate chimpanzees, a member of the Balangi tribe replied: "No; we are not cannibals!"

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* See The Pedagogical Seminary, i, No. 2, p. 220.

ARCHÆOLOGY IN DENMARK.

By Prof. FREDERICK STARR.

A MUSEUM of national history is, in a sense, a symptom of patriotism. No wonder, then, that in Denmark, where every child absorbs love of country with his mother's milk and inhales it at every breath, such museums are in high favor. Two great governmental museums at Copenhagen illustrate the history proper of Denmark; one, the Museum of Northern Antiquities, is chiefly devoted to objects back of history.

Prehistoric archæology may almost be said to have taken its rise in the sturdy little northern kingdom. Here it was that Thomsen in 1836 first proposed the terms age of stone, age of bronze, age of iron, now universally used in the science. Thomsen was a man of profound learning, of most simple and beautiful character, and of immense energy. More than any other single man influential in the establishment of the museum, he shaped its early policy, and his name remains closely associated with its history. Director Thomsen believed in the educational value of the collections, and was ever ready to answer the question of a child or to explain to the common people the meaning and importance of the objects here displayed. This policy has been continued to the present, and the result is that the Museum of Northern Antiquities is known and loved by all good Danes (Fig. 1).

Fig. 1.—C. J. Thomsen.

The greatest name in Danish archæology is that of Worsaae. Of keen intellect, thoroughly scientific in his mode of thought, of remarkable executive ability, he gave final shape to the whole subject. Under his direction the museum grew enormously; most important explorations were conducted; steps were taken for the permanent preservation under governmental patronage of important tumuli, dolmens, and other antiquities and monuments both historic and prehistoric. J. J. A.

Worsaae was, moreover, a writer of force, and his archæological books and lesser writings are classical. The prehistoric chronology of Denmark suggested by him is practically that now used by all students; it is about as follows:

Stone age.	(*a*) Earlier	3000 to 2000 B. C.
	(*b*) Later	2000 to 1000 B. C.
Bronze age.	(*a*) Earlier	1000 to 500 B. C.
	(*b*) Later	500 to 100 B. C.
Iron age.	(*a*) Pre-Roman	100 B. C. to 100 A. D.
	(*b*) Later	100 A. D.

Thus fortunate in its early directors, the museum is no less fortunate in having for its present director a worthy follower of these two great men. Sophus Müller is ably carrying on the work of Thomsen and Worsaae. Assisted by a competent corps of helpers, the museum is vigorously prosecuting the work of field collecting, noting, mapping, and preservation of Denmark's antiquities. Dr. Müller has recently produced two important volumes entitled Ordning af Danmarks Oldsager. Volume I is devoted to the stone age, Volume II to the bronze age. The third volume, upon the iron age, is in preparation. In these works every type of Danish archæology is carefully described and the very great majority accurately figured. The text is Danish, but a *résumé* in French accompanies it; the pictures, of course, speak all languages (Fig. 3).

FIG. 2.—J. J. A. WORSAAE.

In Danish archæology there is *no palæolithic period.* Glacial deposits abound in Denmark, but so far evidence of man's existence there at that time is lacking. Very shortly after the ice retreated man must have appeared, and from that time on both the islands and Jutland have been occupied by busy, active, progressive men.

The oldest monuments seem to be the shell heaps or *kjoekkenmoeddinger.* These abound along certain parts on the coast, especially along the Kategat and elsewhere in Zealand and in Jutland. They are heaps sometimes hundreds of metres in length, dozens of metres in width, and as much as three metres in thickness. They consist mainly of the broken or entire shells of marine mollusks—the oyster, cockle, mussel, and periwinkle being the most common. Scattered through this mass of shells are bones of mammals, birds, and fishes, fragments of rude pottery, flint flakes, an occasional implement of bone, or a roughly chipped axe or knife of flint. Here and there are to be seen signs of fires. The word *kjoekkenmoedden* means a kitchen-refuse heap, and that is just what we have. These "kitchen middens" are old camp sites. Here men once lived. These shells and bones are refuse from their meals; these bits of pottery are parts of their dishes; these flint and bone tools were lost or discarded by the earliest Danes. Although living mainly upon mollusks, the man of the shell heaps was also a hunter. We have referred to bones of beasts and birds in the heaps. The eminent zoölogist Prof. Steenstrup, still living though now a very old man, carefully studied the "kitchen middens." He made an estimate of the frequency of bones in the heaps; each cubic foot contains ten to twelve bones of birds and mammals. It will easily be seen that the number of individuals represented in a large heap is really very great. The mammals found most frequently are the stag, reindeer, and wild boar. The relics from the shell heaps are of very rude workmanship. Flint flakes (Fig. 4) are common; a little chipping makes one of these into an axe, a knife, a saw, or an adze (Figs. 5 and 6). Occasionally little broad-edged chipped flints are found (Fig. 7). The type is one found in other parts of Europe, and it has given rise to considerable discussion among archæologists. There can be little doubt, however, that they are really blunt-

Fig. 3.—Sophus Müller.

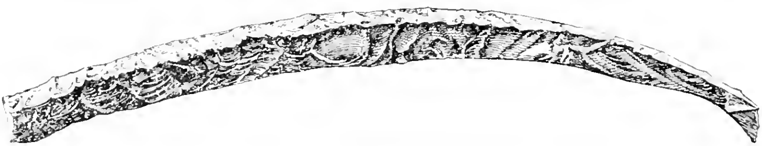

Fig. 4.—Flake. Flint.

point arrowheads; one Danish specimen has been found still attached to its slender shaft. The pottery fragments from the shell heaps are usually small, plain, and very rude and coarse. Bone piercers and combs are found occasionally. All the relics and the conditions of life hinted at by the food supply indicate that the primitive Danes were a low and savage people. Sir John Lubbock reproduces a picture of their life, no doubt very similar to that of the modern Fuegians. He says: "On the low shores of the Danish archipelago dwelt a race of small men, with heavy, overhanging brows, round heads, and faces probably much like those of the present Laplanders; living in tents of skin, they had weapons and implements of stone, bone, horn, and wood. Their food, consisting mainly of shellfish, comprised also fish and game. Probably eating was *gorging* and marrow was a delicacy. They were not summer visitors, but may likely enough have migrated frequently." (Not literal quotation.)

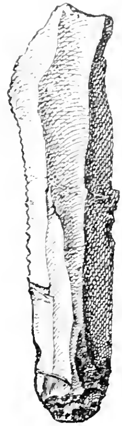

Fig. 5.—Knife or Scraper. Flint.

Yet this savage or barbarous man was not entirely without brute helpers. Among the mammalian bones in the heaps are those of the dog. Of course, the question arises whether these are the remains of wild dogs hunted as food, or those of domesticated or semi-domesticated dogs living about the settlement. Steenstrup's attempts to answer the question are sufficiently well known. He observed that nearly all the long bones of animals and birds were reduced to shafts, the heads or extremities having disappeared; he observed also that short bones were rare or almost lacking—there being fully twenty or twenty-five long bones for every short one. Struck by these facts, he experimented with dogs, giving them bones to gnaw. He found that they devoured short bones and gnawed the heads off the long bones, leaving the shafts in precisely the condition of those from the shell heaps. He concluded that dogs, at least half tamed, lived around the village and gnawed the bones thrown upon the refuse heaps.

Fig. 6.—Axe. Flint.

The Danish shell heaps are old. Worsaae estimates that they date to 3000 to 2000 B. C.

It is certain that since they were heaped up important changes have taken place in Denmark—changes in geography, in fauna, in flora. The sea line has changed; these heaps were formed at the water's edge—to-day many of them are at a considerable distance from the sea. The Baltic has become so fresh that oysters, once abundant and very large, have abandoned its waters. The hollows in the glacial deposits, during the centuries that have elapsed since the ice sheet withdrew, have gradually filled with peat formed by the decay of successive generations of plant life. The peat tells its own story to the geologist and declares that Denmark was clad in coniferous forests after the Glacial period; later it was covered with oak growth; at present, and for centuries past, beech has been the main arboreal product. Ah, well! the "kitchen middens" go back to the time of the evergreen forests. Bones of the capercailzie or blackcock are found in the shell heaps; this bird dwells no longer in Denmark, and it lives only on the buds of certain conifers. When these old gatherers of shellfish and hunters of stags lived here the *Urus* still inhabited Jutland, and game of many kinds was abundant.

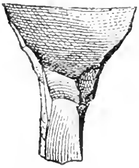

Fig. 7.—Blunt Arrowhead. Flint.

Fig. 8.—Unpolished Celt. Flint.

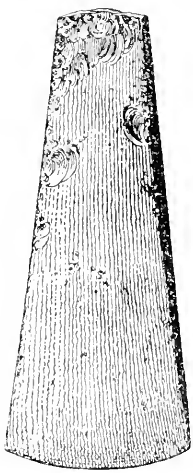

Fig. 9.—Polished Celt or Hatchet. Flint.

A year since we visited a shell heap in West Jutland that was being excavated under the direction of Mr. Neergaard, assistant of the museum. Located at the edge and on the slope of a terrace, at some little distance from the sea, it extended for many metres along the terrace, presenting a width of several metres and a maximum thickness of 1·75 metre. It had been cut across by a trench two metres wide and about eleven metres in length; this section was being removed carefully, a single cubic metre at a time. Every bone, potsherd, flint, or other relic as it was removed was

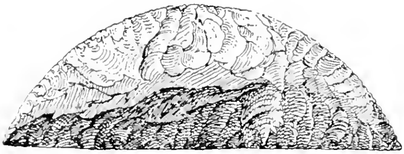

FIG. 10.—SAW. Flint.

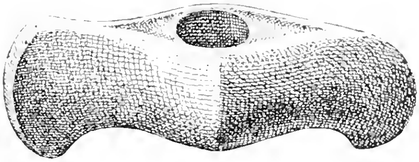

FIG. 11.—AXE. Stone.

at once labeled, and a complete record regarding it entered in a note-book. The commoner shells at this locality were species of the genera *Ostrea*, *Cardium*, *Littorina*, *Nassa*, *Tapes*, and *Mytilus*. Bones of various birds, mammals, and fish were rather common. The day we were there two diggers removed about three cubic metres of material, and the yield of relics was four rude flint axes, one fishhook, and some bits of pottery. The upper level area of the terrace proper is sprinkled with flakes, knives, and hatchets of flint, plain evidence of an old village site.

FIG. 12.—DAGGER. Flint.

The later neolithic of Denmark presents a magnificent development. Flint of the finest quality is found everywhere. In no part of the world did its chipping attain greater perfection. Material for other implements of stone was not rare, and was fully utilized. The consequence is that throughout the country beautiful relics of the later stone age are found; they lie on the surface; they are dug up in plowing and in excavations of all kinds; they are picked out by peat cutters; they are discovered in tumuli or old graves. Lubbock says: "Many of these barrows, indeed, contain in themselves a small collection of antiquities, and the whole country may even be considered as a museum on a great scale. The peat bogs, which occupy so large an area, may almost be said to swarm with antiquities, and Prof. Steenstrup estimates that, on an average, every column of peat three feet square contains some specimen of ancient workmanship."

This part of the stone age was marked by the curious habit of erecting great monuments of stone and earth—dolmens, giant chambers, etc. Such monuments are sometimes called megalithic monuments, from the great size of the stones used in their construction. Erection of megalithic monuments was by no means peculiar to Denmark, but was practiced throughout western Europe during the later stone age and on into the bronze age.

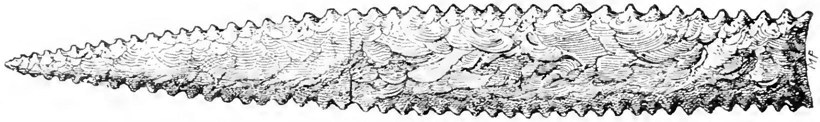

Fig. 13.—Spear Point. Flint.

It is stated that there are upon the islands of Denmark and in eastern Jutland about 47·5 of these monuments to every square myriameter, or one to about two kilometres square. In a single afternoon's drive from Olstyke around by Roskilde Fiord to Roskilde, a distance of but a few miles, we examined fully a dozen of different types. Three of these will illustrate their character. (*a*) *Dolmen:* Near a long and narrow strip of water, on a little mound of earth; consisting of five great granite rocks; four stood upright on edge, set firmly in the ground, and inclosed a nearly rectangular space six feet or more in length, more than three feet wide, and some five feet high. Three of these stones are of equal height, and bear a great cap-stone; the fourth one is not so high, and serves as a sill or threshold to the chamber. The whole structure is now free and exposed, but it was probably originally covered with a mound of earth. (*b*) *Giant's Chamber:* Externally, a simple plain mound of earth about fifteen feet high. As it is one of the monuments preserved by the Government, it is supplied with a little door on one side. Passing through this, we found our way through a short passage into a great chamber at right angles to it; the passage enters this chamber at the middle of one of its long sides. Both chamber and passage are walled with great bowlders, and are roofed with slabs of large size. The chamber is about twenty-one feet long, seven feet wide, and over six feet in height. (*c*) Badly denuded by the weather; a large part of the covering mound is gone; there are no roofing slabs, but the stones are carefully set on edge so as to inclose a space forty feet in length and more than twenty feet in width; there is no sign of a passageway. In the middle of this inclosed space is an admirably made rectangular chamber about four feet deep, six feet in length, and perhaps four feet in width.

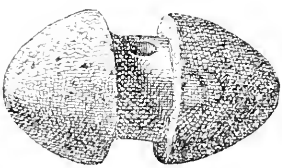

Fig. 14.—Miniature Hammer. Amber.

It is probable that all these structures were burial places.

In those which have remained intact skeletons are often found, together with objects of use or decoration. The dolmen type is generally considered the older; the *jattestue*, or chambers with passage, are later; the rectangular stone coffins, or cists, with no approach are still more recent. The later stone-age man in Denmark cared well for his dead. He apparently believed in a future life, else why should he so carefully bury with his dead such beautiful and valuable objects? In some cases a tumulus might be erected for a single dead man; very commonly, however, several dead were buried in one mound; occasionally scores were thus companions in a common grave.

Fig. 15.—Garments of the Bronze Age.

The man of the later stone age in Denmark was not ill equipped. Implements and tools and ornaments of stone, bone, horn, wood, etc., were his. His list of weapons and tools included beautiful celts or hatchets of flint finely polished, war clubs, lances, arrows, poniards of flint chipped to the most graceful forms, axes, chisels, saws, knives, scrapers, hammers (Figs. 8–13). This is but a part: wonderful samples of chipping, of polishing, of drilling; beautiful in form and finish. Nor were they useless objects. The weapons were perfectly adapted to their purpose. As for the tools, we may be sure that they were serviceable. In the little town of Broholm, in Fünen, is a small wooden house containing a fine collection of stone implements. These were found on the estate of a nobleman, who, after gathering the series, ordered carpenters to build for him a house for their display, stipulating that they should only use the old stone tools in its construction. A book has been written giving the full details of the work, and we can see that a carpenter of our day might be in a worse plight than to be supplied only with a neolithic kit of tools.

That neolithic man in Denmark was an artist is shown by these wonderful stone objects; it is also shown by the beautiful forms and neat decorations of his pottery and by his ornaments. Of these last the most interesting certainly are those of amber. This brilliant yellow fossil resin early attracted his attention. At first he strung the rough pieces, just as he found them, on to strings or thongs, or rounded the bits into rude beads; later on amber was worked carefully into various pretty or curious forms. A favorite pendant was a miniature axe (of the same shape as the stone ones in actual use) in amber (Fig. 14). Curious questions are suggested by these. Neolithic man in Europe seems to have had superstitious ideas or even reverence toward the stone axe. It is possible that these miniatures in amber were amulets or charms.

This rich development of the stone age which we have been considering is generally referred to the period from 2000 to 1000 B. C. It is considered as an outgrowth from the ruder conditions

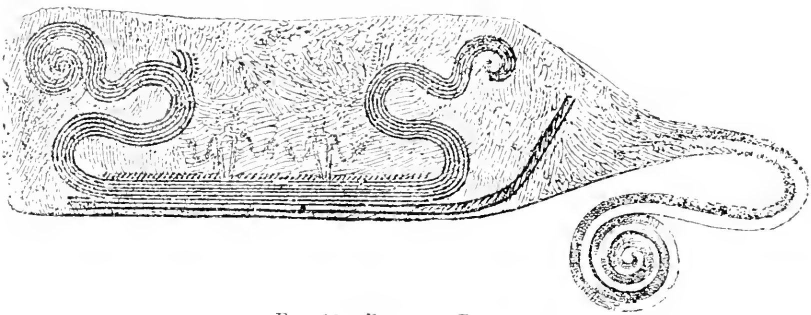

Fig. 16.—Razor of Bronze.

of the kitchen middens. It is but fair to state that a bitter controversy has been carried on over the matter. Some—among them Steenstrup—have argued that this high culture and the savagery of the shell heaps were contemporaneous; that the men of the *kjoekkenmoeddinger* and of the *megalithic monuments* were neighbors; that poor, primitive, backward fisher folk lived side by side with rich, advanced, more civilized agriculturists of the interior. We have not space to present the argument; we follow Worsaae.

The bronze age in Scandinavia was a marvelous development. Probably the knowledge of bronze was brought to Denmark from the Orient; perhaps the amber of the northwestern country was bartered to the cultured people of the East. However that may be, bronze reached Denmark. Nor were the skillful chippers and polishers of stone slow in learning how to use the new and precious material. Those who had been the best lapidaries of Europe became the best metallurgists. Nowhere are there so many peculiar, beautiful, and artistic types in bronze as in Denmark and Sweden. Bronze was made into implements and weapons; it was also fashioned into ornaments. Gold, too, was known and widely used.

We have emphasized the fact that the dead were buried during the neolithic. At the beginning of the bronze age inhumation

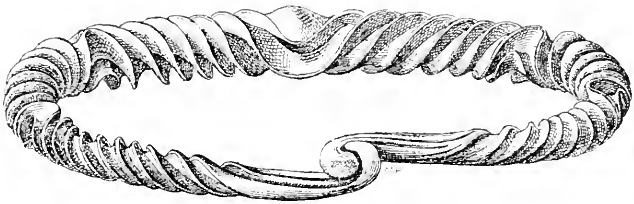

FIG. 17.—BAND OF BRONZE.

was also practiced. Stone cists of full size were constructed in many cases; in others very curious coffins, made by splitting oaken tree trunks and then hollowing the two pieces, one into a trough and the other into a cover, were constructed. As time passed cremation was practiced; the ashes were buried in stone cists, which gradually diminished in size until at last they were only about a foot square. In these latter cists the ashes were frequently placed in a vessel of clay. Finally, the cists disappeared, and the clay urn containing the ashes might be simply covered with a flat stone and buried in the ground. As cremation gained and the grave cists diminished in size, the gifts placed with the dead became fewer and less important; real objects were replaced by inferior ones or miniature make-believes. Had we only the relics from the graves we would be led to think that art degenerated during the bronze age; but the contrary was really true. The objects found in the peat bogs and elsewhere show an improvement and progress in artistic work.

FIG. 18.—GOLD CUP.

Certain grave mounds in Jutland have informed us as to the dress of the people of the bronze age. In them were found oaken coffins such as we have described above. In these, wrapped in cowskin shrouds, have been found the remains of men and women, more or less preserved, with garments and funereal objects almost intact. High woolen caps, with knotted cords all over the outside for ornamentation; wide mantles cut round; mantles of mixed wool and hair; waistbands bound around with a tasseled girdle;

sleeved jackets—all well made and of good material—are among the garments (Fig. 15).

To describe even a tithe of the types in bronze would require more space than we may use. Of weapons we may mention swords and daggers, beautiful in form and decoration, lance and spear heads, battle-axes; of tools and implements, hatchets, axes, knives, razors (so called) of quaint shape and frequently with engraved patterns on the blade (Fig. 16); of ornaments, every conceivable variety of rings for fingers, arms, neck, and head. The ornaments may be either of gold or bronze. Some of the neck or head bands are elaborately twisted (Fig. 17); finger and arm rings may be simple rings or may be spirals; fibulæ or safety pins are worked out in many curious and attractive patterns. Vessels, too, of gold or bronze have been found, and these, reproduced by modern workmen, delighted many visitors to the Exposition in 1893 (Fig. 18).

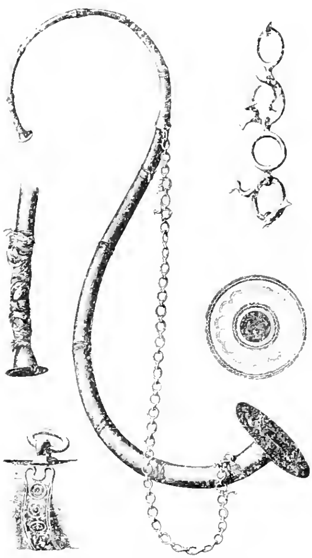

Fig. 19.—Bronze Battle Horn.

Among the masterpieces of the bronze-worker which have come from that olden time to us are great bronze battle-horns, called by the Danes *lur*. These are truly gigantic. Twenty-three specimens have been found in Denmark, all in peat bogs, and most of them in pairs (Fig. 19). For years a dozen of these lurs hung in the museum silent. Recently Dr. A. Hammerich secured permission to study them as musical instruments and to test them. Finally, these were played upon

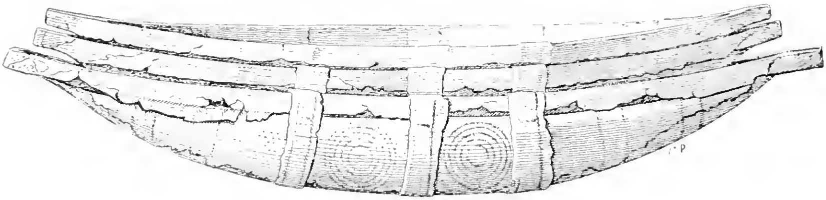

Fig. 20.—Miniature Boat of Gold.

before a large and enthusiastic audience, the king himself being present. Only a few times since have these old horns been sounded, but on one of these occasions we had the good fortune to be present. Two players from the opera were the performers; the court of the museum was filled with hearers. Wonderful, is it not, that horns two thousand years old, buried for long centuries in peat bogs, should, after this long silence, still be capable of giving out clear, ringing—even sweet—tones?

The conditions in which these lurs are found are most suggestive—always in peat bogs, usually in pairs. This could not be the result of accident. Other objects are found purposely laid away in the same manner: thus ten bronze hemispherical plates were found at one spot; nine fine bronze axes, all of one form, at another. Similar clusters of celts, spears, etc., are not uncommon. On one occasion about one hundred miniature boats of thin beaten gold were placed in a vessel and buried; such occurrences are not completely understood. Dr. Sophus Müller believes that such purposely buried or sunken objects are *ex votos* (Fig. 20).

Fig. 21.—A. P. Madsen.

The early iron age presents interesting problems and wonderful relics. Still *prehistoric time* in Denmark, it is *historic time* in much of Europe. The Danes now disposed of their dead both by inhumation and cremation; with those who were buried relics are found. Near Tistrup, in West Jutland, with Captain A. P. Madsen, of the museum, we were present at some excavations. Captain Madsen has long been engaged in studying the archæology of Denmark. He is an artist of no mean ability, and has sketched and painted many of the old monuments. His *Bronzealderen* and other works (one of which is now appearing) are important and especially valuable for their illustrations. He is an indefatigable field explorer (Fig. 21). The spot was a level field overgrown with heather in bloom. Only the practiced eye would have detected aught there of archæological interest. The whole area, however, was covered with low, flat, round mounds several metres in diameter and less than half a metre in height. Digging revealed at the center of each, only a little below the surface, a single pottery vase. The forms were simple, but characteristic of the age. In them were mixed earth and ashes (the remains of a cremated corpse). Iron fibulæ, fragments of bronze rings, and the like were found with some of these.

In such cases the bronze is usually fairly preserved, while the iron is deeply rusted and frequently quite fragile.

The best preserved iron objects come from certain peat mosses. In some of these enormous deposits have been found. The famous localities are *Nydam* and *Thorsbjerg*, now, unfortunately, no longer Danish possessions. At Thorsbjerg the articles were found mainly in a layer of soft dark peat, about five feet thick, which was under eleven feet of peat of a different character. The objects were apparently placed here intentionally and at one time. Several layers of wooden shields, one above the other, with javelins

Fig. 22.—Commemorative Bronze Tablet in Museum Court.

thrust through them; in another spot, pieces of chain mail; elsewhere, bundles of iron spearheads or arrowheads wrapped in chain mail, a cluster of objects of gold, vessels of clay sunk by stones placed in them. Everything had been destroyed or rendered worthless before it was placed here. Of course at that time the upper eleven feet of peat had not formed, and there was probably a pond of water above the antiquities-bearing layer. At Thorsbjerg, for some reason, the iron has not been well preserved; at Nydam it is in excellent condition. Here the relics lay at a depth of some four to seven feet on a sandy and clayey bottom; as at Thorsbjerg, the objects are clustered and grouped together as if sunken in bundles; here, too, the objects have been rendered useless before deposition. Spears and swords were thrust violently, perpendicularly through the stratum containing the relics. At this locality, too, were found two or three boats; the largest, of oak, some seventy-seven feet long and about ten feet wide, was a fine piece of work. These were intentionally sunk. Some of the iron objects were magnificent pieces; certain sword blades were handsomely damascened. Roman workmanship or influence is shown by some of the objects from these mosses. A number of Roman coins from here range from about 60 to 217 A. D. Thus we may fix the age of the deposit.

We have but glanced at a few of many interesting matters which are fully illustrated in this great museum, of which Denmark is so justly proud (Fig. 22).

THE OFFICE OF LUXURY.

By M. PAUL LEROY BEAULIEU.

THE question whether luxury is legitimate or illegitimate, useful or injurious, is most actively debated. The moralists claim that it is within their peculiar field, and it has been one of their favorite subjects for discussion from the days of antiquity down. We can not, however, leave it to them. Economists have an interest in it. It does not concern only precepts and rules for an edifying conduct of life, but bears also upon the direction that ought to be given to production, or to a considerable part of it at least, and upon the influence of certain kinds of consumption on the distribution of wealth and on the respective situations of different classes of society.

One of the difficulties encountered in the discussion, and no small one at that, is that of finding an exact definition of luxury. Most even of the best definitions are insufficient and vague. It is very hard to find an absolute formula for a thing so relative, fluctuating, and variable. The definition we would propose is that luxury consists of that superfluity of enjoyment which exceeds what the generality of the inhabitants of a country at a given time consider essential, not only for the necessities of existence but also for decency and comfort in life. It is, therefore, curiously variable, constantly taking a new position as the limit of ordinary enjoyment advances at a corresponding pace with the increasing wealth and refinement of a society. This definition has the merit of regarding luxury as relative and as changing in standard from age to age.

To the barbarians who ravaged the Roman Empire the simple furniture and wardrobe of a modest household of our middle class of people, or of the better class among our working people, would have seemed to have a profusion of luxurious objects; a few not costly easy-chairs, a carpet, window curtains, cheap wall paper, a looking-glass, a clock, a few vases filled with flowers, a small show of plate, shirts, handkerchiefs, neckties, stockings—all would be new to them, and not essential either for the normal wants of existence or even for decency and pleasant living. The idea of what constitutes luxury varies in the most striking manner according to the country, the times, and the classes of society. Each class considers a luxury whatever its circumstances do not allow it to possess, and which a higher class is, nevertheless, able to enjoy. It has been manifest over and over again that the luxury of one period, or of one social class, tends inevitably to become at least a requisite of respectability for the following age and the next lower class. Civilization is characterized by the gradual, progressive, general distribution of many elements of luxury which thus gradually lose that character. Every ten years, some luxuries cease to be such in consequence of their becoming more common and cheaper.

In speaking of the principle of luxury we should consider it apart from the excesses and excrescences that have been associated with it. A great many men regard luxury as an abuse, a sin, a scandal. Some imagine that if it were got rid of, society would be happier and more moral. Many believe that the superfluities of some are gained at the expense of necessaries of others. The enemies to the principle of luxury may be arranged in two divisions: moralists and politists, and economists.

The political arguments against luxury bear chiefly upon the two points that it increases the separation between the classes of the population, and makes it more marked; and that it enervates man and makes civilized populations more easily subjects for spoliation by barbarians. We have shown in another place that the gap between the conditions of different classes of men is tending to diminish.* This inequality, furthermore, has not unwholesome effects only; it is both the result and the stimulus of civilization. In regard to the dangers that luxury may bring upon the state, it should be observed that luxury is one thing and luxurious living is another. We may love and seek luxury in furniture, decoration, and objects of art, and live simply. The physical deterioration assumed to result from luxurious tastes has not been proved. In almost every country of Europe the young people of the most aristocratic classes display,

* Essai sur la répartition des richesses et la tendance d'une moindre inégalité des conditions.

in physical exercises and acts of courage, at least as much vigor and resolution as men of other social grades. Civilized peoples have during the past three centuries obtained most brilliant advantages over barbarians. If civilization is threatened, it is much less by the taste for elegance in living than by the poison of certain doctrines, and by a mental and moral dilettanteism that has no necessary relation, in its adepts, to an enlightened taste for objects of luxury.

When we read most of the criticisms that have been uttered against luxury, even by great writers, we find that they are inspired by a thought as inexact as it is superficial; by the mistake of supposing that the superfluous luxuries enjoyed by the wealthy are acquired at the expense of the necessaries of the poor. If no fine shoes were made, it is said, everybody would have good shoes; but all men in civilized countries have got their good shoes without the manufacture of fine boots for men and women being diminished. Again, we hear, would the world not be better off if, instead of ten or twenty thousand objects of luxury, ten or twenty thousand useful things were made?

The question can not be put in this way. The conception of social activity that lies at the bottom of this reasoning is false. It regards social activity as a factor fixed once and forever; and it imagines that if we take five hundred thousand days' work for superfluities, this five hundred thousand days' work will be lacking for necessaries. We should ask whether man's productive capacity, his inventive force, his energy in working, and the progress of the arts and sciences have not been kept up and extended by the constant seeking for a more embellished life and the satisfaction of more diversified wants; if a society that does not condemn and proscribe luxury has not, even in the matter of common objects, an infinitely greater productive force than a society that does condemn and proscribe it. We should inquire if the taste for novelty and change that characterizes luxury does not contribute to keep the general spirit of a society more on the alert, more ready to institute better industrial conditions and make discoveries and improvements; and if, on the other hand, a society always held down to the same kind of monotonous, insipid life would be as productive, even in agriculture and the common arts, as another, excited to incessant activity by luxurious tastes.

Industrial progress and the extension of general wealth make common many articles once regarded as luxuries. Sugar, spices, and coffee were once luxuries; drinking glasses, window panes and curtains, and carpets. Watches and clocks were grand luxuries till they could be made for eight or ten dollars. In articles of clothing, shirts, stockings, shoes, pocket-handkerchiefs (even in Montaigne's time), ribbons, and lace were regarded as superfluities which men and women living naturally could well do without. In London, in the eighteenth century, the use of umbrellas was looked upon as effeminate. In the planning of the household, a dining room distinct from the kitchen, a parlor distinct from the dining room, a sitting room distinct from the bedroom, a bath room and water-closet, were considered useless, and are still by some people. Thus, fortunately, the bounds of luxury keep on retreating. The luxury of other days becomes, if not a necessity, an enjoyment of the present, useful or inoffensive, within the reach of a large number of men. Whether its roots lie in sensuality and vanity, as its critics affirm, or in æsthetic taste, luxury, if it is not in violation of Nature, is propagated through the instrumentality of man's imitatve instinct; of his desire to conform to the ways of those in the highest ranks, and to the feelings and manners prevalent in the community. Thus luxuries are gradually transformed into decencies. Old men seldom fail to call every new fashion, and everything of the uses of which they were ignorant in childhood or mature age, a luxury.

The character of a thing in use should be judged, not according to certain ideas we form of human nature in general, but according to circumstances of time, place, climate, profession, and surroundings.

The evolution of luxury has been divided into three periods: the luxury of primitive periods, which was exemplified in patriarchal times, and in the beginning of the middle ages; luxury of flourishing and prosperous peoples, as in the modern age; and the luxury of peoples in decay, like the ancient Romans and the Orientals.

Primitive luxury is very simple. It consists chiefly in the grouping around the rich man, who is also usually of high birth, of a large number of servants supported by him, and in the practice of an extensive hospitality. The furnishings of this luxury are very limited: fine wardrobes, elegant arms, spirited horses, and rich caparisons. Though pleasant in appearance, and having a family air, this patriarchal luxury has its inconveniences, which are much less apparent in modern luxury. It creates and maintains legions of parasites and idlers. Its world of servants and clients do little work, but are supported by the labor of others. It brings no refinement in living, it is burdensome, nurses conceit, diminishes production, and deprives numbers of people of their independence, exposing them to the vices of indolence. Another phase of this primitive luxury was exhibited in the great feasts, which were characterized by quantity rather than quality, with coarse revels lasting many days. This luxury was occasional rather than permanent, and did not penetrate, as the later living did, into the whole tissue of life. The people's equivalent for the expensive feastings and revels of the grandees was found in kirmesses and carnivals. The forced sobriety of these uncultivated ages was interrupted by periodical debauches. No thought was taken of comforts. Except for the furnishings of the church and drinking vessels, there were few things of beautiful finish. Fashions did not change; there was no elegance and no variety in daily personal life, and workmen's wages were very small. Thus all was for display and nothing for comfort, and waste of men and means was the rule. Very different is the luxury of civilized, intelligent, and thoughtful people, which looks more to the comfortable or to elegance and artistic enjoyment than to magnificence and sumptuousness. It includes and penetrates the whole life, and extends in different degrees over all classes of the people. It is distinguished by the use of an infinitely greater variety of goods, and for each kind of an increasingly more considerable range of qualities. It adapts itself to democratic habits, which it has contributed to introduce. Instead of encumbering himself with a great number of domestics, clients, and parasites the prosperous citizen has around him only the number of people he requires for a good and prompt service; while, on the other hand, he has at his command independent outside workmen who develop into the honored class of artisans. Together with the immense permanent household installations, external distinctions and extensive private establishments of all kinds are given up, their places being supplied by those which may be used in common with the public.

The luxury of these prosperous and democratic periods reaches in multiplied and infinite gradations all classes of the people; then, supplying itself with durable objects and permanent arrangements, it becomes an accompaniment of the whole life. Its great characteristic is variety and elegance in necessary and usual objects. The extension of this luxury into all grades of the population is aided by such technical knowledge as permits the substitution of less costly goods for those which are more so, whereby things formerly enjoyed only by the wealthy are put within reach of persons of modest means: thus plate and white metal take the place of silver; electrotypes, of carved work; lithographs and photographs, of engravings and paintings; and figured papers, of tapestries. Cotton and silk mixed or silk waste give the illusion of silk; tulle and gauze, of lace. New substances, like nickel and aluminum, make it easy to possess watches, clocks, and the like, elegant in appearance and yet cheap. Improvements in the mechanic arts aid in this; and everything is imitated, even pearls and diamonds. There is nothing immoral in this sort of luxury, which varies, brightens, and embellishes life, and incites the man to better care of his house and his person. It is, rather, a motive of good economical and domestic habits. And it promotes a kind of saving. A man who will not lay up for old age will save money to buy a gold watch or a chain, or nice furniture. Fondness for variety is one of the characteristic traits of the luxury of intelligent and prosperous peoples. Variety in food, clothing, furnishings, and in amusements is an excellent stimulant to industry, a preventive of enervation of man's mind. It is likewise one of the most vital needs of human nature, one of the legitimate charms of life. The luxury of industrious and prosperous peoples is predominantly exhibited in the dwelling and the furniture. It creates permanent establishments that make life more pleasant. It transforms the house from a simple shelter into a commodious and pleasant mansion, beautified and vivified with numerous and interesting objects. Herein lies the inappreciable benefit of national modern luxury. This it is that has divided up the house according to the various wants and conveniencies for which it is intended to provide. The result is a more becoming, more private, and more independent daily life for each of the members of the family, as well as a more hygienic *régime*. The example spreads from the upper to all the social classes. The house becomes the center of man's efforts to embellish. Many bad habits and many vices are abandoned. It is a general opinion that whenever the workman shall have a sufficiently ample abode, diversified and adorned, the family life will retain more attractions and the saloon will lose them.

While modern taste expends liberally on the construction, furnishing, and decoration of the house, it encourages sobriety in the wardrobe. It is one of its characteristics that it makes itself compatible with civil equality and with fraternity in social relations, colliding with them in nothing. The dress of the men bears witness to this. Men are no longer to be seen, as Henry IV of France used to say, "wearing their mills and their forest estates on their backs." Lace, in sleeves and frills, formerly habitual with middle-class people, has long been left off by the men, and there is no prospect of its returning. Who, when he looks at an assembly of two or three hundred men, including representatives of all classes, from the highest to the most modest, can tell from their dress which are the wealthy ones? It is true that women still indulge in these little extravagances; but this does not prove that the majority of the rich expend more now upon dress than those similarly situated have done during the past three or four hundred years. We complain that maids wish to be dressed like their mistresses, farm-servants like the farmers' wives, and these like the landlords' wives. A few may be extravagant; but nearly all these people, servants and farmers, save; and a little luxury in their lives does no great harm. By virtue of the blending of these shades of luxury between one social stratum and another, the difference in the lives of men of the several classes is much less as to the real enjoyments they are all able to procure than as to the cost of what they possess.

External luxury is becoming less conspicuous. There are no more gilded carriages with footmen and outriders, except to mark the state of ambassadors. The simple carriages now in use, however elegant their forms may be and handsome the horses that draw them, are otherwise as democratic in appearance, without showy harness decorations or extraneous ornaments, as the old-fashioned post chaises.

Judicious investment in luxury constitutes a kind of revenue fund for emergencies and times of need. This is true for all classes and for the whole nation. Jewels, pretty pieces, tapestries, pictures, and choice collections may be sold in periods of misfortune without loss. Even among those in more moderate circumstances the watch, the chain, the clock, and the cheap jewels are adequate to procure in days of distress or illness, if not much, something that could not be had otherwise.

Such luxury as this, far from being immoral and deleterious, is legitimate, commendable, and useful, provided that with it allowance is made from the income for future emergencies, and for saving.

Quite different is it with the luxury of periods of decay and of corrupt classes; for morbid social groups may exist even in a country generally sound. This luxury becomes immoral and unintelligent when, instead of responding to natural and normal physical and intellectual wants, it consists solely in the seeking for costly pleasures and objects simply because they are costly, in systematic waste, and in the single satisfaction of an extravagant vanity. These features of social life were marked among the wealthy classes of the Roman Empire, but appear only in individual examples and a few narrow circles in modern life. It is not by such eccentricities, which have become rare among modern peoples, that luxury is to be judged. As we have described it, it is impossible to condemn it. Regarded in a general aspect, and apart from its abuses, luxury is one of the principal agents of human progress. Mankind has it to thank for nearly everything which to-day adorns and embellishes life, and for a large proportion of what makes life more pleasant and wholesome. It is the father of the arts. Neither painting nor sculpture nor music, nor their popular accompaniments, could ever have become so greatly developed and so widely diffused in a society that had declared war on luxury.

It has been objected that if luxury did not exist the world would be better provided with articles of use. The millions that are spent in luxury, these objectors say, could be better applied to the production of wheat or of potatoes or of common clothing; if some were not too rich, none would be poor. This reasoning is at fault in two points: First, a million's worth of luxuries does not, as some persons think, represent the amount of labor and human force required to produce a million's worth of wheat or potatoes or common clothing or plain furniture. The cost of luxuries bears only a comparatively small relation to the quantity of good work; by far the greater proportion of it is paid for quality. An accomplished jeweler or engraver can earn three or four times as much in working at the art in which he excels as in applying the same quantity of labor to a coarser trade—blacksmithing, for instance. And if luxuries were abolished, and the artists now employed in producing them were set to some common labor in farming or the ruder trades, they would not be able to produce at them more than one third of the value which they now bestow upon the world of taste and refinement. In the second place, we need not deny that materially, and aside from a fact to be noticed, if mankind would limit its wants to bread and meat, to the commonest clothing, the most modest abodes, and the simple articles of use, it would be able to get a considerably larger number of such things. If all the painters, engravers, upholsterers, pleasure-coach makers, jewelers, makers of fine furniture, lace-makers, embroiderers, etc., should return to tilling the soil, spinning, weaving, and knitting, a more ample stock of the products of the common callings might be obtained. This is only possible. It is not certain. In assuming it we leave out of view the indirect consequences of such a profound modification in men's desires, in their life, in their motives to effort as such a change would work. We overlook the depressing, stupefying influence which monotony and uniformity in occupation would exercise upon man's activity, his spirit of initiative, and his zeal in research and invention. A society in which all were engaged upon nearly the same tasks, living in identical conditions, having narrow wants, none of them enjoying visions of a brilliant future different from that of his fellows, would fall dead with inertia and routine. It would lose in elasticity and inevitably becomes stationary, and finally retrograde; and it would not be paradoxical to assert that the suppression of luxury would result, in the course of time, in a diminution even of objects of ordinary consumption.

The stimulating action of luxury is incontestable, and operates upon every grade of the social scale. While luxury is not the only instigator of human activity, or even the principal one it is one of unquestionable importance; and there are none too many instigating forces to arouse man from inertia and idleness. At the highest degree of the scale, some men—we will not say all—impose additional work and mental tension upon themselves in order to have an elegant house, fine gardens, and high style; in the middle of the scale, other men will put themselves to additional trouble in order to procure some comfort which was only recently a luxury, and can still hardly be distinguished from one, or in order to reach a certain standard of respectability in their manner of living, to which decorations and superfluities will contribute. At the bottom of the scale numerous men and women work longer or tax their ingenuity in order to procure for themselves some secondary elegances which have become common but are nevertheless luxuries, in that the abundance of them does not contribute to the satisfaction of man's rudimentary wants.

The influence of luxury is very great upon social progress and the arts, and upon the course of literary and scientific advance. Industrial advancement is usually brought about by the efforts of individuals of remarkable will and intelligence, but sensitive to the attractions of material rewards. The surest of such rewards for the numerous spirits not solely devoted to an ideal is wealth, and this to many men would lose its value if they were deprived of the luxuries which they could obtain with it. While there are many men of noble aspirations among great inventors and the projectors of important enterprises who would be satisfied with the good they accomplished, there are others, energetic, capable, and ardent, and valuable in economic progress, who are guided by less noble ideas, and who, in themselves or their surroundings, have keener perceptions of the attractions of luxury than of pure intellectual enjoyments and the satisfaction of an elevated self-respect. It is important for mankind as a whole that such men do all they can for it.—*Translated for The Popular Science Monthly from the Revue des Deux Mondes.*

The Congo natives of all tribes, Mr. Herbert Ward says, are ready speakers, flowery in expression, adepts in the use of metaphors, clear in reasoning, and alert in debate. The sonorous effect of their speech is greatly aided by the soft inflections and harmonious euphony of their language. In many of the tribes it is common for the speaker to hold in his hand a number of small sticks, each representing a preconsidered point of his argument. Each point is subsequently enumerated and emphasized by selecting and placing one of these sticks upon the ground. A speaker will often begin his address by referring to events that happened in his earliest recollection, and in this manner will refer to every favorable incident in his career, whether his stories apply or not to the subject under discussion.

PROFESSIONAL INSTITUTIONS.

I.—PROFESSIONS IN GENERAL.*

By HERBERT SPENCER.

WHAT character professional institutions have in common, by which they are as a group distinguished from the other groups of institutions contained in a society, it is not very easy to say. But we shall be helped to frame an approximately true conception by contemplating in their ultimate natures the functions of the respective groups.

The lives of a society and of its members are in one way or other subserved by all of them: maintenance of the life of a society, which is an insentient organism, being a proper proximate end only as a means to the ultimate end—maintenance of the lives of its members, which are sentient organisms. The primary function, considered either in order of time or in order of importance, is defense of the tribal or national life—preservation of the society from destruction by enemies. For the better achievement of this end there presently comes some regulation of life. Restraints on individual action are needful for the efficient carrying on of war, which implies subordination to a leader or chief; and when successful leadership ends in permanent chieftainship, it brings, in course of further development, such regulation of life within the society as conduces to efficiency for war purposes. Better defense against enemies, thus furthered, is followed by defense of citizens against one another; and the rules of conduct, originally imposed by the successful chief, come, after his decease, to be re-enforced by the injunctions ascribed to his ghost. So that, with the control of the living king and his agents, there is gradually joined the control of the dead king and his agents. Simultaneously with the rise of agencies for the defense of life and the regulation of life, there grow up agencies for the sustentation of life. Though at first food, clothing, and shelter are obtained by each for himself, yet exchange, beginning with barter of commodities, gradually initiates a set of appliances which greatly facilitate the bodily maintenance of all. But now the defense of life, the regulation of life, and the sustentation of life, having been achieved, what further general function is there? There is the augmentation of life; and this function it is

* The series of articles to which this is introductory will in their eventual form be chapters constituting Part VII of The Principles of Sociology—Professional Institutions. Hence the explanation of the various references and allusions to preceding parts of that work which they will be found to contain. The various references to books will, as in past cases, be found at the end of the volume when published.

which the professions in general subserve. It is obvious that the medical man who removes pains, sets broken bones, cures diseases, and wards off premature death, increases the amount of life. Musical composers and performers, as well as professors of music and dancing, are agents who exalt the emotions and so increase life. The poet, epic, lyric or dramatic, along with the actor, severally in their respective ways yield pleasurable feelings and so increase life. The historian and the man of letters, to some extent by the guidance they furnish, but to a larger extent by the interest which their facts and fictions create, raise men's mental states and so increase life. Though we can not say of the lawyer that he does the like in a direct way, yet by aiding the citizen to resist aggressions he furthers his sustentation and thereby increases life. The multitudinous processes and appliances which the man of science makes possible, as well as the innumerable intellectual interests he arouses and the general illumination he yields, increase life. The teacher, alike by information given and by discipline enforced, enables his pupils more effectually to carry on this or that occupation and obtain better subsistence than they would else do, at the same time that he opens the doors to various special gratifications: in both ways increasing life. Once more, those who carry on the plastic arts—the painter, the sculptor, the architect—excite by their products pleasurable perceptions and emotions of the æsthetic class, and thus increase life.

In what way do the professions arise? From what pre-existing social tissue are they differentiated—to put the question in evolutionary language? Recognizing the general truth, variously illustrated in the preceding parts of this work [The Principles of Sociology], that all social structures result from specializations of a relatively homogeneous mass, our first inquiry must be —in which part of such mass do professional institutions originate.*

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* When, more than twenty years ago, the first part of the Descriptive Sociology was issued, there appeared in a leading weekly journal, specially distinguished as the organ of university culture, a review of it, which, sympathetically written though it was, contained the following remark: "We are at a loss to understand why the column headed 'Professional,' and representing the progress of the secular learned professions . . . appears in the tables as a subdivision of 'Ecclesiastical.'"

The raising of this question shows how superficial is the historical culture ordinarily provided. In all probability the writer of the review knew all about the births, deaths, and marriages of our kings; had read the accounts of various peoples given by Herodotus; could have passed an examination in Thucydides; and besides acquaintance with Gibbon, probably had considerable knowledge of the wars carried on, and dynastic mutations suffered, by most European nations. Yet of a general law in the evolution of societies he was evidently ignorant—conspicuous though it is. For when attention is given, not to the gossip of history, but to the facts which are from time to time incidentally disclosed respecting the changes of social organizations; and when such changes exhibited in one society are

Stated in a definite form the reply is that traces of the professional agencies, or some of them, arise in the primitive politico-ecclesiastical agency; and that as fast as this becomes divided into the political and the ecclesiastical, the ecclesiastical more especially carries with it the germs of the professional, and eventually develops them. Remembering that in the earliest social groups there is temporary chieftainship in time of war, and that where war is frequent the chieftainship becomes permanent—remembering that efficient co-operation in war requires subordination to him, and that when his chieftainship becomes established such subordination, though mainly limited to war times, shows itself at other times and favors social co-operation—remembering that when, under his leadership, his tribe subjugates other tribes, he begins to be propitiated by them, while he is more and more admired and obeyed by his own tribe—remembering that in virtue of the universal ghost-theory the power he is supposed to exercise after death is even greater than the power he displayed during life; we understand how it happens that ministrations to him after death, like in kind to those received by him during life, are maintained and often increased. Among primitive peoples, life in the other world is conceived as identical in nature with life in this world. Hence, as the living chief was supplied with food and drink, oblations are taken to his burial-place and libations poured out. As animals were killed for him while he lived, animals are sacrificed on his grave when he is dead. If he has been a great king with a large retinue, the frequent slaughter of many beasts to maintain his court is paralleled by the hecatombs of cattle and sheep slain for the support of his ghost and the ghosts of his attendants. If he was a cannibal, human victims are furnished to him when dead as when alive; and their blood is poured on the grave-heap, or on the altar which represents the grave-heap. Having had servants in this world he is supposed to need servants in the other, and frequently they are killed at his funeral or sent after him. When the women of his harem are not immolated at his burial-place, as they sometimes are, it is usual to reserve virgins for him in his temple. Visits of homage made to his residence become, in after times, pilgrimages made to his tomb or temple; and presents at the throne reappear as presents at the shrine. Prostrations, genuflections and other obeisances are made in his presence, along with various uncoverings; and worship in his temple has the like accompaniments. Laudations are uttered before him while

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compared with those exhibited in other societies; the truth that the various professional agencies are derived from the ecclesiastical agency, is one which "leaps to the eyes," as the French say.

he is alive, and the like or greater laudations when he is dead. Dancing, at first a spontaneous expression of joy in his presence, becomes a ceremonial observance, and continues to be a ceremonial observance on occasions of worshiping his ghost. And of course it is the same with the accompanying music: instrumental or vocal, it is performed both before the natural ruler and the supernatural ruler.

Obviously, then, if any of these actions and agencies, common to political loyalty and divine worship, have characters akin to certain professional actions and agencies, these last must be considered as having double roots in the politico-ecclesiastical agency. It is also obvious that if, along with increasing differentiation of these twin agencies, the ecclesiastical develops more imposingly and widely, partly because the supposed superhuman being to which it ministers continually increases in ascribed power, and partly because worship of him, instead of being limited to one place, spreads to many places, these professional actions and agencies will develop more especially in connection with it.

Sundry of these actions and agencies included in both political and religious ministrations are of the kind indicated. While among propitiations of the visible king and the invisible deified king, some of course will have for their end the sustentation of life, others are certain to be for the increase of life by its exaltation: yielding to the propitiated being emotional gratifications by praises, by songs, and by various aids to æsthetic pleasures. And naturally the agencies of which laudatory orations, hymnal poetry, dramatized triumphs, as well as sculptured and painted representations in dedicated buildings, are products, will develop in connection chiefly with those who permanently minister to the apotheosized rulers—the priests.

A further reason why the professions thus implied, and others not included among them, such as those of the lawyer and the teacher, have an ecclesiastical origin, is that the priest-class comes of necessity to be distinguished above other classes by knowledge and intellectual capacity. His cunning, skill, and acquaintance with the natures of things, give the primitive priest or medicine-man influence over his fellows; and these traits continue to be distinctive of him when, in later stages, his priestly character becomes distinct. His power as priest is augmented by those feats and products which exceed the ability of the people to achieve or understand; and he is therefore under a constant stimulus to acquire the superior culture and the mental powers needed for those activities which we class as professional.

Once more there is the often-recognized fact, that the priest-class, supplied by other classes with the means of living, becomes, by implication, a leisured class. Not called upon to work for subsistence, its members are able to devote time and energy to that intellectual labor and discipline which are required for professional occupations as distinguished from other occupations.

Carrying with us these general conceptions of the nature of professional institutions and of their origin, we are now prepared for recognizing the significance of those groups of facts which the historical development of the professions presents to us.

KIDD ON "SOCIAL EVOLUTION."

By W. D. LE SUEUR.

TO want to say something and to have something to say are two very different things. Mr. Benjamin Kidd, when he took in hand to write a book on Social Evolution, wanted very badly to say something; but whether he really had anything to say is a question upon which we can hardly imagine his own mind, now that he has had time to think over it, is fully made up. Yet when the book first appeared many persons thought that it was freighted with some important message. There was something so impressive and oracular in the manner of the writer, such an evident conviction on his own part that, like the poet invoked by Clough, he had to come to reveal to "trembling thinkers on the brink (who) shiver and know not how to think" just what was and is the matter with them, that the reader had to be more than usually forearmed against illusion not to find himself taking Mr. Kidd very seriously indeed, and reading into his pages all the high significance that was meant to be there but was not. The book, we are free to confess, is not an everyday one. It has a certain baffling quality which bespeaks a peculiar order of mind in its author. It is interesting to read: the style is good; the language is strong; the thoughts seem to have some substance; the author gives one the impression that he is working steadily forward to some important, or what ought to be an important, conclusion; and yet, when we come to ask ourselves what the main purpose of the book is, and what proposition of any importance it has established, it is uncommonly difficult to pass from interrogation to affirmation. It gives one the impression of a system with a shifting center of gravity. The author at once champions science and disparages it, exalts religion and denies it any footing in common sense; makes progress depend upon the unchecked action of natural selection, and again declares that its most important factor is the "ultra-rational" sanction which religion supplies for right action; condemns socialism as unscientific and totally incompatible with the continued progress of civilization, and again presents as his ideal of the social state, and as the form to which it is surely tending, something which it is difficult to distinguish from socialism; commiserates mankind for being involved in a perpetual struggle for existence, and yet looks forward joyfully to a condition of struggle which he says will be more "intense" than anything the past has witnessed. It is possible that Mr. Kidd sees some way in his own mind of bringing these apparently contradictory views into harmony; but the general impression left on a careful reader of his book will be that his literary art includes the supreme accomplishment, to speak metaphorically, of riding two horses at the same moment in opposite directions.

Unfortunately, all readers are not careful, and some are prejudiced. These are days in which the glib *littérateur* talks about "the bankruptcy of science"; and Mr. Kidd, though he does not use the phrase, has done not a little to give countenance to the silly idea. Science, he tells us, has made such a distressing bungle in its treatment of religion, shown such hopeless incompetency, such amazing blindness, in connection with the whole subject! Alas! why did not Mr. Kidd appear a little earlier upon the scene, in order to prevent this painful scandal? He is a man of science—at least, he discourses with the air of one—and it is too bad that "science" should have incurred all this discredit when help was so near at hand. One might be disposed to ask whether science has not redeemed its character through the discoveries of Mr. Kidd, were it not that the latter is evidently indisposed to let his work go to the credit of science. Achilles has come out of his tent and mingled in the fray; but he does not want his mighty deeds to swell the glory of the Grecian name; rather would he flout the Greeks for the sorry figure they cut before he intervened. But, if Mr. Kidd's achievements are not to be passed to the credit of science, to what account are they to be credited? "Alone I did it" is a proud boast, but still we may ask, in what character? What is science if it is not organized and correlated knowledge? If Mr. Kidd has really helped to organize and correlate our knowledge on the subject of religion he has done a good thing; but Science must really claim that by so doing he has extended *her* boundaries and added to her conquests. And so the historian of nineteenth-century thought will say, if, when the complete work of the century comes to be narrated and appraised, "Kidd on Social Evolution" shall have managed to escape Libitina.

Let us, however, examine with a little attention Mr. Kidd's alleged discoveries, and let us see how far, if at all, science has been at fault in the matter.

It is charged that science "has no answer" to the question, What is the meaning, what is the function of religion in social development? It is asserted that "contemporary literature may be searched almost in vain for evidence of any true realization of the fact" that religious beliefs "must have some immense utilitarian function to perform" in the evolution of society. What are we to say to this? Simply that Mr. Kidd is not well informed on the subject of which he writes. We shall not be accused of diverging very far from the highroad of science, of betaking ourselves to any very obscure or devious paths, if we venture to quote on this point Dr. Henry Maudsley, author of a number of well-known works on mental physiology. Let us, then, turn to his work on Body and Will, republished in this country eleven years ago, and see what we can find bearing on this very question. On page 208 we read: "It is most necessary to bear in mind that forms and ceremonies, stereotyped propositions, articles of faith, and dogmas of theology do not constitute the essence of religion, but its vesture, and that, apart from all such forms and modes of interpretation, it responds to an eternal need of human sentiment. For it is inspired by the moral sentiments of humanity and rests on the deep foundations of sacrifice of self, devotion to the kind, the heroism of duty, pity for the poor and suffering, and faith in the triumph of good. It appeals to and is the outcome of the heart, not of the understanding; and so goes down into lower depths than the fathom line of the understanding can sound; for the intellect is aristocratic and the heart democratic, knowledge puffing up, but love uniting and building up, and the true social problem is to democratize the intellect through the heart. It is the deep fusing feeling of human solidarity, in whatsoever doctrines and ceremonies it may be organized for the time, that is religion in its truest sense; for it is in the social organism what the heart is in the bodily organism, and, when it ceases to beat in conscience, death and corruption ensue." Dr. Maudsley did not sound a trumpet before him that all the world might suspend its ordinary business in order to admire his originality, because he knew enough to know that, while what he was saying was well worth saying, it was not so very original after all. But after reading the above-quoted sentences from so well known a writer, what are we to think of Mr. Kidd's statement that "contemporary literature may be searched almost in vain" for any true recognition of the "utilitarian function of religion in the evolution of society"? And what great degree of originality can we attribute to the definition of religion which, after an elaborate preamble, Mr. Kidd delivers to us: "A religion is a form of belief providing an ultra-rational sanction for that large class of conduct in the individual where his interests and the interests of the social organism are antagonistic, and by which the former are rendered subordinate to the latter in the general interests of the evolution which the race is undergoing." Whatever is true in this definition is expressed in simpler and stronger phraseology by Dr. Maudsley. Whatever meaning there is in the word "ultra-rational" is better expressed, it seems to us, in Dr. Maudsley's declaration that "it (religion) appeals to and is the outcome of the heart, not the understanding, and so goes down into lower depths than the fathom line of the understanding can sound"; while, as regards the furnishing of a sanction for actions performed in the interests of society, the language of Maudsley, who says that religion rests on "the deep foundation of sacrifice of self, devotion to the kind, the heroism of duty," surely covers the whole ground. On the next page to that in which these expressions occur we find the following: "Any one who looks forward with a light heart to the overthrow of Christianity might do well to consider what can ever adequately replace it merely as a social and humanizing force." We turn another page and read: "In him (the founder of Christianity) was the birth of the greatest social force that has ever arisen to modify human evolution"; and the paragraph ends with the declaration that if humanity is to progress, "it will, as heretofore, draw from a source within itself, deeper than knowledge, the inspiration to direct and urge it on the path of its destiny."

Now, we venture to say that Mr. Kidd has nowhere in his book put the case for the social utility of religion more strongly than it has been put in these passages and many others which we might quote from one of the most advanced of modern scientific thinkers. But Dr. Maudsley, as we have already hinted, does not, in what he says on this subject, take up any very peculiar position. Mr. Spencer fully recognizes religion as an indispensable source of moral control in early stages of society, and as one that can ill be discarded even in our own day. He believes that it will be progressively purified of all doctrines that are not essential to it, and that it will abide as an ineradicable consciousness of a power behind phenomena, in and by which all things exist. Schopenhauer declared that the metaphysical impulse of the human race, that by which it seeks to formulate those transcendent truths that are of the substance of religious belief, is no less fundamental in human nature than the scientific impulse; and the later Schopenhauerians, like Prof. Paul Deussen, whose excellent little book on Metaphysics has lately been given to the world in an English dress, use language which might be supposed to have been specially intended to forestall what Mr. Kidd evidently regards as his most striking and original utterances. Take the following passages, for example, from Prof. Deussen: "For opposed to the natural and egoistic actions, affirming the will to life, are certain actions which show a diametrically opposed striving. The only explanation of these actions is that the actor always sacrifices in them, to a certain extent, his own individual and limited existence by expanding his ego beyond the bounds of his individuality, recognizing his own self in others." "In investigating the action of man, which is, in general, an expression of the affirmation of the will to life, we meet a series of actions which are, in the natural order of things, inconceivable, being diametrically opposed to this world and its laws, contradicting these in every sense, and, as it were, totally unhinging them. These phenomena are the deeds of a genuine morality." "Thus the totality of human action appears as the expression of two opposed currents—one, *egoistic, affirming, mundane;* the other, *ascetic, denying* (i. e., self-denying), *supramundane.*" "We may denote faith as that which has as its inevitable result morality." It is impossible for any one who has read these passages and many similar ones to be much startled when he is informed by Mr. Kidd that "throughout its existence (viz., of the social organism) there is maintained within it a conflict of two opposing forces: the disintegrating principle represented by the rational self-assertiveness of the individual units; the integrating principle represented by a religious belief, providing a sanction for social conduct, which is always necessarily ultra-rational."

The fact is that the conception of religion as an influence constraining men to identify their own good with that of the community apart from all calculations of selfish interest is one very generally entertained in the present day, and not less, certainly, by men of science than by others. It lies at the basis of Feuerbach's remarkable book on The Essence of Christianity. It is clearly expressed in one or two of the late Prof. Clifford's essays; it can be traced in the writings of the late Prof. Tyndall and of Prof. Huxley; probably it would be difficult to discover an intellectual region of any note in which it is not more or less distinctly accepted.

But, says Mr. Kidd, "Science from an early stage in her career has been engaged in a personal quarrel" with successive religious systems. The quarrel "has developed into a bitter feud." Yet, instead of investigating this historic antagonism in a scientific spirit, and asking "whether it was not connected with some deep-seated law of social development," Science "seems to have taken up, and to have maintained, down to the present time, the extraordinary position that her only concern with them is to declare that they are without any foundation in reason." Now this seems to us, to speak plainly, not only an incorrect but a very nonsensical statement. Science has only antagonized religion in so far as demonstrable scientific errors have been put forward as essential parts of this or that religious system. And it was not science, be it remembered, that insisted that such errors were essential to the integrity of religion; it was religion, as represented by its official expounders, that took up this position. It was not Galileo who said that religion could not exist if the Ptolemaic system of astronomy were overthrown; it was the Church. All Galileo asked was leave to establish a purely scientific theory. It was not the founders of modern geology who insisted that religion must stand or fall with belief in a six-days creation; it was their opponents, the uncompromising partisans of a traditional theology. It was not Darwin or Spencer who said that religion could not withstand the shock of the evolution theory —the latter said expressly that it could and would—it was again the party that spoke in the name of religion. If a certain number of scientific men were carried away by the vehement assertions of the champions of religion into believing and speaking as if religion itself were about to be involved in the ruin of the erroneous views which had formed part of its popular presentment, can we wonder at it? And if to-day the impression is widespread that religion has been shaken and discredited by the advance of science, on whom must the blame chiefly rest? Without doubt on those who, not distinguishing between the accidents of religion and its essence, fought a losing battle with science on matters that were wholly within the jurisdiction of the latter.

Science, Mr. Kidd says, has lost sight of the main question, which is not whether religious beliefs have "any foundation in reason," but whether they "have a function to perform in the evolution of society." This again is incorrect; science has not lost sight of this question, but on the contrary has of late years devoted a large amount of attention to it. Never was it so clearly recognized as it is to-day that beliefs may have no foundation in reason, and yet have a more or less important "function to perform in the evolution of society." The proofs of this are so abundant that it seems a waste of time to produce them. But for very specific statements take the following from Vignoli's work on Myth and Science, published in the International Scientific Series: "Man rises in the social scale by means of his superstitious and religious feelings, which act as a stimulus and symbol, so far as he subjects his animal and perverse instincts to the precepts which he imagines to be expressed by these myths" (page 106). And again (page 321), "The problem of myth is transformed into the problem of civilization." Turning to a very recent work, Mr. Havelock Ellis's The New Spirit, we find the author asking, "What is the nature of the impulse that underlies, and manifests itself in, that sun worship, Nature worship, fetich worship, ghost worship to which . . . we may succeed in reducing religious phenomena?" Here is the very question which Mr. Kidd says modern science does not face. What is Mr. Ellis's answer?—"The supreme expression of the religious consciousness lies always in an intuition of union with the world, under whatever abstract or concrete names the infinite not-self may be hidden. . . . It comes in the guise of a purification of egoism, a complete renunciation of the limits of individuality—of all the desires and aims that seem to converge in the single personality—and a joyous acceptance of what has generally seemed an immense external Will now first dimly or clearly realized. . . . It is this intuition which is the 'emptiness' of Lao-tsze, the freedom from all aims that center in self." When one has been reading things of this kind from day to day for years, it is a little provocative of fatigue to find Mr. Kidd attaching so much importance to formulas of his own devising that are essentially of the same significance.

But possibly Mr. Kidd, it may be suggested, states the function of religious beliefs much more definitely than has ever been done before, and throws new and vivid light upon their origin and *rationale*. We can not see that there is the least foundation for such a claim. We are told by this author that religion is essentially an "ultra-rational sanction" for actions which, though injurious to the individual, are beneficial to the community. Is any light whatever thrown on the nature of religion by calling it an "ultra-rational sanction"? The term "ultra-rational" is essentially negative. We understand from it that religion is a sanction with which reason has nothing to do. What we want to know is, What *has* to do with it? Whence is its authority derived? How far are rational beings bound or compelled to recognize and bow to it? Is it something like the law of gravitation that no one can resist, or is it a mere habit of mind that can be outgrown, perverted, or destroyed? If all that Mr. Kidd has to tell us of the nature of religion is that it is *a* sanction, and that reason has nothing to do with it, or rather that it is contrary to reason, we certainly have not much to thank him for. Far more are our thanks due to Hegel and Feuerbach and Comte, to Spencer and Martineau and Arnold, to Müller and Reville and Caird, who all, from their several points of view, have endeavored to explain what religion is and to define its place in the sum of human powers and faculties. The time is not far distant, Mr. Kidd says, when Science will "look back with shamefacedness to the attitude in which she has addressed herself to one of the highest problems in history"; but we fail to see either what Science has to be shamefaced about, or what Mr. Kidd has himself done to mark out better lines for the action of Science in the future.

Science finds, we are told, mankind holding beliefs which she asserts have no foundation in reason; and Science has not done the right thing in the premises. What on earth, then, should Science have done? Should Science have refrained from criticising the errors in regard to plain matters of fact which she found incorporated with popular religious creeds? So far as we can judge, Mr. Kidd himself seems to have benefited from such criticisms. In regard to the doctrine of evolution, he is a stalwart of the stalwarts. His faith, anticipating proof, has even taken hold of the extreme theory of Weismann and pressed it into the service of his sociological speculations. But the doctrine of evolution is precisely the one to which the religious world found it most difficult to reconcile itself, and one which, indeed, it is impossible to hold without at least a tacit criticism of views formerly considered as essential to religious faith. Did Mr. Kidd win his present position for himself without antagonizing the religious instincts and convictions of the mass of his fellow-men? If he did, it must have been because other men prepared the way for him; for certainly, not without much tribulation, has Science established its claim to judge freely and according to evidence of things within its ken. The world, we are informed, no longer takes the interest it once would have done in such attacks as Prof. Huxley has lately been making on certain orthodox beliefs. Well, if so, we must regard it as a good sign; for it can only mean that the world—that is to say, the thinking world—looks upon Prof. Huxley's labors as a little superfluous. Still, it is well to remember that even to-day the energetic professor's attack on the miracle of the Gadarene swine has been warmly repelled by eminent ecclesiastical authorities.

It would really be interesting to know Mr. Kidd's precise views as to the etiquette to be observed by "science" in its relations with religious systems which take under their patronage and vouch for gross scientific or historical errors. If science does not criticise such things, who or what is going to do it? If no one does it, what chance is there that religion will ever shake itself free from such accretions? Will the several priesthoods of the world see to it that the faiths they represent are progressively purified from error? In the last two centuries of the Roman Republic and the first two of the Empire, the question how to treat foreign cults, which were seeking a foothold in Rome itself, was a serious one for the state. Mr. Kidd was not present to caution the Roman Senate against rash action, or to point out that the great question was not whether these cults did or did not involve material errors, but what bearing religious systems in general had on the development of society; consequently the Senate had simply to follow its own best lights. "These Bacchic rites," says a recent writer, "of undoubtedly Oriental origin, and for centuries common enough in Greece and Asia Minor, were apparently introduced into Etruria by a Greek adventurer, and from there spread with extreme rapidity both in Italy and Rome. At first women only were admitted into the secret associations which formed the basis of the cult; the initiation took place by day, and the meetings were only held three times a year. But all this was now changed; men were initiated as well as women; the initiated were to be under twenty years of age. Meetings were held five times in every month, and took place under the secrecy of night. The inevitable enormities did not fail to follow, and the Bacchic associations became hotbeds not only of moral corruption, but of civil crimes such as forgery and murder and even of political conspiracy."* Attention having been called to these abuses, the Senate acted vigorously, and the Bacchic rites were stamped out with great severity (B. C. 188). A century later, the same writer tells us, the Roman Government was confronted with the Isis cult, but was not able to deal with it in the same energetic fashion, owing to the fact that the national religion had largely lost its hold upon the people. "Mysterious rites of initiation," we read, "sensuous music, a worship crowded with symbolism no less awe-inspiring that it was imperfectly or not at all understood; and above all, a system of expiatory and purificatory rites in which there was enough of asceticism to satisfy the craving for something personal in religion, and enough of license to attract the crowd in its non-religious moods, all these things made the population of Rome peculiarly susceptible to the influence of cults like the Egyptian." †

What bearing have these historical instances, it may be asked, on the subject in hand? A tolerably direct bearing, we think, as tending to show that if there is anything that needs to be watched and criticised, anything the claims of which to prescribe conduct or to limit knowledge need to be challenged and examined, it is precisely religion in its varying forms and phases. Religion, to go back to Mr. Kidd's definition, provides an ultra-rational sanction for socially useful actions; but when, let us ask, has religion been content with enjoining the performance of such actions on the strength of its ultra-rational sanction? It is true that an apostle has beautifully said, "Pure religion and undefiled before God and the Father is this, to visit the fatherless and widows in their affliction, and to keep himself unspotted from the world"; but this is merely the utterance of a profound individual intuition, not the expression of what, historically, religion has ever been.

* E. G. Hardy, Christianity and the Roman Government, p. 10.

† Hardy, as above, p. 13.

How vehemently the most earnest exponents of religion have repudiated the idea that it could be identified with morality, in however comprehensive a form, need not be insisted on.

To do justice to science it is not necessary to represent it as the unfailing minister of truth, or to assign to it any absolute character whatever. The less we deal in personifications and abstractions the better, when historical or social problems are demanding solution. To understand the function of science in the world we have simply to remind ourselves that man possesses a faculty of comparison and judgment by which he is compelled to recognize, unless overmastered by his imagination, likeness or unlikeness, equality or inequality, agreement or disagreement, in the things which occupy his attention. The exercise of this faculty leads to classification, which, in the higher form of generalization, is the source and vital principle of all knowledge. The more knowledge man acquires, the more certainly he can interpret and correlate the data of sense. Among his impressions and inferences there is a continual struggle as to which shall survive; and those which, by their deeper conformity to unchanging facts, assert their viability, go to form the tissue of what we call science. To talk, therefore, of what "science" does or does not do is very apt to be misleading. Science is like a coral reef, built up of innumerable accretions, the result of the life processes of organic bodies. We may from one point of view define science as the enduring products of man's intellectual activity. That the history of science should be largely a record of errors and failures follows of necessity from the fact that the work of science consists essentially in the attacking of ever-new problems with more or less inadequate means of investigation. But the very failures of science are necessary to its successes; and it never turns aside from its main function and purpose of harmonizing, consolidating, and extending human knowledge. Its permanent relation to religion can thus easily be understood. Religion, appealing to imagination and resting more or less upon myth, incorporates in its creed statements or assumptions which fall within the domain of science, and which, if inacurate, the latter is obliged to challenge; but there is no necessary hostility between the scientific impulse to know that which can be known and the religious impulse to worship a Power that can not be known, and to frame higher sanctions for life than those of the market place and the law courts. Religion, which is essentially emotional, is slow to recognize the rights of science; and science, in the conflicts which ensue, is in danger of overlooking the fact that religion is something more than a misinterpretation of the world and of history.

The signs of the times all give us reason to hope, however, that a better *modus vivendi* than the past has ever known is about to be arrived at. Religion is more and more withdrawing from the disputed territory of facts historical and physical, and saying in effect to Science: "I am no longer your rival on this ground; so now tell us freely all you know about the world and its origin, about man and his descent; tell us whence we sprang, how we have come to be as we are, with such thoughts and instincts, such hopes and fears, such aspirations and superstitions as you wot of; and what the future is to which we may look forward. Tell us if you can the *raison d'être* of this universe. Henceforth I shall not dispute with you one single verifiable fact; so now deliver to the world a free, untrammeled message; tell us all the truth you know." Thus challenged, Science becomes solemn under a new sense of responsibility, and its thoughtful reply might be: "I see but in part, I know but in part. I pass through my hands the successive links of a chain, but the beginning of the chain and the end are not only beyond my vision but beyond the flight of my strongest thought. I organize knowledge, I minister to the physical and intellectual wants of men; whatever a finite faculty of judgment is capable of, I may hope to accomplish; but if man has a craving to know his relation to the universe, I can not determine it; if he wants a higher motive than expediency (in the widest sense) for his actions, I can not supply it; if he craves to believe in an Infinite Goodness, I can not demonstrate it for him; if he longs for a life beyond the present, I can not assure him that such a longing will be realized. Here, then, is *your* province, with which I engage not to interfere; and if, while I increase man's power over the energies of physical Nature, you can raise him to a nobler self-control and a higher sense of moral dignity; if you can satisfy his emotional longings and place his whole life on something more than an empirical foundation, then shall I reverence your work and recognize that I am but your humbler yoke-fellow in the service of the race."

We have reached the limits of our space, and find that we have only dealt with one point of the book under review. In our opinion, however, it is the most important point, as being the one that was most calculated to lead the general reader astray. We should have wished to devote two or three pages to what we consider the very faulty account Mr. Kidd gives of the function of the intellect in connection with social progress; but that, if it is to be done at all, must be done some other day.

The only industry in the hamlet of Nova Varos, Sandjack of Novi Bazar, is the manufacture of carpets and rugs. Every girl, on marriage, takes one or more rugs and a large painted chest to her husband. For this reason each house makes its own rugs, and each house uses what it makes.

AN OLD NATURALIST—CONRAD GESNER (1516–1565).

By W. K. Brooks,
PROFESSOR OF ZOÖLOGY IN THE JOHNS HOPKINS UNIVERSITY.

Illustrated by Photo-engravings reduced from the Original Woodcuts.

SO many lives have been devoted to the earnest study of Nature that disinterested zeal and untiring industry are no peculiar claims to our interest, however inspiring and instructive they may be.

Conrad Gesner was not only a faithful student and a great educational influence, but a hero who took life in his hand for the service of man, and calmly facing horrors more awful than a battlefield, laid it down, like so many forgotten physicians, at his post of duty.

His great work on natural history, which was published in Zurich (1551–1587), is one of the chief sources of that interest in

Fig. 1.

the living world which has grown stronger and stronger from his time to the present day.

There were other men who merit the title of naturalist in Gesner's day. We find the spirit of original research in Rondolet, and in Belon, whose intense love of Nature led him on in his wanderings from his home in France, over the mountains and valleys of Greece and along the shores of the Archipelago, through Asia Minor far into Egypt.

Aldrovandi also made formal calls on Nature, visits of state to her haunts, taking notes on her ways, for he says: "I often wandered through the vineyards and fields, over the marshes and mountains, accompanied by my draughtsman, carrying his pencil, to draw whatever I pointed out; and by my amanuenses, with their note-books, to write down at my dictation whatever occurred to me."

It is the great distinction of Gesner that, without sacrificing the dignity of science, he made it attractive, and thus became a great educational influence. His contemporary and friend, Dürer, has been called the "evangelist of art," and the title of "evangelist of science" might with equal propriety be applied to him, for

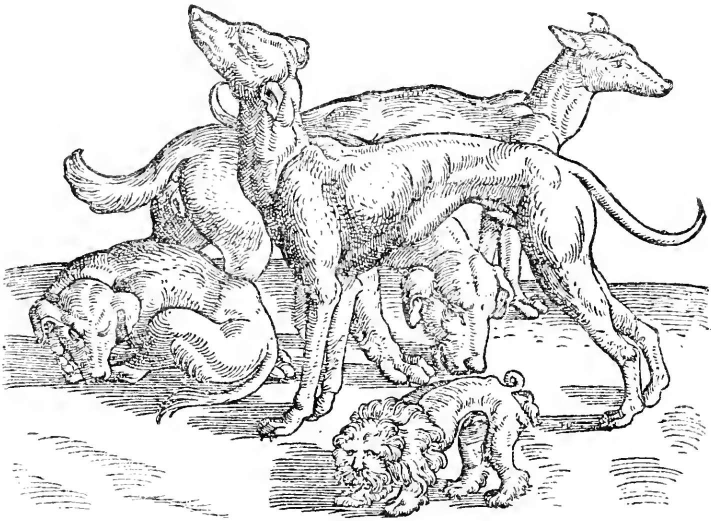


Fig. 2.

he is one of the foremost representatives of that time of intense and contagious industry "when art was still religion."

The modern world takes morbid interest in the crudity and errors of early writers on science, and we are in no danger of forgetting their views on griffins and krakens, on goose barnacles and spontaneous generation. Their merits are less interesting and seem too antiquated and too far below our mark to be notable simply as good, faithful work.

The demands of current scientific literature leave us no time for the ponderous volumes of ancient writers, but if we had time to spare we should find in many of them both pleasure and profit, although it is quite true that their value as sources of scientific knowledge has passed away, and that later writers have helped themselves to all that is best in them, and have passed it on to us.

One of Gesner's greatest services to natural science is the introduction of good illustrations, which he gives his reader by hundreds.

Work under his severe scrutiny was a valuable training to the draughtsman and engraver of his day, and the publication of his natural history, filled with simple but spirited pictures of animals, did much to educate the critical powers of the public.

We can not appreciate the educational value of his work without tracing it into other fields, and studying its influence on contemporary art.

Before the day of photography success in drawing living animals depended to a great degree upon the study of earlier attempts, upon the imitation of their successes, and the correction of their failures and shortcomings; and the success of Gesner's draughtsmen, who had few models to copy, was very notable. Their attempts to draw strange and unfamiliar animals are not always happy, but most of the drawings of familiar forms are full of life and spirit, even after they have been interpreted by the wood engraver, who unquestionably failed to render them with perfect accuracy.

Little is known about the makers of the drawings. Gesner says he made some of the originals himself, and also employed several draughtsmen, who lived in his house and gave him all their service. He also says most of the cuts were drawn from life under his supervision, and that he gives the original source of all that are copied or supplied by friends or correspondents.

Like most authors of illustrated works on natural history, he found his own standard of accuracy hard to reach, and he says:

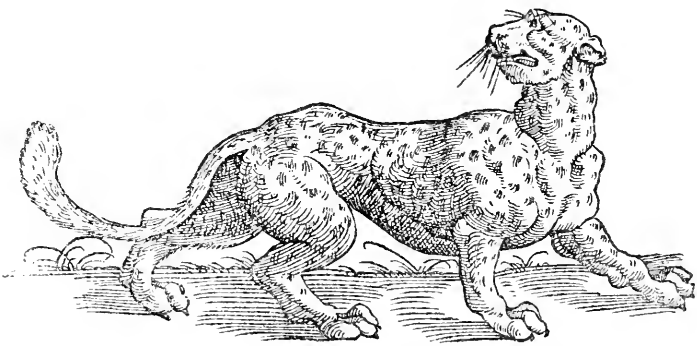


Fig. 3.

"I admit that all the illustrations are not well drawn, but this is not the place for explanations. Most of them are pretty fair, or at least tolerable, especially those of the quadrupeds, which may be considered the best."

The woodcuts made from these drawings are remarkable examples of the skill of the old wood engravers, and they have high claims on the interest of students of the history of their art.

All attention is concentrated on the central figure, and few of the cuts have any accessories whatever; but they are not diagrams, and the engraver boldly faces all the difficulties of texture and markings, and uses his best resources to overcome them. His success is notable, as the photographic reprints show, and work under Gesner must have contributed not a little to the advancement of wood engraving. The cuts which are here reproduced are selected to exhibit the wide field which Gesner covers, and to show at the same time something of the resources of his engravers, and, while good drawings have been chosen, no attempt to pick out the best has been made. All the reproductions are considerably reduced, and they give a false impression of delicacy, although they faithfully exhibit the accuracy and versatility of the old engraver.

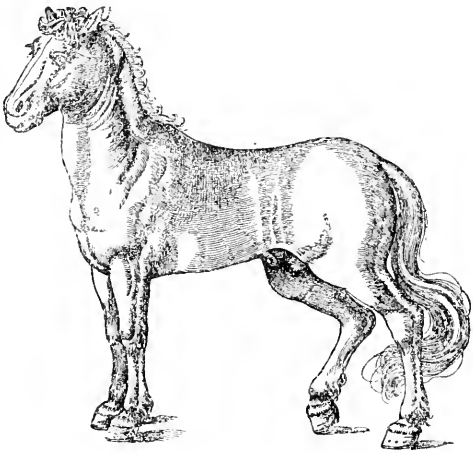


Fig. 4.

The names of very few of the draughtsmen or engravers are known, but Gesner says that Lucas Schrön drew the birds, and that Albrecht Dürer made the cut of the rhinoceros.

This statement has led many writers on wood engraving to reproduce this cut, which has thus become familiar to us, although it is by no means a fair sample of Gesner's illustrations.

The typography of Gesner's book and the binding of many of the copies are as notable as the cuts. In fact, all the craftsmen met the author in generous rivalry and mutual inspiration, and it would be difficult to produce a nobler monument than that which their combined labors created.

While Gesner has recorded many original observations, the work as a whole is a compilation undertaken for the express purpose of gathering in one book a summary of all trustworthy observations on living things. The work was done so thoroughly that it records for all time the status of natural science in his day, and forms a permanent landmark in its history.

Its educational influence upon his contemporaries was due to the attractive and simple way in which he presents the subject, but its scientific value to-day is due to the exhaustive completeness with which he compiled it.

He read nearly two hundred and fifty authors and his literary learning is almost unparalleled. The list of authorities quoted or referred to and of the correspondents who supplied notes, illustrations, and oral information includes nearly every ancient and mediæval writer who makes any reference to animals. He draws from many works which are now known only through his references, and his long list of friends and helpers includes Italians, Frenchmen, Englishmen, Germans, Swiss, and Poles.

He tells us that while it is easy to assert that history should be written from the best books only, he has found no book too bad to yield something to judicious study, and that he has ignored nothing.

"Only those who have tried," he says, "can know what a labor it is to compare the works of different authors and to bring all into unity, with nothing overlooked and nothing repeated. This I have tried to do so faithfully that all may be brought together, a library in itself, so that no one need hereafter consult other writers on the ground which I have covered. As my only purpose," he tells us, "is to make the work more useful and accurate, I have exercised the more incredulity and have critically revised the quotations, and, when possible, verified them by original observations and dissections."

Fig. 5.

The completeness of the work is astonishing when we bear in mind that he was only thirty-five when the first part appeared, and that he had already published thirty-four works, among them two which are as remarkable as the Natural History for learning and industry, and that all the illustrations for the Natural History were prepared and the whole book written with his own hand and printed in eight years.

The dignity and thoroughness of his work are in strong contrast to many of the discursive and trivial works of his time, and his compilation was made with good judgment and independence. When he now and then quotes descriptions of fabulous or imaginary animals or repeats fanciful tales, he seldom fails to record his own opinion of their value, unless they are contained in letters from correspondents, who are always treated with courtesy.

Modern writers have disputed Gesner's title to a position among men of science on two grounds. It is held by some that since science is the reference of the phenomena of the universe to the fundamental properties of matter, none of the old naturalists who did not have this aim have any scientific standing; but as this point of view shuts out men like Wallace, Gesner is expelled in good company.

Others hold that Gesner's weakness is his lack of the conception of systematic zoölogy, and his failure to so arrange his facts as to exhibit natural affinity and do away with endless repetition. As a matter of fact, he does recognize natural relationship, and often treats allied animals together; thus, for example, under Bos we find not only Taurus, Vacca, and Vitulus, but also Bison, Bonasus, and Urus.

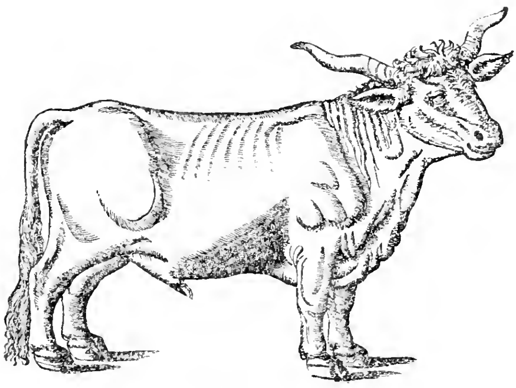


Fig. 6.

He says, in the introduction to the book on water animals, that he has followed the alphabetical order, rather than a more philosophical system, for the sake of easy reference, and on account of his uncertainty regarding the affinities of many of them.

This criticism was to be expected from the systematists of the last generation, but the modern morphologist can not cast it in Gesner's face, for, while he feels sure that there is a natural or genealogical classification of animals, he admits, like Gesner, his "uncertainty about the affinities of many of them."

We are told (Encyclopædia Britannica, article Gesner) that "his life was singularly pure and blameless; his love of knowledge was as disinterested as it was engrossing. He was always ready and glad to acknowledge any help he received. When obliged to engage in controversy, he did so in a dignified and courteous manner. His medical writings show him to have been far above the silly prejudices of his day. A cheerful and amiable piety was a prominent feature in his character—a character chastened, not soured, by the trials of a hard lifetime."

Gesner's short life was a struggle with poverty and ill health, but he did not suffer neglect, for there is evidence that his contemporaries held him in honor and took a just pride in his industry and simple earnestness.

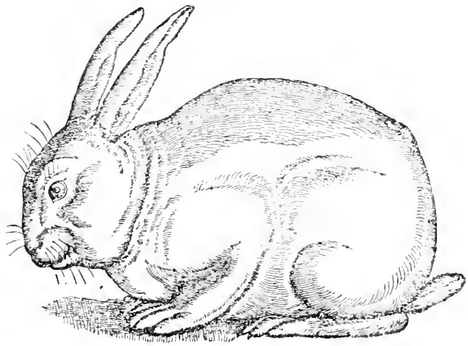


Fig. 7.

The magistrates of Zurich appointed him chief physician and Professor of Philosophy and Natural History in 1553, and the magistrates of Lucerne welcomed him, in 1554, with those distinguished honors which were usually reserved for high public officers.

The Emperor Ferdinand granted armorial bearings to him and his family, with a statement of his desire to express his appreciation of his work, and to encourage others to follow his example.

His death was the glorious climax of his earnest, laborious life. When the plague broke out in Zurich in 1564 he devoted his scientific skill and professional experience to the effort to discover some way to check it; he threw himself into this inquiry with such earnestness that he himself contracted the disease, and, after a short illness, died in his museum, to which he had been carried a short time before, at his request.

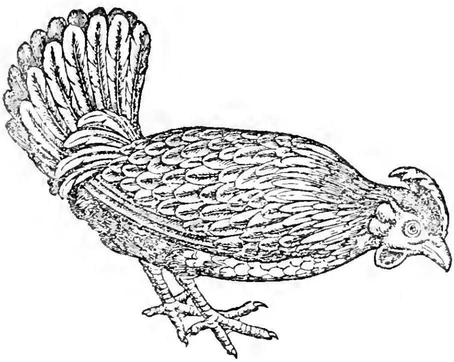


Fig. 8.

He was interred in the cloisters of the great church of Zurich the next day with most distinguished honors, and a large concourse of people of all ranks followed him to the tomb, amid the mourning of the whole city.

I have selected as an illustration of Gesner's method of treating his subjects the chapter on the marmot; for here, as in many other places, we find proof of the injustice of the assertion that he was not an original observer, but simply a compiler.

THE MARMOT (*Mus Alpinus*).

Its Shape and Outline and where to find it.—In shape, outline, and size this animal is like a big rabbit, but lower and with a broader back. Its hair is coarser than that of a rabbit, of a reddish color, darker in some places and lighter in others. It has big eyes, placed above the cheek-pouches. In its mouth are long, yellow teeth, much like those of a beaver, two above and two below. The length of its tail is two hands or more. It has short, thick, hairy feet, like those of a bear, with long, black nails, which enable it to dig deeply into the earth. While the rest of the body is lean, the back is fat, although this fat is not real fat, but something between fat and meat, like the substance of the udder of the cow. This animal is found only on the very highest tops of the Alps. The widely known Dr. Conrad Gesner has himself traveled in these regions and observed its habits.

Its Nature and Properties.—While playing and frolicking together the marmots make a noise not unlike that of a cat, but when they are angry or wish to warn each other of a change in the weather, their cry is sharp and penetrating, and very disagreeable to the ear of man, like the noise of a highly pitched small flute. On account of their offensive voice they are often called manure-barkers.

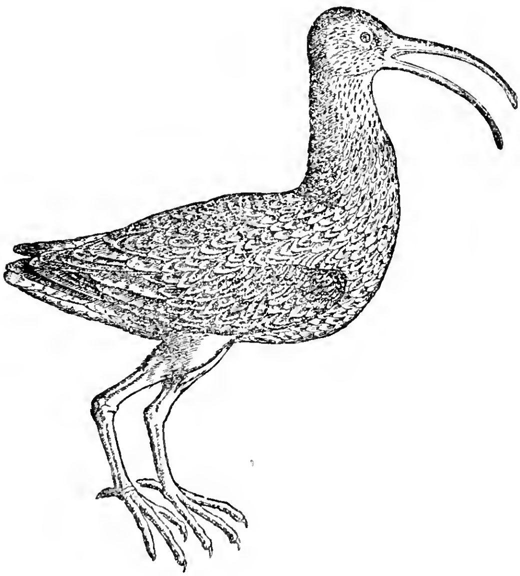


Fig. 9.

This animal sometimes walks on its two hind legs. It uses its fore paws like hands, grasping its food with them, like a squirrel, and eating while it sits on its hind legs. It eats not only fruit, but many other things, such as bread, cheese, meat, fish, and nuts, especially when accustomed to them in captivity. It prefers milk and cheese above all other food, and it is often caught by the peasants in the milk cellars, where it is easily discovered by the noise it makes in drinking the milk, like a young pig.

It is a drowsy animal, sleeping often and long. It makes its nest with two openings—one, pointing up the mountain, is used for walking in and out, while the other, which points down the mountain, is not used for these purposes, but as a place for depositing urine and fæces. A short passage leads from the burrow which connects these openings to a room or nest which is lined with hay, straw, or similar light substances.

About Michaelmas, when the mountains begin to be covered with snow, they hide themselves in their house, first plugging the openings with earth so firmly that they are harder to dig with a

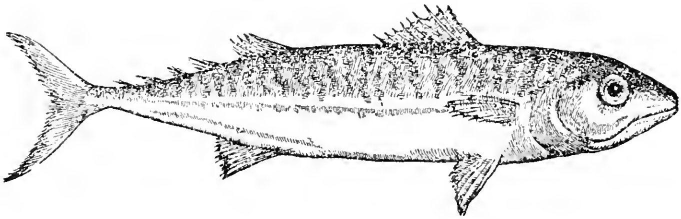


Fig. 10.

shovel than the undisturbed ground around them. Thus securely protected from wind, rain, and cold, and rolled up in balls, like hedgehogs, they sleep through the whole winter, without food or drink, till spring comes again. Five, seven, nine, eleven, or even more, are often found thus sleeping in one nest. The proverb "He sleeps like a marmot" is applied to lazy people by the inhabitants of these regions. Even when kept and fed in houses, they sleep through the winter. That very learned man Dr. Conrad Gesner says that he fed one for some time in his house, and at the beginning of winter, about the time when it should have gone to sleep, he put it in a small pine barrel, which he half filled with straw and then closed up tightly with the head belonging to it, to protect his pet from the cold. When he opened the barrel after many days he found the animal dead. He thinks it was suffocated and that it might have lived if he had made a hole in the barrel, although he is very much astonished by the result of his experiment, and does not now see how they can survive in their nest when the holes are plugged up.

They make use of a peculiar device for bringing home their hay. If they have gathered a great quantity they need a wagon to carry it, and one of them lies down on his back and, lifting his feet toward heaven, forms supports like those of a hay wagon, between which the others pile the hay. When the cart is loaded, the other marmots take the tail in their mouths, drag their brother home like a sled, and, after unloading him, put the hay in their holes. As each one takes his turn of service as a sled, none of them have any hair on their backs at this season of the year.

So long as it is awake this animal is rarely idle. It is always busy carrying hay, straw, etc., into its nest. It fills its mouth with these things, and the amount it can stow away is incredible to one who has not seen it. What it can not get into its mouth it takes between its paws, and carries that too. It never soils itself with its urine or fæces, but either deposits them in the proper place in the burrow, or throws them away from its body. Johannes Stumpff says, in his chronicle, that the marmot always stinks in the summer before it gets fat.

Of its Cleverness and Sweet Nature.—Occasionally they frolic in the sunshine before their holes like kittens or puppies, rolling themselves in balls and frisking and chattering to each other. When reared in the house they carry on their sports before the eye of man. When angry they bite viciously, but when they are once used to captivity they make man their playmate, and sometimes catch his lice like a monkey. Few animals become more familiar than this one. It sometimes bites the dog, which is too well trained to defend itself.

When the marmots gather in the meadows to play, one stands near the mouth of the hole on the watch for men or other enemies, and gives warning of the approach of danger by a bark or a shrill, high-pitched whistle. As soon as the others hear this cry they run to the hole, tumbling over each other in their hurry, the sentinel standing guard till all are in.

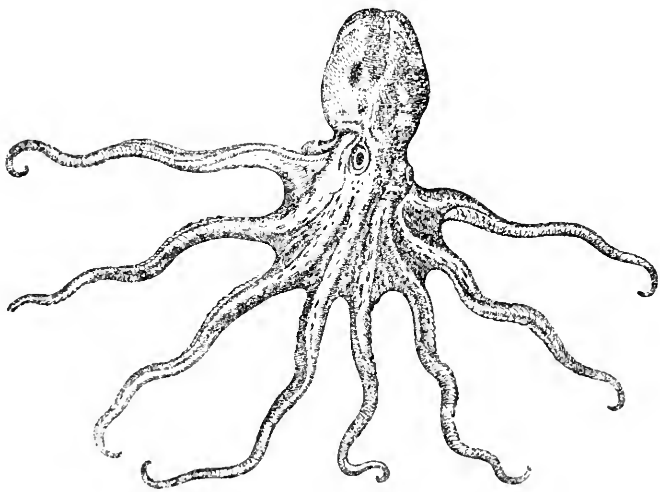


Fig. 11.

In unfavorable weather they remain in their holes; with their high-pitched voices they give notice of changes in the weather as well as of the approach of danger.

THE USES OF THESE ANIMALS.—They are caught in the following way, during their winter sleep when they are nice and fat, by hunters, who sell their meat for money: In the summer the people who live at the foot of the Alps mark the holes with long sticks which will show above the snow in the winter. About Christmas they walk over the snow to these marks on broad wooden runners, carrying picks and shovels, with which they clear away the snow, and digging into the nests, catch them asleep without trouble, although one must not talk loudly or make much noise while catching them, for if awakened they burrow rapidly into the soil, throwing the earth between themselves and the hunter and making it hard for him to follow them. They are also caught in snares laid before their holes, and in many other ways. They are always found in odd numbers, as seven, nine, eleven, or even more.

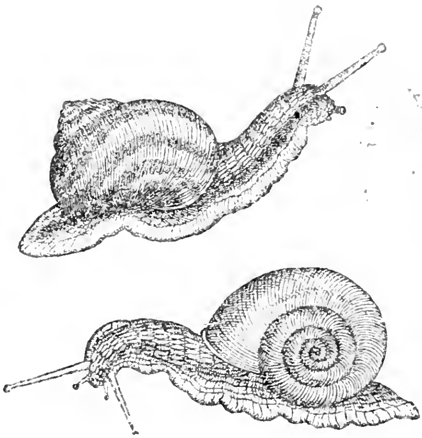


FIG. 12.

The hunters who dig them up in winter notice the length of the cone of dirt with which the animal has plugged up the opening of its burrow, for if this is short the winter will be mild, but very cold and severe if it is several feet long.

THE FLESH OF THE ANIMAL AND HOW TO PREPARE IT.—They are fattest about the Christmas days, and are killed while asleep by cutting the throat with a knife, as calves or swine are slaughtered. They usually die without awakening. The blood is caught, and the animal is scalded with hot water, like a hog, to remove the hair, and is cleaned and made to appear white. The intestines are then taken out, and the body, filled with the blood, is roasted on a spit or is boiled with black pepper. The flesh is sometimes salted and smoked, and is then boiled with black pepper, turnips, or a pumpkin.

The salted flesh is better than the fresh, as the salt dries it and takes away its penetrating odor. It is always indigestible and heating, but it is good for women in their confinement and also for their diseases.

ITS USE IN MEDICINE.—The stomach of the marmot is used as a remedy for stomach ache, and the fat for sclerosis of the arteries, which are rubbed with it.

THE WORK OF THE NATURALIST IN THE WORLD.*

By Prof. CHARLES SEDGWICK MINOT.

THERE can be no broader question, touching us all, than the influence of our profession upon the world. With your permission I will present a series of considerations in regard to our professional careers which ought, in my opinion, to receive more attention than hitherto. I am aware that in doing this I depart very far from our custom, your previous presidents having each dealt with some broad but specific problem of natural history in their formal addresses. I must leave it to your judgment whether or not I have done wisely in not following, in the present address, the example of my distinguished predecessors.

The object of the naturalist is to discover the truth about Nature, and to record his discoveries in a form which will render them available to others. Original research is the pivot of knowledge.

We will examine:

First. The conditions of success in research.

Second. The effect of the naturalist's career on his character.

Third. The influence of the naturalist on mankind.

I. The Conditions of Success in Research.—That the fundamental condition is the love of truth goes without saying. It is an axiom which, before this audience, requires no proof. But, though we all acknowledge Truth to be our sovereign, I fear there is not one of us whose loyalty to her is perfect—not one of us who can say that his allegiance to the truth has never swerved for the sake of competing influences. Yet Truth is the most absolute of despots, and if any man adheres to Error instead, Truth will triumph over him at last and rob him of all the honor which he thought to win. The disloyal investigator may for a time win honor, but in the end the falsity of his claims becomes known and his reputation shrivels. In our own time we have seen the German founder of brilliant embryological theories lose caste because he did not have the discretion to wait to learn whether his ideas were true. Certain great naturalists have suffered in reputation from their inability to accept Darwinian theories, for, had it been possible for them to join with Darwin, their greatness would be to us still greater. A man may be of the highest ability, yet will he rank low among naturalists unless he is quick and sure in his recognition and inflexible in his devotion to truth.

Perfect truth is our ideal, but we encounter so many, many

* Presidential address delivered before the American Society of Naturalists at the annual meeting in Baltimore, December 27, 1894.

obstacles that we do not attain the ideal. The practical question is, What are these obstacles, and how may they be removed, avoided, or overcome? We undoubtedly make many failures, which are inevitable, and for which we are not responsible; I mean such failures as are due to the present limits of scientific knowledge, and the lack of the methods and instruments of research, which are as yet in the future. Nevertheless, the majority of failures to find the absolute truth are due to our own personal deficiencies. It is to the correction and, if possible, removal of these deficiencies that our professional training is very rightly directed.

The naturalist should be trained in observation, experimentation, and in reasoning.

Observation is our mainstay, the foundation of all our work. I believe that in many of our laboratories a student becomes well disciplined in observation, and acquires practical acquaintance with the principal sources of error in observation in his special line of work. This part of the naturalist's education is the part best done, and we must regretfully admit that his training in experimentation is almost nil, while his training in reasoning power leaves very much to be desired.

I should like to plead before you for experimentation. It is a most difficult art—far more difficult than that of observation, because the possibilities of error are far greater. The observer inquires "What?" the experimenter "Why?" The experimenter endeavors to determine an effect and a cause. He seeks, if you will allow me the expression, to find two "whats" and their mutual relation. Every science begins with observation, and, when it is advanced enough, takes to experiments. Natural history is still in the descriptive stage. The statement is almost strictly true of meteorology and zoölogy, nearly so of geology, least so of botany. I attribute so great value to experimental work that I regard botany as being at the present time the most valuable of the natural-history sciences from an educational point of view. As regards the zoölogists—with whom I must be counted—we are most of us either systematists or morphologists. Such experimental physiological work as has been done stands not to the credit of zoölogists, but almost entirely to that of medical men. In the slow advance of experimental morphology, through the labors of Driesch, Hertwig, Morgan, Roux, Whitman, Wilson, and others, we have the initiation of a most significant and beneficent reform. In all natural-history departments the great work of the future will, I believe, be done by experimenters.

For this reason it is to be desired earnestly that all young naturalists should be disciplined in making experiments. When that is done we shall hear less phylogenetic speculation and more of true causes. There are still many morphologists who feel that they have somehow explained matters when, for example, they state that the human embryo has gill-clefts *because* man is descended from a fishlike ancestor. In reality such a statement is no explanation of the causation, any more than it would explain vegetable humus to say that it is due to vegetable matter deposited on the ground. Such assertions may be true, but the omission of all links between the initial cause and the terminal effect shows that the notion of causation is in its rudimentary stage. There are too many naturalists who have still to develop a just conception of cause and effect; and it is just this development that we must look for in connection with experimental work. The biologists especially ought to profit more than they do by the opportunities offered in physiological laboratories.

The reasoning faculty is our weak point. Of the late Prof. Helmholtz, his friend, the physiologist Carl Ludwig, once remarked to me, "*Er ist eine reine Denkmaschine.*" It was the possession of a superlative reasoning faculty that rendered Helmholtz to many of us the foremost scientific man of his time. Most of us certainly find that, when we try to reason, our reasoning is disturbed by various personal factors, and, though we know that emotional factors must be eliminated from intellectual processes if our conclusions are to be sure, yet experience has taught us that logic in our practice is rarely divorced from all emotion. Sound reasoning involves the character of the individual. To train a naturalist, it is even more important to perfect his character than his intellect. For this reason no teacher can deal advantageously with more than a few students, because he must understand the individual characteristics, and give each man personal guidance, which necessarily is different for each student.

Let us consider some of the factors which are most apt to disturb or distort the work of reason.

First and foremost is the love of one's own observations and opinions. If it takes the form of pride, which leads us to be so careful that our opinions deserve trust, well and good; but if it is merely an excitable vanity, it lures us to disaster. Think of the innumerable controversies of science, and tell me how often have the disputants cared less to prove themselves right, than to ascertain the truth, be their own opinions right or wrong. What we strive for and, I fear, never attain is perfect indifference to the sources of an idea. It is almost impossible not to feel an undue interest in our own idea, yet such an interest inevitably leads to overvaluation of the evidence in favor of our idea, and undervaluation of the evidence against it. Let us, therefore, avoid polemics, and so avoid the temptation to search for proof of a personal theory, when we ought to search for the truth only. Never let a pupil say: "I am sorry it did not turn out thus and so; it would have been so fine if it only had been so." Let him be glad at discovering the truth. When he is eager for controversy, teach him the difference between discussion and controversy, and keep him out of the latter. Point out to him that erroneous conclusions are to be set aside, not so much by disproving them as by demonstrating the true conclusion. Darwin's theory of pangenesis has been set aside, not by being disproved, but by the demonstration that the theory of germinal continuity is well founded. The cataclysmic theories of Adam Sedgwick and the older geologists have been overthrown by the accumulated proofs of the gradual character of geologic changes. An error is hard to kill, but with a truth you may drive it away; therefore research is better than controversy.

The love of one's own opinion is the most insidious and fruitful of all sources of human error, and accordingly we recognize vanity and self-conceit as the gravest of defects in the naturalist's character. It is easier to make a competent investigator out of a dull man than out of a conceited man.

A second source of error is impatience—impatience to get results before the data are sufficient to support conclusions. What a horrible record against this century has been piled up by the accumulation of "preliminary notices," "*vorläufige Mittheilungen*, and *notes préventives!*"—a vast mass of mistakes, a terrible impediment to science, and all to gratify the mad longing for priority. I wish that the publication of a preliminary notice to secure priority should disqualify for membership in this society, and I trust that every one of us will stand firmly and sternly against this abuse, which is doing more to degrade science than any other influence I know of. Indeed, I am almost ready to say that the Académie des Sciences at Paris has done more against science than for science, because in its Comptes-Rendus it initiated the custom of brief premature publication for priority.

A third difficulty in the way of reason is the tendency to speculate. The annual waste of cerebral protoplasm in speculation must amount to millions of pounds. A vast generalization has its allurements, but in yielding to them we are apt to be drawn away from the actual facts. There is another danger, for the mere lapse of time gives hypotheses a dignity and apparent worth, and it were easy to give illustrations. You are doubtless all familiar with the hypothesis of *panmixia*, which was advanced on the flimsiest of bases; yet a few years later its propounder treats it as an established law. The like misfortune might happen to any of us, since it is easy to remember the conclusion and to forget the evidence. Among zoölogists speculation has long been rife, and for many years we have been deluged with phylogenetic inferences, with the evil accompaniment of eager welcome for facts which agree with the favorite phylogenetic theories of the day, and of disdain for such facts as did not concord with these theories. Thus has been created that biological mythology against which Prof. E. B. Wilson has protested so suitably.

Philosophy and science are practically often incompatible—not because philosophy is unworthy of our entire respect, but because would-be philosophers are not seekers for wisdom but lovers of speculation. Twenty years ago we thought that Oken, whose *Natur-philosophie* was created by his speculative enthusiasm, would never have another imitator, but since then biological speculation has become almost a fetich. Let us part company from the horde of foolish thoughts which have too long masqueraded under the false garb of philosophy. For our lifetimes the labor of inductive research will suffice, and we may well leave deduction for future generations. Philosophy, so called, is often an effort to decide what must be, but while knowledge remains imperfect the "must be's" will guide us wrong more frequently than they will guide us aright. As long as Science seeks to determine what *is*, her work will endure. My protest against speculation is no idle rhetoric, for the evil is very great. I hope that Weismann's mystical treatise on Germplasm will prove to be the culminating effort of the speculative school, and that the influence of the school will be as brief as it has been widespread.

A hypothesis may be a good serving maid to clean away rubbish and get the workroom in order. It is for us to remember that this good maid makes the worst mistress.

There are many other difficulties of character which obstruct reason, but you will excuse me from an exhaustive review of them, and therefore I will refer only to one more, and that briefly. I mean the artistic perception which induces us to look for completeness, clearness, and simplicity, so that we are tempted to add a little or more to our conclusions, or to accept a result partly because it is complete, clear, and simple. The most eminent illustration of this tendency is Herbert Spencer, whose mental processes are so far governed by his love of clear, simple formulæ that he uses simplicity as a test of his conclusions, and makes formulation a test of truth and a substitute for proof. We are all inclined to be lax as to our proofs if the generalization is satisfactory and pleasing, but Spencer's mistakes may warn us against the danger of gratifying this inclination. Science is not one of the fine arts. Its work can not be directed by the love of beauty or by sentiments. Science is a pursuit for the intellect and for the intellect alone.

I will turn to another part of our work—publication. Scientific publications naturally group themselves in four classes: original memoirs, handbooks, text-books, and bibliographies. Now in the three latter good workmanship is indispensable, for their utility depends on their arrangement, the right proportion of parts, and the skillful use of language; but the value of original memoirs depends upon the discoveries which they report and the sufficiency of the evidence presented to support the discoveries claimed; hence the form in which the matter is presented appears less important than in a handbook or text-book. Moreover, our original memoirs, saving a very few which mark epochs of progress in natural science, are, as we all perfectly know, destined to oblivion. In time our new discoveries will become old-established facts, the original authorities for which will be forgotten. Who of us would search, save as a student of the history of science, for the original authority on the muscles of the human arm, or for the proof that fossils are not *lusus naturæ* but genuine remains, or that some rocks are of sedimentary origin? When we have attained certainty in our discoveries, they gradually become so verified that the memoirs, which originally brought the proofs, lose their value. Original memoirs are like digestive organs; they are filled with raw facts, which they prepare for assimilation, but to build the body of science these same facts must be absorbed and transmuted.

We are, of course, convinced that our original memoirs are for temporary service, though their recorded facts are to be permanently added to knowledge. To the influence of this conviction we may ascribe that carelessness of style, verbosity, and frequent padding which mar scientific writings too commonly, because the necessary care does not appear worth while for a temporary essay. But the time has now come when the burden of reading the thousands of pages of memoirs which are published annually even in a single field of research is overwhelming, and it is evident that for the advantage of science every legitimate means to lessen this heavy burden should be adopted. The habit of conciseness and clearness should be sedulously cultivated.

With a view of estimating what might be done in this direction, I have gone over a number of articles upon embryology which have been published in the four accepted languages of science—German, English, French, and Italian—during the last two years. I am compelled to admit that the majority of these articles could be easily shortened by a half, and many of them shortened by much more than that, and still offer a thorough, or, better, said an exhaustive account of the matter presented. I have been astonished at the amount of perfectly irrelevant matter and of personal details which appears. The author informs us that he could not leave home until Tuesday; that it rained on Friday; that he had to carry the eggs eleven kilometres on Saturday;

that he used Delafield's hæmatoxyline solution, of which he gives the formula; that he began making his sections with a Thoma microtome, but later used a Schanze, as Prof. X—needed the Thoma; the author's work was interrupted because he was called home on account of his father's illness; his father lived in Meyerstadt or Smithville. What have these and thousands of similar items to do with the plane of the first cleavage of the ovum, the origin of the centrosome, or the development of the notochord, or any other problem of embryology? I have not invented my illustrations; on the contrary, I have taken them from some of the best of recent embryological articles. Similar illustrations can be collected from recent literature of any branch of natural-history research.

So far as embryological literature is concerned, the French standard is certainly the lowest. Their verbosity is infinite, and one must read page after page for a single fact. Many of the French memoirs I have read are literally ten times too long for the matter. Next to the French come the Germans and ourselves—Americans—who, in the biological sciences, are disciples of the Germans. The best-written memoirs are the English, owing, I think, to Huxley's influence. Huxley has carried scientific writing to unsurpassed excellence, combining clearness and brevity in a marvelous way, and his pupils, Francis Balfour and Michael Foster, have invariably sustained a high literary standard. Their example has been all the more telling because literary art holds the same position in England that music holds in Germany and painting in France.

No doubt the ark of science will traverse the deluge of publication safely and land us on the Ararat of natural law, but I fear our Ararat will not appear until the deluge subsides.

But I must hasten to the second part of my address.

II. The Effect of the Naturalist's Career on his Character.—The occasion does not permit me to refer to more than two or three professional traits.

The best that we gain from the pursuit of research is, I believe, our characteristic optimism. We are engaged in achieving results, and results of the most permanent and enduring quality. A business man may achieve a fortune; but time will dissipate it. A statesman may be the savior of a nation; but how long do nations live? Knowledge has no country, belongs to no class, but is the might of mankind, and it is mightier for what each of us has done. We have brought our stones, and they are built into the edifice and into its grandeur. My stone is a small one. It will certainly be forgotten that it is mine, nevertheless it will remain in place.

How different is the pessimism toward which literary men are seen to tend! Harvard University lost James Russell Lowell in 1891, and Asa Gray in 1888. The letters of both of these eminent men have been published. Lowell's letters grow sad and discouraged, and he gives way more and more to the pessimistic spirit. Gray is optimistic steadily and to the end. The difference was partly due to natural temperament, but chiefly, I think, to the influence of their respective professions. The subject material of the literary man is familiar human nature and familiar human surroundings, and his task is to express the thoughts and dreams which these suggest. He must compete with the whole past, with all the genius that has been. There is nothing new under the sun, he exclaims. But to us it is a proverb contradicted by our daily experience.

The attitude of literary men is indeed sad. Lowell opens his essay on Chaucer with the question, "Can any one hope to say anything, not new, but even fresh, on a topic so well worn?" and answers, "It may well be doubted." This feeling that anything new is impossible is not modern. La Bruyère begins his Caractères with "Tout est dit, et l'on vient trop tard depuis plus de sept mille ans qu'il y a des hommes, et qui pensent"; and two hundred years later Joubert repeats: "Toutes les choses, qui sont aisées à bien dire, ont été parfaitement dites; le reste est notre affaire ou notre tâche: tâche pénible."

Another trait which is very striking shows itself, not in all naturalists, but in nearly all great naturalists—the trait of humility—not the humility of self-depreciation, but the humility which is the privilege of those who pursue a high ideal. The great naturalist cares for the absolulely true, and, though he may know that he is abler than other men, he feels only a minor interest in personal comparison, and measures himself by a different standard. A man who estimates himself by an ideal which he never fully attains, learns humility in its noblest form. Von Baer, Ernst Heinrich Weber, Helmholtz, and Darwin were men of that rank; and doubtless the very greatness mentally of such men enables them to estimate justly the proportion their personal contributions bear to the whole of science.

The sad side of an investigator's life is its inevitable loneliness, so far as his special work is concerned. It rarely happens that one of us finds a colleague at hand able to appreciate his special work; but at these meetings we each find appreciation and stimulus, and we return refreshed to our isolated labors, return stronger to stand by ourselves, as men must who wish to share in the serious work of the world.

The solidarity of our profession, the mutual loyalty not only of naturalists but of all scientific men, is very great and of immense value. It is perhaps the most important function of this society to maintain and strengthen our professional loyalty, because upon that loyalty depends our success as a body, and as a body we have a great work to do. Loyalty implies generous co-operation, and secures that unity of feeling and action which breeds success. Our influence is not yet large enough, and I hope that it will be vastly increased by carrying out the scheme of affiliation between ourselves and kindred societies. Unity is power.

It is believed by many outside of our profession that a scientific career is narrowing in effect, and tends to obliterate human, artistic, and religious interests. They look upon Darwin's loss of sympathy with poetry as typical. The idea seems to me false. The naturalists whom I know are as genuinely interested in their friends and in art and in literature as any other group of liberally educated men. One of our foremost geologists is a learned musical enthusiast; one of our botanists, a loving student of the best European literature; one of our anatomists, an earnest participant in charitable work. I claim, in short, that the pursuit of pure science broadens and deepens the character. Science is full of sublimity, of charm, of inspiration; but the poet has not yet been found who will express this aspect of science. We are like colonists: our pioneers are continually advancing into new territories; we must work incessantly to secure mere possession; so it is not yet quite time for the poet.

Another characteristic of the naturalist is faith. He must preserve his faith in the possibility and value of knowledge of the truth. We often forget that this necessity exists. Although we know not whither truth will lead us, whether to happiness or to unhappiness, we nevertheless believe in it, trust in it, and strive for it. Let us therefore have a broad-minded respect for the faculty of faith, for the loss of it is a crushing disaster to a naturalist.

The loss of faith in the truth is rare; its opposite, an exaggerated confidence in the possibilities of science, is not rare. I think that we habitually measure science incorrectly, because we estimate its magnitude by our individual capacity for knowledge, and so come thoughtlessly to call that infinite which is merely large. I hold the opposite conception, that the extent of possible human knowledge is comparatively small so soon as we omit the details. Huet, Bishop of Avranches, thought that the real knowledge of his time,* aside from the details of history, etc., could be put in ten folio volumes. He was probably not far from right. All the knowledge of our time could be brought within the compass of a moderate number of volumes. Nor does the future ap-

* The latter part of the reign of Louis XIV.

pear to me to offer more than very finite possibilities. Discovery can not always go on with its present rapidity. We live in the golden age of research. We are surrounded on every side by discoveries so easy that they seem to beg for our attention. But as each one is made and its result added to the known, the unknown is equally diminished. It diminishes daily, and the store of easy discoveries lessens so fast that the time is not very distant when investigators of moderate abilities will no longer enjoy such opportunities as they have now. If we consider the whole of science, we have a sense of boundlessness; but each part has its end, and its end is not far away. It will not be long before nearly everything easily known will be known. It would be presumptuous to assume that, even when the whole knowable has become known, there will not still be problems which the human intellect can apprehend but not solve. As to-day, so hereafter, the naturalist's final thought must be reverent submission.

III. The Influence of the Naturalist on Mankind.—The influence and utility of natural science need neither defense nor explanation to a generation which has witnessed the establishment of the theory of natural selection and of the germ theory of disease; nor need we argue for the pre-eminence of original research, but there are certain principles for which we stand individually and collectively. I think that it will be profitable to review and to formulate some of these.

We stand for the value of good intellectual work and for the recognition of the value of proper training. We do not admit that scientific work requires a peculiar mind, but only the cultivation of those fundamental faculties of observation and induction which every one should possess and use. On the other hand, we claim that in addition to the development and disciplining of these faculties the naturalist must have his special professional training, and that without it he is not qualified for his professional work. In upholding this standard we not only serve the cause of science, but we serve the whole country. It is safe to say that the greatest evil in the social life of the United States is the habitual disregard of competency—a disregard which prevails not only with the people at large, but also among the most highly educated men. Democracy is the belief that every man is the equal of his betters. Americans are loath to admit that training and experience make experts, and that experts are better than others for their special work. The spoils system of the office-seekers is based upon the assumption that training and experience do not render a man more competent. When a water board is established to plan a water supply, we do not appoint chemists, engineers, and sanitarians, but grocers, novelists, and ward politicians. It is a rare exception if among the trustees of endowed educational institutions a man is found with extensive knowledge of educational methods. It is common for a man who has never been trained to teach to take up teaching for a few years, when he changes to some business or profession. These, and thousands of other instances, crowded in our memories, illustrate the dislike of real competency.

Imagination anticipates the revolution which must come, and foresees the time when public workers of all kinds shall be chosen —first, because they have been properly trained and educated for the work which is to be their lifelong profession; second, according to the relative ability of those so prepared. Democracy appears as a permanent factor of steadily increasing influence in social evolution. It has, of course, done much good, but its failure to secure honest government has raised one of the gravest problems of our time. Some persons advocate restriction of the right to vote, but to me restriction of the right to be a candidate offers the practicable solution of the problem. We are a few among millions, but the educational and other offices we hold give us an influence out of proportion to our mere numbers. If we demand within the limits which becomes us that men must be chosen for their competency, we shall uphold effectively a principle the defense of which is among the foremost duties of every patriotic citizen.

We have already done something to improve school education. We should do more, especially in the direction of adding scientific courses to the school curriculum. A man is liberally educated when he has learned to take an appreciative interest in the intellectual life of his time, and a man who has not learned enough of the natural sciences to understand something of their progress can to-day scarcely rank as an educated man. It is true that science is better adapted to serve as a basis of education than the classics, and it is true also that it is easier to give a liberal education without classics than without science; nevertheless we must urge the claims of science in schools conservatively. A reform is better than a revolution. A reform saves strength and spares prejudices. We must remember, too, that centuries have been spent in testing and perfecting the classical system of education, and that it has rendered services which can hardly be overestimated. The education based on science has scarcely two decades of imperfect and hesitating trial, and the people at large have still to learn that it is feasible and more valuable than the older system. The methods of utilizing science for school courses are still crude. We suffer from an *embarras des richesses.* There is here an opportunity for public usefulness for this society. Could we not through a committee prepare a plan for a system of school education in which science should have its place, and by which our children should acquire some information about themselves, the world around them, and at the same time be disciplined in observation and reasoning?

In regard to our schools there prevails the miserable delusion that they are good. We have many private and public good schools, but they constitute the small minority. Most of the young men who enter my classes after leaving our public schools are poorly disciplined in every respect, and a great many of them are absolutely uneducated: they can not express their thoughts in English; they can not spell common words; they can not translate correctly a simple phrase in Latin or any modern language, and they are ignorant of all sciences. Such is too often the condition of the graduates of the primary, grammar, and high schools of the country which claims to afford the best system of public education in the world. I have very little personal acquaintance with our schools, but to my mind their product condemns them, and I believe that our influence can do much to redeem them from their present condition.

Another public duty, which belongs especially to us, is to advance the development of universities in America. There are three grades of education—school, college, and university. In schools elementary knowledge is used to inform and develop the mind; in colleges advanced knowledge is used for the same purposes. Now it is one thing to teach what is known, as in schools, and to teach how to confirm what is known, as in colleges; but it is a fundamentally different task to advance a student to successful original investigation of the unknown. As Mill has justly remarked, the vast majority of mental operations are neither inductive nor deductive, but reasoning from particular to the particular. Minds which work in this way suffice for the routine affairs of existence, but the progress of the world depends on the higher faculty of originality, either in the inductive establishment of laws by the comparison of particulars or in the deductive applications of these laws. It is the function of universities to develop and discipline originality, to cultivate the faculty of thinking out a conclusion for the first time—not for the first time in the history of the thinker, but for the first time in the history of the world.

To train men to originality in every field of production is the proper function of a true university. This has long been the accepted ideal of German universities, and because they have steadily striven for this ideal they have attained a fame which draws to them students from every other country. In America we are slowly creating a few universities. Of nominal universities we have too many—false *Duessas*, fair in semblance, but not true to their pretensions. We have, in fact, as yet nothing to rank with the German universities. We are handicapped by the college tradition of four years' education to fit a man for everything in general and nothing in particular. But the colleges are rapidly losing ground, and it seems to be only a question of time as to their total disappearance. I do not mean that they will cease to exist in name, but that a college (in the sense of the term as universally accepted thirty years ago) is an institution which will have no place in the American educational system of the future, just as it is unknown in the present educational system of Europe. In fact, our best colleges are passing through rapid revolutionary changes, and, like Harvard, Yale, Columbia, and others, are becoming universities. Let it be our part to help the transformation, to hasten it, and to secure for research its place as the basis of the highest education in science. Every one admits that the value of a university depends chiefly upon its professors, but it is not understood that ability to give instruction six to ten hours a week successfully by no means qualifies a man to be a university professor. The essential qualifications for a professor of any natural science are, first, ability to carry on original research; second, ability to train others to carry on original research. All other qualifications are subsidiary. Of university life research is the Alpha and research is the Omega.

We welcome the growth of the university idea in this country, and we can not gather in this place without speaking with grateful recognition of the services rendered to the cause of the highest education by the university whose guests we are to-day. The Johns Hopkins University has the glory of having been the first American institution to accept unreservedly the genuine university ideal. Would that she had had more imitators!

Summing up the conclusions announced by Mr. Worthington C. Smith in his book, Man, the Primeval Savage, Dr. W. Boyd Dawkins agrees with the author in the opinion that man inhabited southeastern England after the Glacial period; also in the view that the preglacial or postglacial age of man is to be regarded as merely of local significance, because the Glacial period is a purely local phenomenon, not marked in the warmer southern lands, such as the Indian Peninsula, which was inhabited by the palæolithic hunter. "We know him in India simply as living in the Pleistocene age. He probably invaded Europe in the preglacial age, and lived in the south while Britain lay buried under a mass of glaciers, or was covered by a berg-laden sea. He is postglacial in the valley of the Thames. He is not separated from our own times either by a wall of ice—the ice age of Prof. James Geikie—or by the tumultuous waters of a vast deluge, such as that recently put before us by Sir Henry Howorth. He is separated by a geographical revolution during which the seaboard of northwestern Europe, as we find it now, came into being, and Britain became an island—as well as by a change in our land from a continental to an insular climate."

BUSINESS, FRIENDSHIP, AND CHARITY.

By LOGAN G. McPHERSON.

AS man has learned with increasing complexity of means toward an increasing variety of ends to wrest food and fuel and shelter from the earth and all that springs therefrom, each man has had to depend more and more upon the efforts of his fellowmen; and hence has arisen that marvelously intricate intertwining of effort that characterizes the civilization of to-day. Interwoven in ministering to the needs and gratifications of mankind are the laborer's muscle, the hand of the mechanic, the brain of the merchant, the painter's touch, the singer's voice.

This intertwining of effort is nowhere separable; the result is the blood of civilization that, flowing through the arteries of commerce, connects the hemispheres. Europe and America eat the cattle and the wheat of the western plains, wear the fabrics of England and France, and drink the tea of the Orient. The results of the researches of the German laboratory, and of the inventor of whatever nation, are utilized throughout the world, and books of whatever press penetrate to the households of every clime. Patti sings in San Francisco and St. Petersburg; Irving and Booth act in Berlin, Paris, London, and New York. In public gallery and public park the masterpiece of painter and sculptor is seen by thousands, and, as reproduced by engraving and etching, is brought to the sight of thousands more. The English specialist discovers a remedy that all physicians use; the American lawyer collates, systematizes, and formulates a code that eases the burden of all litigation.

In the simplicity of primeval life each man obtained for himself his own crude subsistence, prepared his own rude clothing, and fashioned his own rude tools. In time it was learned that, by yielding a portion of the result of one's efforts for the benefit of another in return for a portion of the results achieved by that other, increased benefit was obtained by each. Thus began that co-operation that, through the centuries of slavery, feudalism, and absolutism, has increased and extended until to-day all who by work of hand or brain achieve results that contribute to the benefit of others receive the measure of their material reward in money obtained as wages, salaries, fees, or profits.

The man of affairs, before taking the morning train that conveys him to his place of business, gives a penny to the boy at the station and receives in return a newspaper. In exchange for that penny he receives knowledge of the happenings of the previous day, which may play a part in determining his course in connection with the production and distribution of commodities that may directly affect hundreds of workmen and thousands of consumers. The boy who receives the penny receives many other pennies, a portion of which accrues to him as his profit from the sale of the papers. The greater portion goes with hundreds of other pennies, from each of hundreds of other boys, to the office of the newspaper, where they form a considerable portion of the fund that pays for the paper whereon, and the ink, type, and presses wherewith, the newspaper is printed; that goes in wages and salaries to the foreman, compositors, correspondents, and editors. The portion of this fund that goes to the manufacturers of ink, paper, and presses contributes to their profits and to the wages and salaries of the workmen employed by them. Portions of the wages and salaries of foreman, compositors, correspondents, and editors, and of the workmen that make ink, paper, and presses, are in turn paid by them to dealers in shoes, hats, clothes, meat, flour and potatoes, coal, furniture, carpets, and so on. The dealers in these commodities make remittances to the manufacturers who in turn, pay the wages of the workmen who produce shoes, hats, and clothes; to the killers of cattle; the packers and shippers of meat; the raisers of wheat and millers of flour; the miners of coal; the makers of furniture, and the weavers of carpets. Each is a purchaser of products that all are concerned in producing. The money that goes to each as a reward for his efforts is distributed through various channels to all others as a portion of the reward for their efforts. The exchange of the penny and the paper between the man and the newsboy is one of a myriad of exchanges between man and man that are interlinked one with the other in bringing to each a portion of the benefit of the efforts of all the others, and which, giving a broad significance to the term, constitute Business.

Without this interlinking of effort the fabric of our civilization would be impossible. Not under any conceivable conditions could any one family supply its needs as those needs are supplied by the various producing and distributing agencies of to-day.

With the increasing interdependence of man and man in ministering to material needs has been an increasing tendency toward association for that satisfaction which is obtained from the common enjoyment of a pleasure, the sharing of grief, the expression and exchange of thought and opinion, from social conversation. Association, from necessity or convenience, frequently develops a similarity of taste and habit that brings congeniality; the wider the range of association permitted by the conditions of their lives, the greater is the opportunity for persons of particular tastes and habits to form companionships affording the greatest gratification, and the likelihood that they will do so. With the congeniality thus formed is the growth of sympathy of one with the other, and this sympathy or fellow-feeling is the basis of that relation known as Friendship. This sympathy, leading to the desire on the part of those between whom it exists that the life of each shall be free from discomfort and annoyance, prompts the doing of kindly acts one for another. These acts are frequently the dispensing of hospitality; they frequently are the extending of aid in misfortune and adversity, and, now and then, result in the sharing of fortune, to a greater or less extent, by one more richly endowed with the means for the satisfaction of his material needs, with those to whom he is bound by this sympathy of friendship. It will be perceived, therefore, that when a person, prompted by this sympathy, contributes to the material welfare of another, that other receives from his gift benefit that he might not otherwise obtain, except as the reward of effort toward the satisfaction of the material needs of mankind. Thus friendship bestows what otherwise would not be obtained but through the channels of business.

Akin in a measure to that sympathy which prompts acts of kindness which inure to the benefit of one's friends, is that sympathy which prompts acts of charity intended to inure to the benefit of the needy and unfortunate—of those who, whether by reason of bodily, mental, or moral defects, or by the grinding force of untoward circumstance, live in misery. The giving of alms to a beggar, the contribution to a hospital, asylum, or missionary fund, springing from this feeling of sympathy, have directly or indirectly for their object the bettering of the material condition of the beneficiaries.

As the actions prompted by the desire for pecuniary gain, many of the actions prompted by friendship, and the actions prompted by charity have for their object the satisfaction of the desires of others, the conferring of benefit upon others, it is proper to consider to what extent, in what manner, and under what conditions one should confer benefit upon or receive benefit from others.

It has been demonstrated by the greatest philosophers that the highest end to be attained by each individual for the good of himself and the good of civilization is the greatest harmonious physical, mental, and moral development of which he is capable. The benefits conferred by each individual upon others should therefore be such as to lead to this end for each of the beneficiaries, and the benefits received by each individual from others should lead to this end for him.

To its wholesome use, as well as to its highest development, is essential that the body receive that food and clothing and the bodily organs that alternate exercise and rest that promote regularity and fullness of the vital processes; that nerves and muscles receive that training which brings them under the complete control of the will; that the perceptive organs be habituated to convey clear and accurate impressions to the brain.

To the wholesome use of the mind it is essential that the impressions coming thereto be perceived in their exact relation, so that nerve and muscle may be directed to most efficient result; its development means the more extended and the more complex correlation of an increasing number and variety of impressions.

The highest moral development is attained through the increasing and constantly more refined perception of that conduct which contributes to the highest good of one's self and others, and action in accordance therewith.

Here arises the fact that the physical and mental structures of different individuals are of greatly varying capacities. An amount of physical exertion that serves only as wholesome exercise to one man might ruin another of less sturdy structure. The amount of mental exertion upon which one brain thrives and develops would cause another pain, and would be utterly impossible for yet another. Different impressions coming under different conditions, through bodies of different fiber, to brains of different caliber, have, together with the mold given by differing influences of heredity, produced that difference of characteristics in different individuals that is so incalculable that it is accepted as a truism that no two persons are exactly alike. It is obvious, therefore, that no one can contribute to the totality of effort in greater degree or in kind other than his physical and mental structure and characteristics will permit. The laborer on the embankment has the muscle wherewith to use the pick and shovel, but ordinarily is incapable of that co-ordination of hand and brain which would enable him to use tools of a higher class. The blacksmith has that adjustment of brain and muscle which enables him to bend and shape the bars of iron. Through the ascending ranks of artisans this adjustment of brain and muscle becomes more delicate, reaching a rare degree of precision in, for example, the optician who grinds and shapes the glasses for spectacles, microscope, and telescope. The clerk who keeps journal and ledger, or who prepares deeds and mortgages, has that control of the hand and that mental development which suffice for this work. Neither laborer, blacksmith, optician, nor clerk could perform the work accomplished by the other; but each, by giving to others the benefit of effort of which he is physically and mentally capable, receives that which enables him to obtain the food, shelter, and clothing necessary to his maintenance.

And it is through work of body and brain that yet higher result is achieved. The blacksmith's son, compelled to contribute early in life to the support of himself, his brothers and sisters, becomes perhaps a machinist's apprentice. As he sweeps the shop, carries tools, and blows the bellows, he sees the firing of the boilers, the turning of the wheels and belts, and the men at their work. In time he comes to use tools and lathe himself. His hands become deft, and his brain increases in perception of what tools and machines can be made to do; he is being trained and developed, physically and mentally, to a capacity for increased usefulness, which brings increased reward. This development perhaps may result in the invention of appliances or the discovery of methods whereby greater results may be accomplished with less effort, thereby giving to civilization that extraordinary benefit and obtaining for himself that extraordinary reward which comes to the inventor. And so, likewise, with all men in all vocations. The printer's devil, step by step, may rise to the foremanship of the composing room, or to the editorship of the paper. The office boy becomes shipping clerk, or bookkeeper, and may acquire that knowledge of commerce and that judgment which fit him to control the operations of a great manufacturing or mercantile establishment.

Throughout the field of human effort, extraordinary achievement proceeds from a correlation of ideas in an original perception of far-reaching relation of cause and effect that, through nerve and muscle, results in handiwork or delivered word that places that relation in tangible shape for the benefit of mankind. And in any line of human effort extraordinary achievement is usually attained only after years of toil, in which body and brain are trained and tempered to this perception of far-reaching relation of cause and effect and the ability to give it expression. Different individuals, however, attain different degrees of usefulness, and different degrees of reward; only the few achieve extraordinary result, the vast majority in any vocation laboring year after year without more than average achievement or more than average reward. But the work of each brings that which sustains the body; it gives body and brain the use by which they are exercised and developed; it contributes to that totality of effort by which all individuals of the civilized world are sustained; and it is by means of toil that civilization is advanced; that better machines are made; that better cloths are produced; that more nutritious food is prepared; that better houses are built; that better books are written; and better songs are better sung.

In every community different people live in different degrees of comfort. Their habitations vary greatly in size, strength, and durability. Their clothing differs greatly in warmth and adaptability, and varies in quantity. There is great variety in the kind and quantity of food which each family can afford, and the opportunities for other pleasurable gratifications of the senses widely differ. And therefore the question, Why do different individuals obtain from the totality of effort different proportions of benefit?

The reply is suggested by the actions of men in primeval barter. When man first learned that, by yielding a portion of the result of his efforts for the benefit of another in return for a portion of the benefit of the result achieved by that other, increased benefit could be obtained for himself, he naturally yielded only so much of benefit as would bring him greater benefit in return, and so also with the other. Each yielded as little and obtained as much as he could. In that intricate intertwining of effort that characterizes the civilization of to-day that primeval principle of exchange holds good. The wage of the laborer and servant, or the salary of the clerk, as a rule, is as little as can be paid for the work which each performs; likewise with the fees of the physician, lawyer, writer, painter; and, as a rule, the least consideration for which commodities can be obtained is the price that is paid for them. And likewise laborer, servant, clerk, musician, lawyer, writer, or painter, as a rule, endeavors to obtain the highest price for his services or the result of his efforts, and the merchant the highest price for his commodities. And this basis, which seems to be of unmixed selfishness, is the only basis that will lead to ultimate justice to all.

For if A produces the same quantity, quality, and result of work as B, and receives greater wages, salary, fees, or profits in return therefor, he is able to obtain from the efforts of others a greater proportion than B of all that contributes to the well-being of himself and of his family. That is, in return for equal contributions to the totality of effort A receives more than B, which is manifestly unjust. If there can be obtained from C, D, E, or F the same quantity, quality, and result of work as is obtained from B and for the same reward as is paid to B, society, as a whole, by paying to A a greater reward than it pays to B, C, D, E, or F, diminishes the totality of effort by the amount of effort that B, C, D, E, or F would produce in return for the difference between the reward paid to A and that paid to B, C, D, E, or F for the same result. If, however, society can not obtain from C, D, E, or F, or any other source, the same quantity, quality, and result of work as it obtains from B—except for a reward equal to that paid to A, and it needs a greater amount of such work than can be produced by B—it is obliged to avail itself of all or a portion of the efforts of A, C, D, E, and F. If it continues to obtain results from B equal to the result obtained from either A, C, D, E, or F for less reward than is paid to A, C, D, E, or F, B by reason of the discrimination has a grievance which is not adjusted until his reward is made equal to that paid A, C, D, E, and F. But if from B, G, H, I, and K work can be obtained equal to that obtained from A, C, D, E, and F for the same reward to each as that paid to B, the totality of effort would be increased by employing B, G, H, I, and K at the lesser reward. Society as a whole, therefore, receives greatest benefit, other things equal, by obtaining needed results for the least reward. But by paying unequal rewards for equal services it incites the antagonism of those discriminated against as soon as the discrimination is perceived by them. The merchant, who pays one clerk a greater salary than another whose services are of equal value, incites that other to the demand for an increase of salary. A class of laborers receiving wages less than other laborers to whose services they think their own equal, are incited to demand equal wages; and so throughout all society.

But if A and B for equal results receive equal reward, and in a given time A produces more than B, it follows that to make equal contributions to, and to receive equal reward from, the totality of effort, B must work longer than A. And if A in a given time produces not only more than B, but of more important result than B, it follows that his reward should be greater than that of B. In other words, to receive the greatest reward that he can obtain from the totality of effort, each individual should contribute to his capacity to that totality; and that the totality of effort may be the greatest, society must bestow upon each individual such proportion of benefit as in return for which the proportion of effort of which he is capable can be obtained.

And it is not difficult to perceive that the value of effort is directly proportionate to the intelligence with which it is guided and by which its results are directed. On roads and embankments, in the fields, mines, and quarries, is necessary a vast amount of work that depends almost entirely on physical exertion and endurance. While the aggregate of this work forms a large proportion of the totality of effort, the portion contributed by each individual is but an infinitesimal portion of the whole, and, as requiring but little intelligence or experience or training, it can be performed substantially as well by one as another the proportion of benefit accruing to each individual in return is small, and this also because such work is without avail unless it is directed to efficient result, and its results are co-ordinated to beneficial ends, and this directing and co-ordinating come from others than those performing the work. On the plane with these laborers may be classed teamsters, stevedores, porters, and like functionaries. For their individually slight and easily obtained services, which are immediately directed by the intelligence of others, society gives but slight reward. In stores and offices are needed the services of multitudes of clerks, who, by helping purchasers to secure desired commodities, by writing letters and keeping accounts, contribute to the benefit of society effort that requires a considerable degree of intelligence in addition to manual labor. Their contributions to the totality of effort, and likewise those of artisans, such as carpenters and machinists, to the performance of whose work is necessary a considerable degree of intelligence, training, and experience, meet with ampler reward than those whose efforts spring from physical exertion alone. To those who direct the efforts of others toward results of great benefit to a great number of people still greater reward is given. The manufacturer, who employs the services of numerous employees in producing commodities of a design and quality that cause them to be of use to multitudes of people throughout an extended territory, and the transportation manager and the merchant who utilize the efforts of legions of subordinates in effecting their distribution, frequently amass fortunes. Those from whose brains spring ideas that are of extraordinary benefit to mankind, and those who have made practical utilization of such ideas, have received extraordinary reward. Instance after instance occurs of inventors whose devices have wonderfully cheapened and facilitated production and distribution, and who have thereby reaped immense personal gain. And likewise throughout the professions and the arts. There is a vast difference between the remuneration accruing to the lawyer of slight and unimportant practice and that to him who contributes to the adjustment and maintenance of vast and important interests; between the reward given the actor of little histrionic ability and that flowing in upon a Jefferson or a Booth. At the extreme end of the scale are the vagabond and the tramp, who, contributing nothing to the well-being of any one, are entitled to nothing in return.

Out of the different capacities of different men that have been accentuated by the increasing specialization by which alone it has been possible to administer to the growing and varied needs of mankind has arisen the present industrial system. Each man, to obtain the satisfaction of his own needs, must contribute to the needs of others; each man, in the endeavor to obtain the most for himself, strives for higher wages and salaries and for greater fees and profits; and all men, that they may supply their own needs to the fullest extent, strive to obtain services and commodities for the lowest price. Therefrom arises the great force of competition that, acting through the merchant who sells, upon the manufacturer who produces articles of use and consumption, compels production in best adapted localities, the adoption of economical appliances and thrifty methods, the placing of particular functions in charge of those best fitted to their performance. The increasing use of machinery and the development of methods of production and distribution necessitate the employ of a constantly increasing, number of men of the higher grades of ability and intelligence and the efforts of other grades of those who work increase both in vigor and system toward securing the greatest remuneration for their services. The result, as amply proved by statistics, is that the reward of effort constantly increases both by reason that wages, salaries, and incomes become greater, and the prices of commodities and of the result of services become less. That this holds true even during the radical industrial readjustment of the past two years is evidenced by the following extract from the editorial summary of business in Dun's Review of January 5, 1895:

"The complete review of different branches of business given to-day places in a clear light the fact that prices of commodities are at the lowest level ever known. Eight years ago, in July, prices averaged only 73·69 per cent of the same articles and in the same markets January 1, 1860, and this remained the lowest point ever touched until August 10, 1893, when the average fell to 72·76, but early this year prices dropped below all previous records and have never recovered, the average December 26th being only 68·73 per cent of the prices in 1860. These changes contrast sharply with the decline of wages paid per hour's work, which, as was shown last week, average only 1·2 per cent less than a year ago."

It should, however, be perceived that the greatest contribution which any one can make to the totality of effort is not the result of effort pushed to excess in any one direction for a limited time, for such effort results in the premature impairment of physical and mental power; but the total result of his efforts for the longest time that his mental and physical efficiency can be preserved. It therefore follows that periods of expenditure should be followed by periods of recuperation; that each man for the benefit both of himself and of society should have that rest and recreation and the opportunity for that bodily and mental gratification which offset the wear and tear of energy persistently expended in one direction, and contribute to the preservation and symmetrical development and rounding of his bodily and mental life.

All the foregoing statement leads irresistibly to the conclusion that each man should work as best he can in fulfillment of his duty to himself and his duty to all others, whether his contemporaries or those who come after him. And therefore stands clear and firm the corollary that each man should find pleasure and satisfaction in that work which it is possible for him to do. And it doubtless would be so if throughout the world all people recognized the full meaning of work, and it were true, and all people clearly perceived it to be true, that each man receives benefit in proportion to the value of his efforts. But all history shows that man has ever had to fight for the fruit of his labor; to stand guard over that which his efforts have gained. Herein lies the meaning of theft. In broad significance, to steal is to deprive another of benefit without yielding benefit in return. The robber and the thief that directly filch are shown to become less in each decade in proportion to the total population; but, in the complexity of the growing industrial mechanism, the greed of the unscrupulous has found new channels through which to wrest from others that for which adequate recompense is not given. But after war is peace, and as a wider sense of justice has followed the struggles of mankind in the past, there is reason to believe that the industrial warfare that now confronts us on every hand and the discussion of political, economical, and industrial problems which is now intense throughout the civilized world will result in that increased intelligence and increased morality which tend ever more and more to give each man his due.

And contributing to this end must be a fuller understanding of the nature of friendship and charity and of their just limitations. For these much-extolled virtues are but too frequently with mistaken intent devoted to unworthy ends; in devious ways their counterfeits are made to serve as instruments for obtaining unearned gain. That a monarch of old who gave to a genial comrade power to devote tribute obtained from the subjects of the realm to his personal pleasure and indulgence allowed friendship for his comrade to result in wrong to his people is apparent without other proof than that of the fact. Because of the pleasure obtained by the king from association with him, the favorite benefited by the efforts of thousands of people to whom he contributed no benefit in return. And so also with every man occupying position of power or trust who bestows place, authority, or privilege because of friendship upon a man incompetent and unworthy. For, as the efforts of each man are interlinked in greater or less degree with the efforts of all others, so to do would be to diminish the totality of effort that is the lifeblood of civilization. The human nature quickly adjusts itself to that which is pleasant; the frequent bestowal of unearned benefit upon a friend tends to adjust his nature to the reception of that benefit, to lead him to expect it. His perception of the fact that benefit should come to him in proportion to the value of his contribution to the totality of effort is thereby weakened, to his mental and moral detriment. And he who by the display of a kindly interest, whether real or simulated, in another's welfare obtains benefit from the effort of that other for which he does not make due recompense adds to theft the vice of hypocrisy. It is only under the unhindered working of the law of supply and demand that exchange of effort can be made with ultimate justice to all, and this ultimate justice can only be attained when all persons whose efforts are interchanged clearly perceive the value of any particular effort, and willingly exchange effort for effort, benefit for benefit, in proportion to their true value. That increased morality which comes from increased intelligence alone will lead to this end.

And so also with charity. That there should be a distinction between helping those who can not work and contributing to the comfort of those who will not work, is being ever made more clear by those who have given studious attention to the ministration of charity. As to steal is to deprive others of benefit without yielding benefit in return, those who are physically and mentally able and have the opportunity to maintain themselves, but who abstract from others the benefit that conduces to that maintenance by the simulation of helplessness and appeal to sympathy, are no less than thieves. And, likewise, those who by appeal to sympathy obtain from others benefit in excess of that to which they are entitled under the unhindered working of the law of supply and demand, in common with those who because of sympathy extend that benefit, inflict a wrong upon society as a whole. Many persons of fine sensibilities, who live in comfort and are kindly disposed toward all men, feeling it their duty to alleviate pain, succor the distressed, and elevate the lowly, in the attempt to lift to a higher standard the life of those whose lot appeals to them in piteous contrast with their own, have scattered gifts and expended energy often misdirected because they have not recognized that the mold given by heredity and environment can not suddenly be changed, that true and lasting improvement to any one can only result from his own perception of and desire to reach a higher standard, and his own effort directed toward that end.

But, says one of the well-to-do, " Am I to be debarred from the exercise of kindness to my friends, to whom the giving of pleasure yields me manifold pleasure in return; am I not to have my good friend who lives more humbly than I at my house for dinner, for a drive in my carriage, or may I not take him with me for a journey that will give him needed rest and build up his health? Am I not to extend token of friendship by gifts to whom I choose?" The reply first and foremost is, that the highest end of friendship is removed far and above the exchange of material benefit. From the association of minds that are congenial and natures that accord, there is derived a rare and refined delight to which in proper bounds the exchange of kindness and gifts may minister; but it is polluted and broken the instant it becomes on either side a means for obtaining unrequited material gain.

Continuing the inquiry, he asks: "Is there no good to be accomplished by giving in charity? Am I to be prohibited from aiding the needy and giving succor to the distressed? Am I to use no endeavor toward bettering the lot of the more lowly than I?" The reply in part has been amply suggested. The highest charity to those who are able and have opportunity to work, but decline to do so, is to endeavor to make them clearly understand that unless they contribute as they are able to the benefit of others, there is no reason that from the efforts of others benefit should accrue to them. The highest charity to those who are able and willing to work, but have not the opportunity to do so, is to use every endeavor to establish conditions that will permit them to contribute as best they can to the benefit of others, and to receive benefit in full proportion to the value of their efforts in return; and, likewise, the highest charity to those who are susceptible to that training which would develop the capacity and willingness for contribution to the benefit of others, is to establish conditions whereunder they may receive that training. It should go without saying that those who are in affliction by reason of sickness, by the sudden death of those upon whom they have justly been dependent, or by reason of "plague, pestilence, or famine," should be given that succor which will restore or lead them to usefulness, and it should go without saying that, when it is just for one to give, it is just for the other to receive. And those who, from mental, moral, and physical defects, are actually incapable of maintaining themselves by their own exertions should be placed under conditions that will render them as little burdensome as possible to the community as a whole.

The foregoing are generalizations that bear upon the serious problems of the treatment of the criminal and shiftless, of labor, wages, and of education, and whose practical application under the existing status can not but often be most difficult. If, however, all who desire the betterment of their kind—all those who make and execute laws, who instruct their fellow-men in pulpit or press, who mold the minds of the young in school or home—would perceive as a principle that the greatest good to all comes from the contribution of each in kind and degree as may be possible to the totality of effort in return for benefit to the full value thereof, and would give that principle the fullest possible application in their own actions and in the endeavor to instill it in the minds of those under their guidance, or otherwise associated with them, all these problems, which are important factors in the great problem of civilization, will sooner or later, upon the basis of that principle, be solved.

It will be perceived that the full application of that principle will nullify many beliefs and traditions that, descending through the centuries, still influence the mass of mankind. For example, the injunction of the Old Testament, "In the sweat of thy face shalt thou eat bread," which is reiterated from the pulpit as the decree of punishment that weighs as a burden upon mankind, fades in the perception of the grandeur of human effort; while a deeper significance comes to the injunction, "If any would not work neither should he eat"; and to the utterance, "Give every man according to his ways and according to the fruit of his doings." The fallacy that work is for hirelings, and the life of a gentleman a life of leisure, falls in the perception that no servitude is dishonorable, for from the maid in the kitchen to the statesman in the cabinet the efforts of all are in the service of mankind. The widely prevalent and not infrequently lauded practice in business circles, whereunder each party to every exchange endeavors to reap the entire benefit, will disappear. The man who ostentatiously disburses in so-called charity the fortune that he has amassed by sharp practice and overbearing greed will be unknown. When all people clearly perceive that they should receive benefit from all in proportion as they contribute to the benefit of all, the core will be reached of the dissatisfaction that breeds jealousy and distrust between the employer and employee, that leads to the grosser forms of socialism and anarchy; and when that perception is carried into practice the core will be removed. And not least, many of the accepted opinions in regard to the tenure of property acquired by inheritance will join the crumbled belief in the divine right of kings.

This essay, however, has not touched upon those actions whereby benefit is conferred by one upon another under the immediate relationship of family and marriage. The application of the principle to the elucidation of which it has been devoted can not but constantly be traversed by such actions, which comprise the begetting and rearing of children, the care by one for those who, under family ties, are justly dependent upon him, the transfer of property by marriage and inheritance. Did space permit it might be shown that in the last analysis all these actions, which are interwoven with all the other actions of mankind in the continuance and advancement of civilization, rest upon that principle also; that these, in common with all other actions, contribute to ultimate justice to all to the extent that that principle is recognized and given effect.

One of the most remarkable features of Albanian "full dress" is a petticoat reaching to the knee, made of white linen, sixty yards in width. The weight of the costume is very great; but the more yards in the garment, the greater dandy is the wearer.

RACE MIXTURE AND NATIONAL CHARACTER.

By LEWIS R. HARLEY, A. M.

THE term "nation" as used at the present time involves much confusion in thought; and an eminent writer, in order to fix clearly the meaning of this term in the mind of the student, has defined the nation as a population of an ethnic unity, inhabiting a territory of a geographic unity.* This high development of the nation has scarcely been reached in any part of the world, but as the geographic and ethnic elements tend to coincide, the national character grows stronger, and resolves itself into a political form called the state. In order to attain this high ideal, the territory must be separated by natural barriers, so that the national unity may not be disturbed by foreign influence, and in the development of ethnic unity there must be, first of all, a common language, so that men may understand each other and agree upon certain views. The introduction of the large number of foreigners into our country leads us to inquire whether there is such a thing as national character in the United States. Bancroft describes all the colonial traits as coming from the English or Anglo-Saxon. The Germans are often spoken of in the sense of being local, yet there is no better illustration of national unity than in the German empire. The English are often looked upon as being extremely practical, but the Puritan Commonwealth was ideal. It seems to have been an original principle in the political psychology of the Anglo-Saxons to evolve the national idea, and thus give to the world the strongest political organization, at the same time offering the widest range of liberty. It is generally admitted at present that there should be some restriction upon immigration. The influx of foreigners, being measurable by statistics, is wonderful. Since 1820 we have had statistics on immigration, which form a very important study. In the first decade, ending with 1830, there were 143,439 immigrants to the United States, while in the decade ending with 1890 the number had reached 5,246,613. In the census of 1850, statistics were for the first time obtained concerning the number of persons of foreign birth in the country. The proportion which each of these elements bore to the total population in 1850 was 90·32 per cent native born to 9·68 per cent foreign born, while in 1890 the proportion was 85·23 per cent native born to 14·77 per cent foreign born. Before 1820 immigration was trifling in amount, but in 1847 it set in upon a wonderful scale, and the famines in Ireland at that time led to a migration to this country which has been

* Burgess, Political Science and Constitutional Law, vol. i, pp. 1–4.

continued to the present day. The total immigration since 1820 amounts to 15,427,657, and of this number 40·42 per cent came from Great Britain and 29·20 per cent from Germany. Thus Great Britain and Germany have furnished 69·62 per cent of all the immigration to this country, while Norway and Sweden have supplied but six per cent. But the past decade furnishes statistics of special significance. Between 1881 and 1890 only 27·88 per cent came from Great Britain and 27·69 per cent from Germany. The immigration from Norway and Sweden has increased very much; while almost all the Hungarians, Italians, and Poles have come during the past decade. Indeed, it is said that in 1890 two thirds of the entire emigration movement of the world was directed toward the United States. The distribution of the foreign element is confined almost entirely to the Northern and Western States. In the North Atlantic division 22·34 per cent of the population is foreign born, the proportion ranging from 30·77 per cent in Rhode Island to 11·94 per cent in Maine. In the North Central division 18·16 per cent of the proportion is foreign born, the extremes being North Dakota with 44·58 per cent, and Indiana with 6·67 per cent. In the Western division the proportion of foreign born is 25·46 per cent, ranging between 32·61 per cent in Montana to 7·33 per cent in New Mexico. The South Atlantic division has been affected but very little by immigration, only 2·35 per cent being foreign born. Of this group of States, Maryland has the largest proportion, 9·05 per cent, and North Carolina the smallest, with 0·23 per cent. In the South Central division the foreign element is also very slight, being only 2·93 per cent, the greatest proportion being in Texas, where it is 6·84 per cent, and the least in Mississippi, 0·62 per cent. A study of the eleventh census shows that the States which a generation ago attracted foreigners still attract them in almost the same degree. Immigration was thus turned to the North and West by economic and climatic conditions. On account of the slave system in the South, there was no inducement for immigrants to locate there; thus the ideas of this section were never modified by foreign influence; again, the Germans and other immigrants from the northern part of Europe were attracted to the Northwest on account of the climate. Accordingly, the movement of population was westward along the parallels. The institutions of the South remained unmodified by the influx of foreigners, and the sections became more and more estranged, making the civil war possible.

Another element which enters into the problem is the proportions in which the total white population is made up of native whites of native parents and of whites of foreign parentage. This is of great importance, as it presents the distribution of the native and foreign blood throughout the country. In Massachusetts 56·87 per cent of the population have one or both parents foreign born; Rhode Island, 59·29 per cent; New York, 57·45 per cent; Maryland, 30·27 per cent; Wisconsin, 74·14 per cent; Minnesota, 76·01 per cent; North Dakota, 79·74 per cent; Louisiana, 26·02 per cent; Utah, 66·75 per cent. We notice again that the white element of foreign extraction is found chiefly in the Northern and Western States. The native whites having both parents foreign should also be considered. The proportion of this element varies as follows: Massachusetts, 27·09 per cent; Rhode Island, 27·29 per cent; New York, 30·64 per cent; Maryland, 15·01 per cent; Wisconsin, 43·09 per cent; Minnesota, 39·80 per cent; Utah, 41·04 per cent. The Southern States show the usual small percentage, ranging as follows: Virginia, 1·52 per cent; Georgia, 1·07 per cent; Mississippi, 1·30 per cent; while, taking the Southern and South Central sections together, the proportion is only 4·13 per cent.

The colored element in 1890 amounted to 7,470,040, the population being distributed as follows:

North Atlantic division	1·55 per cent;
South Atlantic division	36·83 " "
North Central division	1·93 " "
South Central division	31·71 " "
Western division	·89 " "

In taking the South as a whole there was a proportional increase in the colored population up to 1840, but since then the proportion has diminished gradually. Having stated the principal elements with which we have to deal, let us now consider the various methods of dealing with the problem.

If we consider the problem from an ethnological standpoint, we shall have four races in the United States—the white, negro, Indian, and Chinese. But these races do not mingle together. The Indian is dying out, and, although the negroes mingled in the days of slavery, the offspring carried the stigma of the race. Herbert Spencer is the chief authority on the sociological theory of the mixture of races. He claims that it is a theory of evolution, and the unity that is developed is not of blood but of institutions. The historical theory does not try to determine whether there is really a mixture of blood, but it simply considers the institutions, customs, and laws, and how these have been modified. In applying this theory to the United States, the mixture of races does not mean a mixture of blood but of institutions.

The mixture of nationalities in this country has differed from that of other parts of the world. In other countries mixture has occurred by conquest, but it has been peaceful in the United States. There has been no forcing of institutions or blood, except in the case of the negro, and we thus have the unique negro problem whose solution no one can predict. The immigrants did not come here in tribes, but as individuals. If the millions of Germans had come with state encouragement in a body, the results might have been different, but they came as individuals and mingled with our people.

I have already stated the elements that are to be assimilated. For the purpose of convenience, they may be classed into four groups as follows: 1. Colored, 7,000,000, or twelve per cent. 2. Native whites of native parents, 34,000,000, or fifty-five per cent. 3. Native whites of foreign parents, 11,000,000, or eighteen per cent. 4. Foreign born, 9,000,000, or fifteen per cent.

These elements differ by blood, by parentage, and by birthplace, and they are of great importance. No other country has such important elements, and no nation has ever sought to solve such a question in a peaceful way. The native American is the element about which all others must be grouped, and they must be assimilated to this. The third element is very interesting. This class stands halfway between the foreign and the native. It represents the process of assimilation in the act. The fourth element is the foreign born, and it is the most difficult to assimilate on account of its constant renewal.

There are two ways of combining these figures. The third and fourth elements may be added together, and we will then have 20,000,000. These figures show how large the foreign element is. In regard to its distribution in New England and the Northwest, New England would have forty-seven per cent foreign population; in Massachusetts alone this element constitutes fifty-six per cent; in Rhode Island, fifty-eight per cent; in New York, eighty two per cent; in Wisconsin, ninety per cent. But it is not right to consider the second generation as foreigners. They are more American than foreign. It is best to contrast these two classes and measure their relative strength. We find in the East that the first generation outnumbers the second, while in the West the second generation is the stronger. Thus the question of foreign influence is a more serious one in New England than in the Western States.

The chief forces tending toward the assimilation of races in our country are physical environment and social environment. The physical environment means not only the influence of Nature, but also the habits of life. In this respect the influence of frontier life should be considered. From the beginning, the people along the frontier have had a struggle with Nature, and they developed self-reliance and the capacity for self-government. So the pioneer set up self-government in the wilderness, and the State Constitutions of the West and Northwest, where the proportion of immigration is so great, show no signs of foreign influence, but they all contain the fundamental ideas of American liberty. This influence of physical environment still goes on, and in subduing the wilderness the pioneer abandons the habits of the Old World and takes up those of the New. Thus the continent forced the conditions of its conquest.

Herbert Spencer, in his Principles of Sociology, states that the earlier development was at the mercy of the physical environment, while civilized man has reduced Nature to subjection. As society progresses, new factors come in to modify the physical organization, which Spencer calls the super-environment or social environment. Spencer claims that the social environment is more powerful than the physical environment. The men who settled this country had a social history behind them, and the institutions that they brought here greatly influenced their children. What I said in regard to the physical environment may also be said of the social environment. The immigrants did not come in bands, but individually, and the social environment had full play. During the colonial period the immigrants were chiefly English, and the English stamp was upon the institutions which they planted here. So it has not been a mingling of institutions, but foreigners have assimilated the institutions already established here.

One of the chief influences of the social environment is education. This is very important, as so many ignorant come. It is important to know how receptive these people are to our institutions. This will depend upon their power to learn our language, and upon the standard of intelligence of the native country. Out of the 15,000,000 foreigners who landed here between 1820 and 1850, forty per cent came from English countries. This proportion is growing less, as in 1891 only twenty-two per cent came from English countries, while from all German countries the proportion is thirty-one per cent. A new difficulty may arise here, in that people of other languages may now find communities where their own language is spoken; but this can hardly be urged as an objection, for, in the case of the German immigrants, they come from a country with a high standard of education. We depend upon our school system to reach the immigrants and prepare them for citizenship. The parents can not be reached by the schools directly, so the system must exert its influence upon the children of the immigrants. The eleventh census shows that the foreign-born element of school age between five and seventeen years is 900,000. The second generation, or native born of foreign parents, is 12,400,000, and the number of immigrants foreign born above seventeen years is 8,332,000. This shows that the problem is very favorable, as, for every hundred who can not come under the influence of our schools, there are one hundred and fifty who can. In the Eastern States the second generation is less numerous than in the West. The influence of our schools is apparent, for, if we take Massachusetts as an example, we find that of the native-born population one per cent are illiterate, while of the foreign born twenty per cent are illiterate.

Another influence of the social environment is the exercise of political rights. Here the second generation can not be looked upon as foreigners, as all persons born or naturalized in the United States are citizens thereof. The terms of naturalization are such that the foreign born may become citizens in five years. Whatever may be the dangers of foreign influence upon our government, surely one of the best methods of assimilating the discordant elements is to make all classes feel that they have an interest in our institutions, by the exercise of political rights. If this process of assimilation had not been going on, we should be able to notice some effect upon legislation in the different States. Assimilation is promoted by the participation in the holding of property. Thousands of foreigners have availed themselves of the land grants by the homestead and other laws. Having vested interests, they are loyal to the Government, for very few property-holders become anarchists. Self-reliance and independence also tend to attach the foreigner to our institutions. Our system is not paternal in its character, but the guarantees of civil liberty are so broad that they offer the greatest measure of individual action. Every man's house is his castle, and some writer has said that, although the snow and rain may blow in, the king can not enter. The prominence given to labor in America is also conducive to the assimilation of the foreign elements. A new dignity has been placed upon labor here, and we are passing over from a political to an economic attitude, which will have its effect upon all classes. Titles and rank, which have done so much in the Old World to keep the classes alienated, are unknown here, and their absence is the means of encouraging foreigners to accept the responsibilities of citizenship. Economic influences which have frequently been overlooked, are also a potent factor in the assimilation of races. I have already referred to the dignity of labor in this country. The laborer is not regarded as depending upon a wage fund for support, but he is looked upon as an integral part of society, receiving a share in distribution. There are causes at work affecting consumption, and society is in a dynamic state. Changes in the economic order of consumption are taking place which tend to raise the standard of life. Economic conditions induce the foreigner to leave his native land and come to America. On arriving here, he is probably influenced as much by the standard of life of our people as by any other cause. He enters the field of labor and attempts to reach our standard of life, and in doing so he must abandon his old habits of life and adopt those of our country. Thus, through labor an assimilation takes place. This has been the process in our Northern and Western States, which have received that great bulk of immigration during the century.

WOMAN AS AN INVENTOR AND MANUFACTURER.*

THE question has been seriously raised whether woman is capable of important achievements as an inventor, and an opinion actually exists and is held in good faith by some otherwise intelligent persons that she is not. The Patent-Office records have been searched to show that woman's modern work in inventive art has been insignificant; and occasionally, when some woman's invention is announced, it is treated as something unusual and very remarkable. A perusal of Dr. O. T. Mason's narrative of Woman's Share in Primitive Culture should convince the unprejudiced reader that this is a most shallow view to take of the matter. In that book she is shown to be the earliest inventor, and is proved in numberless cases to be the author from the most ancient times of the most important inventions and those which have contributed most to human well-being.

From the primitive age when the division of duties was first made between man and woman (somewhat roughly drawn, it is true, as the rudeness of the then existing conditions compelled) but substantially along the lines it has followed among all peoples who labor, woman's ingenuity has been an important element of progress. As the food-bringer, which is the character under which Dr. Mason first presents her, "to feed the flock under her immediate care, woman had to become an inventor, and it is in this activity of her mind that she is specially interesting here. The hen scratches for her chicks all day long because Nature has furnished her hoes and rakes and cutting apparatus upon her body. But here stands a creature on the edge of time who had to create the implements of such industry." In the search for food materials she first appears as taking fruits and other parts of plants that are ready for consumption without further preparation. Next she took a stick and carrying basket and sought out roots and other parts that might be prepared by roasting or perhaps by boiling with hot stones. "On her third journey she gathered seeds of all kinds, but especially the seeds of grasses, which at

* Woman's Share in Primitive Culture. By Otis Tufton Mason. Anthropological Series, No. 1. New York: D. Appleton & Co., 1894.

her hand were to undergo a multitude of transformations. These had to be broken up or ground, and called for the devising of grinding apparatus. Wherever the tribes went in the early days women found out by and by the great staple productions that

Fig. 1.—The Basket-maker—California Woman at Work. (After Henshaw.)

were to be their chief reliance; and "the whole industrial life of woman is built up around these staples. From the first journey on foot to procure the raw materials until the food is served and eaten there is a line of trades that are continuous and that are born of the environment."

The five sources of information respecting primitive woman's activities are found in history, which records the things of pristine culture that lingered three or four thousand years ago; language, which has crystallized expressions descriptive of early conditions; archæology, which recovers the things they did before there was any history: folklore, a perpetual record of the most ancient occupations and customs; and living tribes that have stood still during all the ages.

Fig. 2.—The Primitive Loom Weaver—Navajo Woman, Arizona. (After Matthews.)

The variety of occupations in which primitive woman displays her genius is illustrated in a description quoted from Im Thurn of the day's work of a Carib woman in British Guiana, in which she is seen performing the parts of a "mother, butcher, cook, beast of burden, fire maker and tender, miller, stonecutter (stone-griddle maker), most delicate and ingenious weaver, engineer (devising a mechanical press and sieve in one woven bag and using a lever of the third kind), baker, and preserver of food. Add to this her function of brewer, and you have no mean collection of primitive industries performed by one little body, all of which underlie occupations which in our day involve the outlay of millions of dollars and the co-operation of thousands of men."

Fig. 3.—Eskimo "Scraper," made to fit the Woman's Hand. (After Mason.)

"Suppose a certain kind of raw material to abound in any area or country; you may be sure that savage women searched it out and developed it in their crude way. Furthermore, the peculiar qualities and idiosyncrasies of each substance suggest and demand a certain treatment. Women of the lowest grades of culture have not been slow in discovering this; so that between them and the natural product there has been a kind of understanding or co-operation leading to local styles. If these women were moved far away, they carried oftentimes these processes with them and plied their old trade upon such strange materials as they discovered in the new home." So negro women brought basket-making from Africa to America and taught it to the Indians.

Subsidiary to the weaving and basket-making practiced by women in savagery are spinning, netting, looping, braiding, sewing, and embroidery. Bark-cloth weaving is practiced by women in the tropics all round the world. "Each and all of these require tools which the workwomen must fashion for themselves. And, though the earth had the raw materials in abundance, it did not yield them without a search which would do honor to the manufacturers of our day. . . . Aboriginal woman's basketry excites the admiration of all lovers of fine work. It is difficult to say which receives the most praise — the forms, the coloring, the patterns, or the delicacy of manipulation. Primarily, her basketry divides itself into two sorts of types—the *woven* and the *sewed*, the former built up on a warp, the latter produced by the continuous stitching of a coil. Of these two main classes there are many subclasses, which have been necessitated by the nature of the material which the fabricator has at her hands, and by the uses to which the products have to be put."

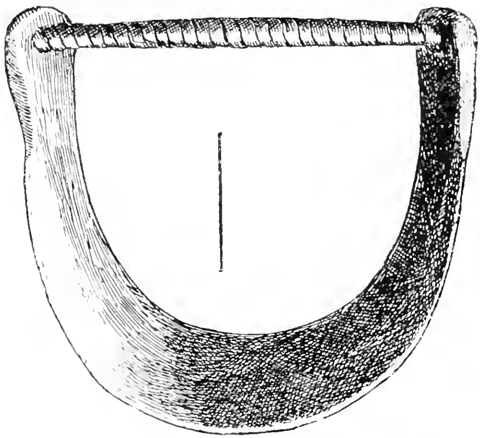


FIG. 4.—ESKIMO FAT SCRAPER OF REINDEER ANTLER AND RAWHIDE. (After Mason.)

Weaving is the climax of the textile industry; and "among all the types of modern savagery—American, negroid, and Malayo-Polynesian—intricate processes of weaving were in vogue before they were approached by the white race." In comparison with the complex and world-embracing activity of modern weaving and commerce, "how simple the process in savagery! The women there go to the fields or to the animals for the fiber, or hair, or wool. They transport the material on their backs, in carrying frames and apparatus that they themselves have made, and prepare it . . . to be woven, or sewed, or embroidered. They make up the bag, or mat, or garment, or sail of a whole piece, and wear it out in use, the same woman in each case following the material from the cradle to the grave." The subsidiary textile arts are of much importance in savagery, and they are of great antiquity, remains having been found in very old deposits.

In her tanning and skin-dressing work the savage woman's problem was to remove the dermis from the hide, and leave the hair adhering to the epidermis, with only a thin portion of the true skin. If the work were creditably done, the surface of the robe, "frequently more than thirty square feet in extent, had to be uniform in thickness throughout, and she should not cut through

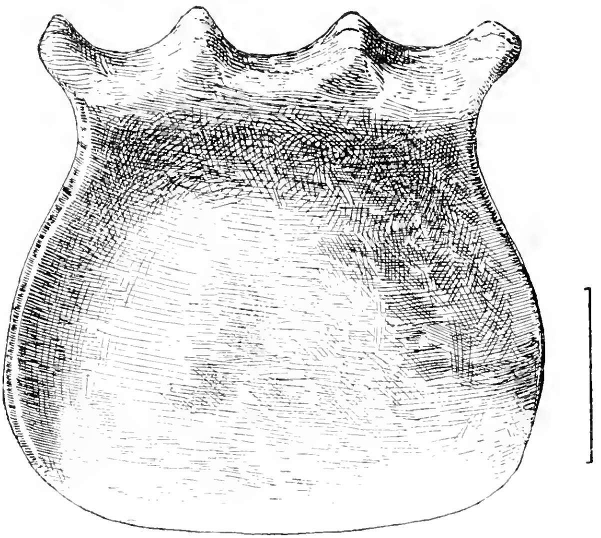


Fig. 5.—Eskimo Fat Scraper of Walrus Ivory, made to fit the Fingers. (After Mason.)

the epidermis once. The whole must be as pliable, too, as a woolen blanket: the problem was to reduce a hide of varying thickness and twice too thick everywhere to a robe of uniform thickness throughout without once cutting through the outer part of the skin. Her tools for this varied with the locality. The Eskimo women scrape off the fat with a special tool made of walrus ivory or bone and plane down the dermis with a stone scraper. The Indian women cut off bits of meat and fat and remove the dermis with a hoe or adze. In the good old days of savagery the Eskimo woman made her fat scraper of walrus ivory or antler; her skin scraper was of flinty stone set in a handle of ivory, wood, or horn, whichever material was easiest to procure. But later on, it may be, the whalers helped her with steel tools. The Indian woman had three tools—to wit: the stone knife for cutting away the flesh; the hoe-shaped scraper for splitting the skin; and the grainer, a hoe or chisel-like tool with serrated edge to roughen up the inner side of the robe and give it flexibility. Besides these, both Eskimo and Indian had hands and feet and teeth for pulling and pounding and breaking the grain. They had also a wonderful supply of pride in their work, and love of applause, which kept them up to the mark of doing the best that could be done with their resources." The scraper is the oldest instrument of any craft in the world. The Indian women of Montana still receive their trade from their mothers, and they, in turn, were taught by theirs in unbroken succession since the birth of the human species. With the scraper the hair was removed, when that was desired, after having been loosened by exposure to chemical treatment with quicklime, or by a process of fermentation. The methods of preparation corresponded with the purposes to which the skin was to be applied, and these were various. "The tailoring of savage women, especially that of the North American women, is most interesting. While the weavers in the south were making blankets and *serapes* in the whole piece, never cutting their goods, the tailors north of the Mexican border were excellent cutters. For scissors they used the woman's knife, called *ula* by the Eskimos, a blade of chert or other rock, crescent-

FIG. 6.—MAKING COILED WARE IN BASKET BOWL. (After Cushing.)

FIG. 7.—BASKET BOWL AS BASE MOLD FOR LARGE VESSEL, SHOWING ALSO THE SMOOTHING PROCESS AFTER COILING. (After Cushing.)

shaped on the outer edge, and a most excellent device for cutting skin without marring the hair. Scissors would be useless in this connection, for they would shear the hair as well as the hide and make an ugly seam. In the fitting of garments these primitive tailors anticipated the long list of terms, such as puckering, gathering, inserting gores, and the like. For tucks in their more beautiful dresses they inserted band after band of the skins of different animals, bits from different parts of the same hide, and strips of bare hide ornamented by quill-work. Tufts of feathers or long hair, pendants of shell, hoof, teeth, or bone—in short, all objects of comely shape and pretty color and proper size—were gathered into the costumes of men and children as well as into their own." The reticule, the tobacco bag, the traveling case, the bandbox, and the packing trunk all exist among savages, and in North America were made by women, chiefly from the hides of animals.

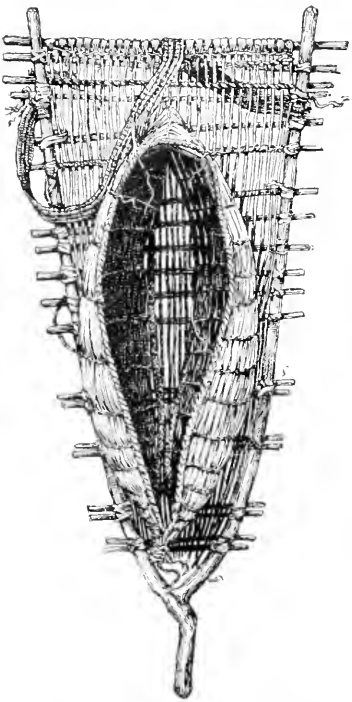


Fig. 8.—California Cradle Frame. (After Mason.)

The potter's art may be seen in its pristine simplicity in the soapstone or earthen lamp and stove of the Eskimo, and in the arid regions of New Mexico and Arizona, as well as in South America, Africa, and New Guinea; and it is woman that carries it on. "In the Southwestern States of our Union women have, from time immemorial, practiced the art of pottery with the greatest success. There is no reason to believe that their present methods and tools and products are different at all from what they were a thousand years ago. . . . The women go forth to the *mesa*, where the proper layers of clay are exposed, and quarry the raw material. To do this, one would say they ought to be good mineralogists and skillful engineers. They also gather from the sediment of the streams most excellent clay for their paste." If the potter-woman does not find this excellent paste, she gathers and carries home on her back the clay quarried from the *mesa;* and in doing this she becomes a pack-woman. She washes the clay, lets the gravel and worthless material sink or float, decants the liquid, and allows the fine aluminous earth to settle. "Though the term 'specific gravity' was unknown to her, she seems to have seized upon this principle in order to gather out the elements desired. This fine paste will not make pottery; it will crack badly in drying and baking. But our ceramic worker is equal to the occasion, and long ago had discovered, as every archæologist knows, that sand or some other tempering material must be added. The oldest fragments yet discovered reveal in their texture grains of sand, put there by Nature or by the potter, bits of pulverized shells, or the remains of old pots ground fine and worked over into new vessels." She sorts material for coarser and for finer ware, turns it with her hand, guided by her eye, molds it around or within some object to give it shape, using gourds, nets, or baskets for the purpose, whose forms and peculiar markings are thus preserved, and arrives at the stage of

FIG. 9.—ESKIMO MOTHERS. (After Healy.)

making pottery like basketry, for which she rolls out a slender cylinder of prepared paste, and builds her vessel by coiling this cylinder around the form. The evolution of form in this Pueblo ware, by which a flat disk becomes a bowl, and from that are derived various forms of bottles and vases, has been well studied by Mr. Frank Cushing.

"From woman's back to the car and the stately ship" is the history of the carrier's art; and woman "was primarily the only creature that transformed Nature to produce an apparatus for the carrying of burdens. . . . Many other industries were created, stimulated, and modified by this carrying trade. The member of pristine society who went to the fields to gather nuts and seeds and fruit must necessarily have brought them home. Hence the burden-bearer must be a basket-maker, and the pack-woman is a patron of husbandry and of the textile art. Clay and fuel must be brought to make pottery, and pottery, in turn, has to be shaped to carry water and food; so the potter and the carrier are sisters. It can not fail to be interesting to know how ingeniously these early passenger cars were constructed." The builders were strictly scientific in their methods, in that they ingeniously adapted structure to function and environment. To the Eskimo mother the great consideration is to protect the child from the cold. "So she makes a baby carriage of her hood, and her offspring, when she takes it abroad or when she is on a journey, is safely ensconced between the soft fur and the mother's warm neck. All the American tribes used a papoose frame of some sort." The distinguishing marks of this apparatus were the back, the sides, the lashing, the bed, the pillow, the covering, the awning, the decoration. All these were present in some form, but in each stock, and especially in each natural-history region, there were just such variations as were necessary and proper. In Canada the cradle was made of birch bark and the bed was of the finest fur. In the coast region of British Columbia and southward little arklike troughs were excavated as the boats were, and beds and pillows and wrappings of the finest shredded cedar bark took the place of furs. Farther south still, as the climate became milder, the ark gave place to a little rack or gridiron of osier, sumac, or reed, and the face of the child was shaded from the sun by a delicate awning. Across the Rocky Mountains, in the land of the buffalo, the papoose frame looks like a great shoe lashed to an inverted trellis or ladder, and nowadays the whole surface is covered with embroidered beadwork. It matters not where we travel within the limits assigned

Fig. 10.—The Knapsack in Woman's Work—German Peasant Woman.

on the western continent, the primitive passenger car was exactly suited to the meteorological and other conditions." This is one class of devices that women have contrived for carrying precious

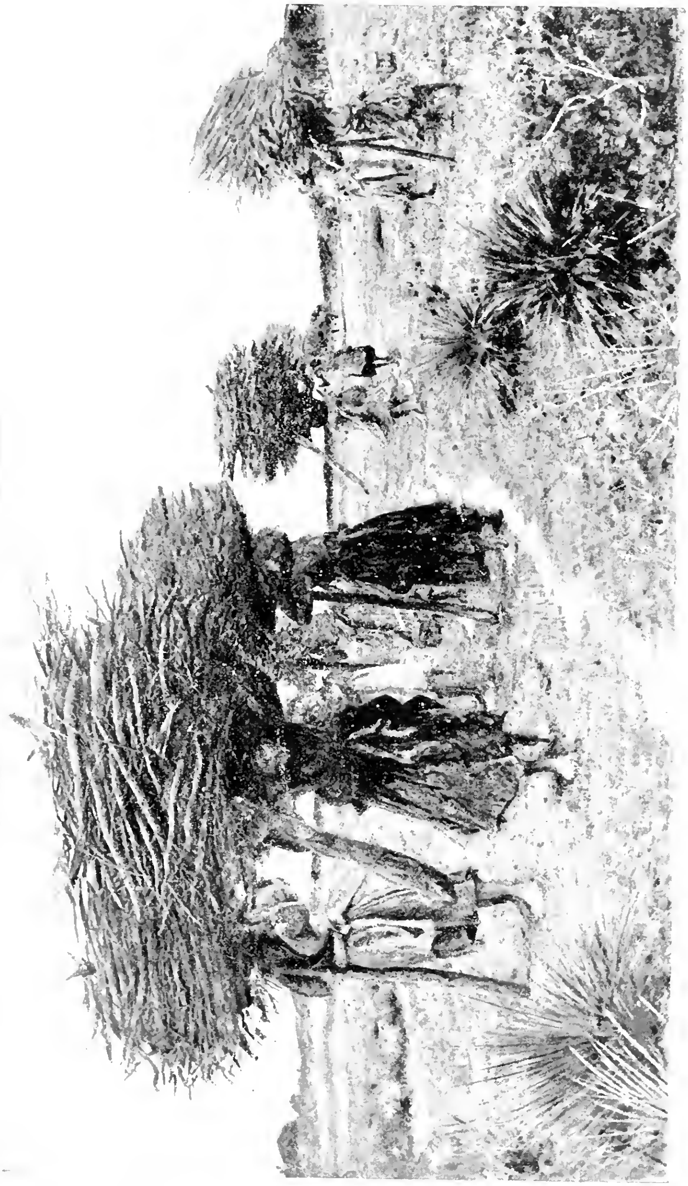


FIG. 11.—FLORENTINE WOOD GATHERERS. (After Gioli.)

burdens. They are also in all savage lands, and in some civilized, the bearers of loads of a more common and grosser sort, and for these they have invented a variety of appliances, adapted to different positions and different kinds of loads: cushions for placing the burden on the head; cords or straps for supporting it from the head while it is carried on the shoulder or the back. "Away down in Arizona hay is delivered at the agency by Mojave Indian women, who go out and cut with common house knives the 'grama grass,' put it up in immense sheaves, and bring it to the agency on their backs," or rather shoulders, a sheaf of hay sticking from each end of a pole that rests on the shoulders, and knapsack contrivances of different kinds. We generally suppose that the knapsack belongs to soldiers and schoolboys; but "if you will get up early some morning and walk around the busy portions of a German city, you will see upon a box or table a cylindrical basket, holding half a bushel, more or less, with the sticks of the frame projecting an inch or two downward from the bottom, and two broad straps fastened at one end to the rim of the basket and having eyelets or loops at the loose ends. Presently you will see a woman back up to the basket, draw the straps over her shoulders, and pass the ends backward around the projecting frame sticks below. She is now hitched up and may walk off with such load as the basket may contain. Perhaps this is older than the knapsack." Women are carriers, too, in France, and a picture by Gioli, exhibited at Venice in 1887, shows that in Italy, also, that work has not been taken off from her.

"It is not enough, in speaking of savage women, to say that they, as a class, do this or that. It should also be asked how many of these are performed by one woman—in short, by every woman. Recalling what was previously said about the user of an implement having to be the maker of it, one sees to what a diversity of occupations this would naturally lead. . . . It is not enough to say in any case, as we have seen, that she was food-bringer, weaver, skin-dresser, potter, or beast of burden. This view of her is absolutely misleading. It is not sufficient to say that the modern lucrative employments originated with her. We are bound to keep in mind that each woman was all of these. As in the animal world one part of the body performs many functions, in the social world one woman is mistress of many cares. The diversification of duties in well-regulated houses among the civilized nations produces the matron. The savage woman is really the ancestress and prototype of the modern housewife, and not of our factory specialists."

Savage woman next appears on the scene as an artist; and her originality and skill in this line are illustrated in every piece of pottery and every basket; in decorative work of all kinds, and in costumes in a thousand designs of form and color, all of which the maker had to invent, and furthermore to find means and instruments for producing them.

In the aspects of a linguist, the founder of society, and the patron of religion, in all of which Mr. Mason exhibits woman as a leader, we have not space to follow him. We therefore leave her here, as the founder of some of our most useful material arts.

MICROBES AS FACTORS IN SOCIETY.*

By M. L. CAPITAN.

IN an address delivered before the Anthropological Society of Paris, July 2, 1867, Paul Broca very neatly emphasized the fact that the population of a country can not increase indefinitely. As the population multiplies on a territory that is extensible, the more undesirable lands are gradually improved and occupied. The holdings are made smaller, woods are cleared, barren tracts are fertilized, and marshes are drained. Till these works are completed all goes well, but the time comes at last when every place is occupied. The resource remains of emigration to unsettled countries. Our planet, however, is not elastic; when all of it is occupied and bears all the population it can sustain, what will then become of the human race? The balance of population and resources is kept up by death, which cuts down the living and leaves the places they filled to the newborn.

Dead beings, too, must be got out of the way. Even in that condition they claim too much space. They, moreover, fix an important quantity of matter—that of which their tissues are constituted. Matter, we all know, is not infinite in amount; it is undergoing incessant transformations, and is never created. It is therefore necessary that dead organic matter, which is essentially insoluble, be disaggregated, dissociated, and dissolved, to be fixed again by new beings. This is accomplished through the intervention of the phenomenon of decomposition or putrefaction. Putrefaction, Pasteur has demonstrated, is the function of microbes. Without them the disaggregation of matter which would probably be produced by solar radiations would be absolutely insufficient; consequently matter would accumulate in continually multiplying and insufficiently dissociated organic combinations. Without microbes, therefore, life would not be able, for lack of available matter, to continue on the globe. Applying these data to the accumulations of human beings which make up societies, we find that they are rigorously exact. We have, then, in this reduction of fixed matter to conditions under which it can be

* An address (*Conférence Broca*) delivered December 14, 1893, before the Anthropological Society of Paris.

assimilated, the first and a considerable function which microbes perform in society.

Microbes have other equally important and useful offices. Of these is their action in digestion. Ordinary digestion is performed in the stomach and the intestine by means of soluble ferments secreted by the organic cells, which attack alimentary substances, dissociate them, and render them assimilable; and this is perceived to be a function very similar to that of microbes. The digestive passages, however, contain immense quantities of microbes continually brought in with the food, multiplying infinitely, and performing exceedingly complex offices. Even if we take up only a few of these offices, we are compelled of necessity to assume that they intervene in digestive operations, either as aids to the organic diastases or as themselves effective agents. M. Duclaux, insisting on this point, has remarked that some celluloses are capable of being attacked only by microbes, no organic juice having sufficient strength to affect them. M. Pasteur does not believe in the possibility of digestion in a medium completely deprived of microbes.

Of the chemical activity of microbes, what we know is as nothing in comparison with what it may be. Every species, every race, every variety of microbe is charged with a special function; the division of labor is carried among them to its extreme limits, so much so that in any chemical reaction each microbe takes its part in producing the process at different stages. Each variety has its duty in the work, determines a partial dissociation of the material which another species completes, and so on to the extreme simplification of organic matter, reduced to its elementary constituents, or to such conditions as to be assimilable by the plant.

These chemical actions determined by the microbe are therefore infinite and infinitely varied. Take two examples among a thousand. Starting with a single body—sugar, for example—the microbes may transform it into dextrolactic or serolactic acid or an indifferent acid, according to their own activity, the culture medium, or the associated reactions. Reducing agents in a high degree, microbes transform sulphates into sulphites, and even into sulphurets, the latter yielding, still by means of microbic reactions, sulphohydric acid. Thus, by this mechanism of successive dislocations, microbes, starting from sulphates, end by producing sulphurous water. This simple enunciation of a very special microbic process illustrates the extreme complexity of the chemical function of microbes, which are furthermore often aided in their work by solar radiation, likewise a powerful chemical agent, the action of which, though less immense than that of microbes, is similar to it. As a chemist, the sun proceeds like a microbe—a strange and remarkable similarity of action, mentioned by Claude Bernard in his last notes, and now demonstrated by M. Duclaux and his pupils. The climax of these complex chemical reactions is reached in the *humus*, which is compared by M. Duclaux to a laboratory in ceaseless activity, into which the primary matter is continuously entering to be worked up there and transformed into new products assimilable by the plant.

Availing itself of the action of an external force, the solar light and heat, this laboratory employs as its workmen the microbes, which only are capable of carrying the complicated task to a good result. Fixers of nitrogen, for example, in the nodular formations of the leguminous plants, preparers of nitrates, and constantly producing soluble organic substances at the expense of insoluble matters, the microbes work untiringly in this vast abode of chemical transformations.

Yet more: as old as the living world, contemporaries of the earliest generations of plants, microbes have contributed in a powerful way to the constitution and formation of the geological strata. Peat, which later becomes coal, has been formed by the action of microbes; they have been the agents in the complex processes of precipitation by which the immense masses of various limestones have been formed; they have played a part in other reactions from which deposits of iron, sulphur, and most of the metals have resulted. This enumeration might be very much extended. These innumerable and strong chemical actions, ancient as some of them are, still play an immense part, which is absolutely necessary to the existence of the social medium. From the point of view solely of producer of coal and preparer of iron, the microbe justifies its claim to be an agent indispensable to the life of all society. But its function is still more complex and extended.

The chemical work of microbes is often used industrially by man. Two examples in which this is done may be taken as typical. Indigo is extracted from a plant which is cultivated chiefly in India, Japan, and Central America. The plant contains a sugar, indiglucin, which is separated by washing in warm water, and is then subjected to a special fermentation. The microbe splits it into indigotin and glucose. The indigotin, which is colorless, is oxidized, still by means of a microbian reaction, and is transformed into blue indigo. This preparation would be impossible without these special microbian reactions.

Another example of the chemical activity of microbes is furnished in the preparation of opium for smoking. The juice of the poppy, from which opium is derived, was till lately fermented in tubs to give it the desired qualities. Recently M. Calmette, of Saigon, discovered that this transformation was due to the *Asper* *gillus*, a fungus allied to the microbes. Since then it has been enough to sow the tubs in which the fermentation proceeded with the pure *Aspergillus* to obtain a better return and an opium of superior quality in only one or two months.

In the preparation of several most indispensable alimentary products certain micro-organisms, domesticated as it were, prove themselves incomparable chemists. Without them these preparations would be impossible. Among such products are bread, alcohol, wine, beer, and such fermented substances as koumiss, cheese, and sauerkraut.

These microbes are inferior algæ formed of one cell, usually with an envelope. They live almost everywhere on and with living beings, in the ground, in water, on solids, etc., and multiply with extreme rapidity. They produce a great variety of actions, some of which, as we have seen, are beneficial, while others are injurious.

As microbes decompose dead matter, so they are capable of disorganizing living matter. Some species have this power in a marked degree, which is distinguished as virulence. They are called pathogenic microbes, which means capable of causing illness. Each species of pathogenic microbe produces a particular kind of disease, and has a power that varies considerably according to a number of circumstances. The microbe alone, however, can not produce disease: that requires the intervention of the organism of the subject in which the disorder is to be developed. The disease is, in fact, the resultant of the reaction of the one upon the other of the two factors, the microbe and the organism. According to the felicitous comparison of Prof. Bouchard, the organism is a strong place, the microbe is its assailant, and the struggle between them is the infectious disease. The condition of the organic estate which the microbe endeavors to seize is therefore important. If the person is in general good health, he will offer a vigorous resistance to the microbes. If, on the other hand, his health is not perfect, there will be a point where the defenses are weak, and his danger will be proportionately great; for, as M. Bouchard said some time ago, one does not become ill till he is already not in good health. There are many ways of getting into poor health. It may be done by a number of processes, which may be summarized under the two categories of troubles of the organic functions or lesions of the tissues. Some of these pathogenic processes depend directly on a variety of social influences.

Wealth and poverty are alike efficient factors of disease. The rich man, by his often superabundant diet, his neglect of exercise, and his excess of luxury, readily contracts obesity, gout, or diabetes; his kidneys and his heart are frequently afflicted with disorder. The poor man, by different forms of inanition, overwork, exposure, or uncleanliness, is liable to derangements of the lungs, liver, kidneys, bowels, etc. Like the rich man, he has a pathology special to certain organs, and different from that of the other, but which is due to his social sanitary situation.

The professions also entail their special maladies, which are liable to infect those who exercise them. Lead chemically poisons those who handle it—painters, printers, white-lead makers, etc.—and mercury is dangerous to silverers of glass and gilders; while each poison affects particular organs most directly—lead the kidneys, bowels, and brain, mercury the brain and nerves. Examples might be multiplied to show how the profession may injure the organs, create real diseases, or induce an imperfect condition of health which will facilitate the invasion of the microbe. It is not necessary to dwell here on the pathogenic effects of alcoholic intoxication—a condition which is in every feature the product of social influences. It ravages all classes of society, and is illustrated in the most various pathological modalities.

In short, we find that a great multiplicity of mechanisms, all of social origin, may affect the internal organs in their structure or their work, and bring the person into a condition of receptivity to microbes. A thousand social conditions may expose us to the invasion of microbes and thus make real the second term required to constitute an infectious disease. The hostile microbe is in fact everywhere—within and without us, seeking, we might say, what it may devour. All the natural cavities of the body—the nose, the mouth, and the digestive tube—having exterior openings are seeded with microbes brought from without by air or food, and afterward multiplied. The skin is similarly exposed. Among these microbes there are also others, the relics of infectious diseases, with which the subject, now well, has been formerly attacked. All these microbes live in the normal condition of a later life; they are sometimes useful, as we have seen in regard to digestion; more frequently inoffensive in the face of the resistance opposed to them by the cellular coverings of the organic cavities or by the activity of those zealous defenders of the organism, the white globules, or by the chemical action of the organic liquids. But when the texture of these coverings is modified by some of a variety of circumstances, whether of external or of internal origin, or when one or more of the microbes attain an unusual degree of virulence, then the protective barriers will be overcome, the microbe will penetrate to the interior of the tissues, and will be able to bring on some of a great variety of diseases, from pneumonia to erysipelas, meningitis, or liver disease.

The microbes living without the organism are likewise of various origin. We have already mentioned the innumerable varieties living in the ground, in the water, and on plants, which play so many important parts. Some of them may, under many circumstances, borrow a pathogenic power and produce diseases. There are also others, normally pathogenic, which have been eliminated from diseased organisms, and instead of succumbing at once they have fallen into the outer world, have adapted themselves to the new medium, and are living another life in the ground or in water. They are all ready when, with food or by respiration, or by a scratch of the tissues, they enter a living organism anew, to determine in it, if circumstances are favorable, the disease characteristic of them. So do the microbes of cholera, tetanus, etc. Social influences play an important part also from this point of view. All kinds of microbes may be carried to long distances by the solid matters of every kind that are employed in innumerable ways in the life of society. The solids may transport the microbes just mentioned as living in the external medium, and also those which come direct from a diseased subject. This distribution of agents of infection by solids is of extreme importance, but has attracted attention only within a few years. The hands may retain infectious germs and carry them to a long distance, often without the person carrying them being affected. Examples are abundant that illustrate the transportation and propagation in this way of pyogenic and septic infections, erysipelas, etc. Clothing, carriage cushions, tapestries, and bedding may preserve and carry cholera, smallpox, scarlatina, diphtheria, and erysipelas. The most various utensils, food, and particularly bread, may be soiled by pathogenic microbes, and thus facilitate their penetration into the organism.

We may understand, therefore, without having to insist upon it, how a large number of social circumstances may expose persons who live in society to the attacks of microbes. One's occupation will often force a person to come into contact with patients afflicted with infectious disorders, or with excreta from such patients containing pathogenic microbes, and thus cause him to contract such diseases as cholera or typhoid fever. Occupations having to do with diseased animals may also expose those who are engaged in them to direct infections, as when a groom takes care of a glandered horse; or to indirect infections, as with tanners preparing the hides of animals that had anthrax.

These examples show that there are extremely multiplied processes that may expose men living in society directly to infection by microbes, while mechanisms not less complex and equally of social origin may prepare the organic ground for the invasion of the microbe by changing either the structure or the working of the organism.

To these special causes of infectious disorders—invasion by microbes and their intra-organic evolution—hygiene is able to oppose a number of means of protection or defense; this is the part of prophylaxis. The physician can, besides, assist the organism to make a victorious struggle against the microbe; this is the part of therapeutics. On these two points, also, social influences have an extremely active effect. These interventions may be greatly modified by the position of the subject in society, and rendered, according to circumstances, insufficient and illusory, or more efficacious and even potent.

The facts thus far glanced at in this rapid review relate only to isolated cases, or to diseases which reach and kill only a few subjects. Suppose, however, these pathogenic influences raging at their extreme height; we shall then be dealing with epidemics carrying men off by thousands, by hundreds of thousands, as actually takes place with cholera, yellow fever, and the plague. Under such circumstances the microbe performs destructive work, carries death abroad, and decimates populations.

So we are brought back to the beginning of this discussion; and, examining philosophically this phase of the complex question of the office of the microbe in society, we are able to answer Broca's question, quoted at first, "What will take place in future generations when they shall have exhausted the temporary resources of emigration?" We say: Then the microbe will intervene, as it does periodically; it will decimate populations and will sow death; but it will be to renew life by enabling new existences to take the place of those which have become extinct, and by furnishing them, under an assimilable form, the organic matter which they will require for their life and healthy growth.

We thus see, even from this rudimentary sketch, that the function of microbes in society is very important. Good or evil, useful or injurious, they all have a part which is indispensable to the regular evolution of social bodies. Moreover, paradoxical as the assertion may at first sight appear, I believe the fact has been rigorously demonstrated, and may be formulated in the words, that society can not exist, live, or subsist except with the aid of the constant intervention of microbes, the great purveyors of death, but also the dispensers of matter, and therefore all-potent purveyors of life.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

THE mass of the asteroids has been computed by B. M. Roszell, of Johns Hopkins University, and found—including the whole three hundred and eleven bodies whose elements had been calculated at the time—to be ·026 of the mass of the moon.

THE ILLUSTRIOUS BOERHAAVE.*

By WILLIAM T. LUSK, M.D., LL. D.

Of the serious questions which need to be considered at the outset of a professional career there is none more vital than that of personal conduct. This is recognized by the provision for the medical man of a code of ethics, which shows him how the portion of the ten commandments which teaches one's duty toward one's neighbor, is applicable to his dealings with the public and with other medical men. It is useful to the class which need to be reminded that for uprightness a man should do no murder, should not steal, should not bear false witness, should not covet. But the sweetness and light which should govern our relations to others are not the product of written law. The real training comes from action with attendant victories and defeats. There is, however, a special inspiration to higher effort which is derived from the study of the lives of distinguished men. For this reason I have thought it might be profitable for you to follow with me on this occasion the career of the Dutch physician Hermann Boerhaave. In his day his fame was world-wide. A letter addressed to the "illustrious Boerhaave, physician in Europe," by a mandarin in China, in those days of limited communication, reached him without inquiry or delay. In the history of medicine he ranks as the peer of Hippocrates and Sydenham.

He was born in Voorhut, a small village, two miles distant from Leyden, on December 31, 1668. His father, James Boerhaave, was a poor minister with a large family. He had, as we learn from a few but very precious memoranda left by his famous son, a good acquaintance with Latin, Greek, and Hebrew, and was well versed in historical studies. He was, in fact, a modest scholar, simple and unpretending, but with high ideals, and respected by all for his probity and honor. With special gratitude the son recalls the self-denying economy by which the father sought to provide the means of educating his nine living children.

James Boerhaave was twice married. Hagar, the mother of Hermann, died when he was five years old. She left seven children. From her Hermann inherited his taste for natural science. At the end of a year, James married a Mrs. Dubois, a minister's daughter. By her he had six children, but, owing to her obliging, impartial disposition, the old home sheltered an undivided family. In his memoranda Hermann commemorates the

* An address delivered before the graduating class of the Medical Department of Yale University, June 26, 1894.

"*mores sanctissimos, raram virtutem, amabilem indolem*" of this beloved stepmother.

The elder son by the second marriage, James was selected for the medical profession, but the influence of heredity was too strong. He tired of physic, and became an eminent divine at Leyden.

Hermann, on the other hand, was designed for the pulpit. His maternal grandfather, Hermann Daeldir, was famous as a maker of instruments of navigation in Amsterdam. His mother was regarded as a great authority in the simple medication for the parish poor. He was brought up to regard divinity as the highest of all professions, and was deeply imbued with the religious sense; but his native instincts and tastes were always for scientific investigation, and a trivial incident made him one of the greatest physicians of all times. In after life, when at the zenith of his fame, he modestly wrote a dedication of his work on chemistry to his brother; in referring to the plans laid out for them both in their boyhood he says: "Providence disposed of us otherwise; and exchanging our views, consigned you to the service of religion, and made me, whose talents were unequal to higher things, humbly contented with the profession of physic."

At eleven, under his father's instruction, he was well versed in Latin and Greek, and ready at the grammatical rules of both tongues, for to be a good grammarian was the ambition of the countrymen of Erasmus. To write Latin with elegance and ease was essential when the Latin language was the means of communication between learned men over the entire civilized world.

In those childish days it is interesting to learn that the serious minded boy delighted in devoting his leisure hours to the culture of the little garden of the parsonage. Holland was then, Griffin tells us, the gayest garden land of Europe, and later, under the skilled direction of Boerhaave, the botanical garden of Leyden became the most renowned in the world.

From the twelfth to the seventeenth year the boy suffered greatly from hip disease. He tells us it was the grievous pain from this source which led him to contemplate the study of medicine. But the malady seems scarcely to have affected his progress in his studies. At fourteen he was sent to the public school in Leyden, where he was rapidly advanced in his studies, winning all the prizes, and at sixteen, he was admitted to the university. It may here be parenthetically stated that the schools of Holland were the best in the world. They received state aid, and were free to the needy student.

Meantime the father of Boerhaave had died, and left his family in straitened circumstances; but, in Leyden, where, after its heroic siege, while the memory of plague and famine was still fresh upon them, its people had asked for a university in place of the proffered exemption from taxation; in Leyden, which, when Scaliger was invited to a professorship, had ordered a ship of war to receive him, a helping hand was always outstretched to aid the meritorious student. Trigland, one of the divinity professors of the university, who had been a friend of Boerhaave's father, and who entertained great expectations as to the boy's future, procured for him the patronage of Van Alphen, the burgomaster, to whose paternal, continuous, and benevolent interest Boerhaave renders grateful tribute.

While a student at the university, by the advice of his instructors, in addition to studies in Greek, Latin, Hebrew, and Chaldee he attended lectures on natural philosophy and mathematics. During his undergraduate course he was often called upon by Siguerd, his professor, to take part in discussions upon the latter subjects. The study of algebra, geometry, and trigonometry he tells us he found most entertaining. In his twenty-first year he delivered the academic oration upon the subject that "the Doctrine of Epicurus concerning the Chief Good was well understood by Cicero," for which he received the gold medal.

It may perhaps be of interest to recall at this time the dignified formalities with which the competition for university honors was then surrounded.* The candidate first announced his intentions to the rector and senators, and these in turn informed the curators, who appointed the day for the oration. Then the applicant waited on each of the curators, and on the chief magistrate and sheriff of the city, to desire their presence. If the oration gave satisfaction to the curators, their secretary was sent to his habitation to thank him in their name, and to acquaint him that he should be presented with the gold medal. This was worth thirteen pounds, and bore a Pallas in relief on the front, and an engraved inscription relating the name of the person and the occasion on the reverse.

"The University of Leyden," Thorold Rogers tells us, "was far more renowned in the seventeenth century than Oxford, Cambridge, or Paris, and students from all countries crowded into this the youngest of the great universities. The student was exempted from taxation; he received his wine, beer, tea, coffee, salt, soup, and books free; and when once his name had been on the university rolls he was amenable for all offenses to a special court composed of the rector, four professors, and a representation in the city magistracy. One of the gravest punishments with which he could be visited, in the popular apprehension,

* Burton's Life and Writings of Boerhaave, 1746, p. 9.

was banishment from town for a term of years, and deprivation of academic privileges.

After receiving his philosophical degree, Boerhaave entered upon his theological studies. He delighted, he tells us, in the primitive fathers, whom he highly reverenced for the purity and simplicity of their doctrine, for the sanctity of their instruction, and for the perfection of their lives, dedicated to God; but he had no patience with the efforts of the schoolmen to make the sacred writings conform to the metaphysical abstractions of Plato, Aristotle, Aquinas, Scotus, and Descartes, with the confusion ensuing, and with an outcome, as he regarded it, contrary to peace with God and man. Independent judgment, it may be stated, was not favorably regarded in those days by the orthodox in Holland.

Meantime, to aid in his support, Boerhaave received a small number of pupils for private instruction, and, contemporaneously with his religious exercises, he took up the study of anatomy as a diversion. To him the works of Vesalius, of Fallopius, and of Bartholin were of absorbing interest. He attended likewise the dissections of Prof. Nuck, and with the true scientific spirit, eager for personal observation, he frequented slaughterhouses, and sought to increase his knowledge by vivisections. Anatomy was then to the student a revelation, and not a compulsory task. Chemistry, too, with the hopes it inspired of new and wonderful discoveries, filled him with splendid dreams.

Thus it came to pass that while loyal to his father's wish that he should devote his life to the ministry, and though still believing that his duty lay in that direction, he decided that he would, in addition to his theological studies, take a degree in medicine. For that purpose he entered the University of Harderwick, and in July, 1693, was made a Doctor of Physic. There now occurred to him one of those accidents which happen to most men at some time in their career by which the nature of their life's work is determined for them independently of their volition. On his way home from Harderwick a discussion was started on the passage-boat about the doctrines of Spinoza as subversive of all religion. Now, the universal education which was the glory of Holland bred a goodly number of blatherskites as well as famous scholars. One of the former was filling the air with loud invectives against the great philosopher; whereupon Boerhaave quietly asked him whether he had ever inspected the works of the author he decried. The clamorous orator, Burton tells us, was struck dumb. Inquiry was at once made as to the name of the troublesome student, and, after their arrival in Leyden, it was soon current gossip that Boerhaave had become a Spinozist. Strong opposition was organized to his receiving a license to preach. On the advice of his three steadfast friends—Van Alphen, his earliest patron; Trigland, the most famous of the instructors in the theological department; and Van der Berg, for some time burgomaster, a man of wealth and great influence—Boerhaave decided not to risk a refusal, but to devote his life to the practice of medicine.

He had already a reputation for prodigious powers of intellect, and those who knew his easy mastery of every subject to which he directed his attention anticipated for him a most brilliant future. Yet for a long time few patients sought his counsel. While awaiting at Leyden the advent of remunerative practice, he was invited by a prime favorite of King William to settle at the Hague and to establish himself as a court physician. But this temptation he resolutely put aside. He devoted the waiting period which falls to the lot of most young physicians to teaching mathematics, to work in a laboratory which he fitted up in his own domicile, and to reading the Scriptures and those authors who best teach the true way of loving God.

It may be interesting to state that Leyden, in the seventeenth century, according to the account of John Mollett,* was "rich and prosperous, beautiful, clean, and pleasant, abounding in handsome houses, intersected with canals of fast-running water, its broad streets planted with trees; its houses of red brick, faced with white masonry, shadowed the pathways with their projecting gables; and their ornamentation of arches, festoons, and medallions carved with quaint and heraldic devices completed a style of architecture that was characteristic and charming. Above these houses rose a large and splendid Town Hall, two beautiful Gothic churches, and a number of buildings originally dedicated to religious but at that time to secular uses."

The city, in the height of its prosperity, had a population of nearly one hundred thousand souls. The most perfect order prevailed. At the same time there were everywhere activity, vigor, and exuberance of life. It had a wide fame for the product of its looms, and Leyden cloth, Leyden baize, and Leyden camlet became familiar terms at home and abroad.† It was the birthplace of Rembrandt, Jan Steen, and Gerard Douw. Important works of every kind issued from its printing presses. The classic editions of the Elzevirs of Leyden are still the book-lover's delight.

In this favorable environment, Boerhaave's mental powers were ripened by observation and study. In 1701, in his thirty-third year, he was induced by his friends, on the death of Drelincourt, to lecture on the institutes of physic. His success was

* Rembrandt, by John Mollett. The Great Artist Series.

† British Encyclopædia. Art. Leyden.

such that at the end of his course his delighted pupils prevailed upon him to instruct them in chemistry likewise.

Two years later he was invited to a vacant professorship at Groningen, which he declined with grateful acknowledgments. Thereupon his trusty friend Van der Berg, President of the Burgomasters and one of the seven curators of the university, induced the authorities to increase his salary, and to promise to him the first vacancy in the regular professorships. This did not occur until 1709, when, on the death of Dr. Hotton, he was made Professor of Medicine and of Botany.

By the aid of returning captains, at a time when Dutch ships ruled the sea, and by a system of exchanges with noted correspondents, in ten years he had doubled the number of plants in the botanical garden. Crocodiles, turtles, and other strange creatures were imported from distant settlements in the Indies. The bamboo, the papyrus, the palm, the coffee plant, trees of cinnamon, camphor, and mahogany could be seen growing in the open air and in hothouses. The plants were especially remarkable for their strength and vigor. In their classification Boerhaave prepared the way for Linnæus.

In 1714 Boerhaave was elected to the rectorship of the university—"of their Noble High Mightenesses' University of Leyden," he terms it in his correspondence—and in the same year was appointed Professor of Physic in place of Prof. Bidloo, and to a position in the University Hospital. By this time his fame had outgrown its local limits, and students flocked to him from all parts of the world. When he began his public teachings, the doctrines of Van Helmont and Paracelsus were held in high favor. Indeed, he tells us that the works of the former he read through seven times and those of the latter four times. Van Helmont he regarded rather as a philosopher than as a physician, as his boasted remedies fell far short of their promised efficiency. Yet Paracelsus swore by his own soul, and calls every god in heaven to witness, that with one single remedy he was able to cure all diseases, be they what they would; and in another place he declares that no one need scruple about getting certain secrets of physic from the devil, and boasts of holding conversations with Galen and Avicenna at the gates of hell. By the school of Paracelsus it was claimed that the doctrine of transmutation was contained in the Pentateuch, in the books of Solomon, and in the Revelation of St. John.

Van Helmont's methods are illustrated by an account he gives us of how he treated himself for pneumonia. In 1640, in the sixty-third year of his age, he was seized with a fever, attended with a slight shivering which made his teeth chatter; a pricking pain about the sternum, a difficulty of respiration, and a spitting first of bloody matter and then of pure blood. For the removal thereof he took certain scrapings, which seem to have been in anticipation of the animal extracts of the present day, upon which the pains grew less. Then he took a drink of goat's blood, and the spitting of blood ceased in four days, leaving only a slight cough with a moderate expectoration; but the fever still remained, and was followed by a pain in the spleen, for which he took wine boiled with crabs' eyes, whereupon all the symptoms disappeared.

Medicine was not only obscured by the vagaries of the chemists, but knowledge was darkened by the theories of philosophers, who sought by shutting their eyes to arrive at truth by purely intellectual processes. Now, Boerhaave's teaching was an unceasing protest against the errors of his times. His introductory oration at the beginning of his career as a teacher was one extolling Hippocrates. To you, to whom the father of medicine is probably little more than a name, it may be proper to mention that the veneration in which he has been held is due to his having been the first to found medical teaching upon naked and indisputable facts. He was the nineteenth physician in succession in the same family. The records of his forefathers, the fruits of travel, the clinical experiences upon the isle of Cos, and the reports of his pupils formed the material of his Observations, which still are read with wonder and with profit. After him, from Galen to Vesalius, great advances were made in anatomy, and Harvey had discovered the circulation of the blood, but there was little contributed to the practice of medicine until Sydenham—the "immortal Sydenham" Boerhaave loved to term him, though at that time his merits had not been recognized by his own countrymen.

The qualifications of Boerhaave for the reconstruction of medicine were extraordinary. His memory was amazing. He had a familiar acquaintance with the works of his predecessors in medicine and in the kindred sciences. He conversed in English, French, and German, and could read easily Italian and Spanish, so that few new reports from those countries escaped his notice. He had studied with profit the writings of Lord Bacon, of Sir Isaac Newton, and of Robert Boyle. He had followed with eager interest the microscopic discoveries of Malpighi, Leuwenhoeck, and Ruysch, and he had a vision which could overlook the entire field, and see all branches of knowledge in their proper relations. With such gifts and training his Institutes of Medicine, published in 1707, in which all the teachings in anatomy, in physiology, and in pathology up to his time were, after the severest personal scrutiny, made the foundation of the theory and treament of disease, rapidly became the text-book of Europe and of the East, and long remained in the hands of his pupils the basis of medical teaching. Yet there were so-called "practical men" in those days who received the work with scant favor. They boasted that they read nothing; that all available knowledge was the product of experience only. They sneered at museum doctors, and said that such were not fit to doctor a cat.

But Boerhaave's greatest glory was the prominence he gave to clinical instruction. Instead of aimless wandering through the hospital wards, he adopted the plan of examining few patients, but with them to be exact, thorough, and exhaustive. At the bedside he taught with great minuteness the conditions that prevail in health, and then the changes wrought by disease, and upon these data he proceeded to formulate his therapeusis. Under him the post-mortem room assumed the same importance as the library, the chemical laboratory, the dissecting room, and the botanical gardens. His pupils in other lands established clinics and clinical instruction in conformity with the precedents he established. The clinical schools of Edinburgh and Vienna, under the guidance of Cullen and Van Swieten, owe their glory to his transplanted spirit.

His system of treatment, like that of Sydenham and Hippocrates, comprised few remedies, and laid great stress upon hygiene. He had little faith in the prevailing *elixirs ad longam vitam.* "As to nostrums," he says, "let those who have them keep them till they can convince impartial observers of their real worth." In a footnote to this, Burton, who was his Boswell and worshiper, says, "Mrs. Stephens' saponaceous dissolvent for stone in the kidneys and bladder may be a proof of one of them."

In 1718 he accepted, in addition to his other public positions, the professorship of chemistry, then left vacant by the death of Le Mort. In 1738 he published his Elements of Chemistry. It is divided into three parts. The first is historical, and is full of curious learning; the second part presents Boerhaave's theoretical views; while in the third part the author's personal observations are given. These are chiefly of interest as showing the volume of useless experimentation that preceded solid advances in chemical science.

As a sample of old-time ways, Burton, with loving admiration, details Boerhaave's attempt to accomplish the consummate purification of quicksilver. "With matchless perseverance he tortured it by conquassation, trituration, digestion, and by distillation. He amalgamated it with lead, tin, or gold, repeating this operation to 511 or even to 877 distillations." But alas! owing to an inherent turpitude in the metal, at the end it was only the same quicksilver as at the beginning.

That this and similar experiences were not satisfactory to Boerhaave is evident from his preface. The work, he complains, was produced at the instance of his friends, and because of spurious accounts of his lectures which were then in circulation. "This brought Petrarch to my mind, who bewails the unhappiness of his age upon finding himself ranked among the chief poets in it. With what confidence could I, conscious of my own insufficiency, and full of admiration of other authors, enter the list of writers of chemistry? At length, however, I undertook the disgustful work which I now declare was extorted from me."

In his prime Boerhaave was tall, robust, and athletic, hardened by exercise, negligent in dress, with a large head, curly brown hair, bright, piercing eyes, and a florid complexion. He was a sincere and affectionate friend, courteous in his professional intercourse, never talking of his own affairs, ready with praise for others, but silent concerning himself.* "There was in his air something rough and artless, but so majestic and great at the same time that no man ever looked upon him without veneration and a kind of tacit submission to the superiority of his genius." He rose at four o'clock in summer and at five in winter. Ten was his usual bedtime. One hour he devoted to prayer and meditation. This, he said, gave him spirit and vigor in the business of the day. All his abilities he ascribed to the goodness of God. In the severest winter he had neither fire nor stove in his study, where he passed three to four hours in the morning. His library abounded in the works of the best historians, poets, and authors of polite literature as well as in those upon medicine.

By unceasing industry he produced in rapid succession books, minor treatises, orations, and discussions. Besides the public lecture on botany and the private lectures on chemistry, the institutes and practice of physics, which employed him four hours in speaking, he frequently spent an hour in giving a public lecture on some special subject. He allowed nothing to interfere with his duties as a teacher.

He brought to the lecture room a vast comprehension, a prodigious memory, and a solid experience. He used no notes; his manner was concise, clear, and methodical. He illustrated his subjects with quotations from the poets, of which his favorites were Virgil, Ovid, Rapin, and Cowley. Sometimes by a delicate irony he stirred his audience to laughter, but never moved a muscle of his own face. His lecture room was thronged. Men came to Leyden from all parts of the world, who regarded it as a special glory to have been taught by the illustrious Boerhaave. As a writer said of him after his death: "Long was he the oracle of his faculty. Never was preceptor more beloved, professor more celebrated, nor physician more consulted." †

His practice was enormous. A hundred patients, it is said,

* Gentleman's Magazine, 1739. * Burton, footnote, p. 73.

were frequently waiting in his anteroom. The Czar Peter once lay all night in his pleasure barge outside of Boerhaave's house, to have two hours' conversation with him before college time. He was temperate in his habits. He rarely touched wine. Water was his common drink. In the German student song it reads:

> "Hermann Boerhaave schreibet ja:
> Aqua paullo frigida
> Potio est optima."

Until infirmity came upon him his favorite exercise was riding. When he was weary he distracted himself with music, of which he was very fond. He had a good voice and played a number of musical instruments. It was his custom to have a weekly concert at his own house.

At forty-two he married Mrs. Mary Drolenveaux, the only child of the Burgomaster of Leyden. They had four children; three died in infancy—one, a daughter, survived him.

In 1722, when fifty-four years of age, his physical constitution gave the first warning of the effects of the strain to which it was subjected. He had an attack of arthritis, whether of a gouty or rheumatic nature is uncertain, though it is stated that it was the result of exposing himself to the morning dews before sunrising, which kept him in bed six months. The pains were atrocious. Once, after fifteen hours of continued suffering, he prayed that his disease might end his life and misery. This afterward gave him great concern, for he wished, he said, to abide by this maxim living or dying: "That only is best, and alone to be desired, which is perfectly agreeable to the Divine Goodness and Majesty."

When in 1723 Boerhaave had sufficiently recovered to reopen his private college, the citizens of Leyden celebrated the event in the evening by illuminations and by public rejoicings. In 1727, on a return of the attack, he gave up the chairs of chemistry and botany, though he continued to teach actively in other branches until his final illness. In his later life his greatest pleasure was in his country home. This was large and roomy, with eight acres of ground. His garden was filled with the exotic shrubs and trees which would flourish in that climate. A present of American shrub seed he styles "a gift more precious than gold," and two cedar trees "a royal benefaction."

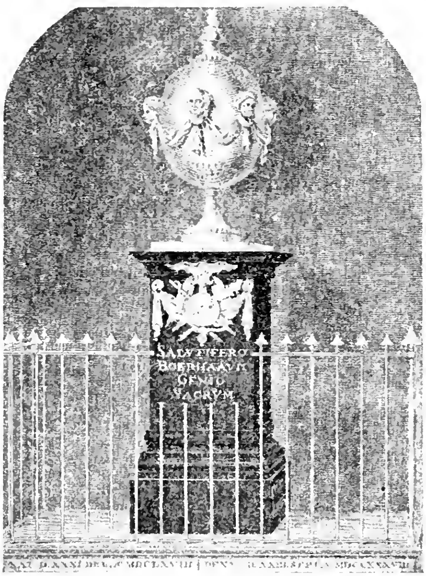
In 1725, at the expiration of his rectorship, he delivered an oration in which he reprehended the philosophers who have attempted to invent rather than to discover principles, and in particular he singled out Descartes. Andala, an orthodox Cartesian professor, set up a cry that the Church was in danger, and that the dreaded evil of Spinozism would be the result. But the times had changed since the journey of the young student from Harderwick. The governors of the university insisted on a retraction. To Andala's recantation Boerhaave replied with fine courtesy that the most agreeable satisfaction he could receive was that so eminent a divine should have no more trouble on his account.

Boerhaave was through life cheerful and desirous of promoting mirth by a facetious and humorous conversation. He was never soured by calumny and detraction, nor ever thought it necessary to confute them, "for they are sparks," he said, "which if you do not blow them will go out of themselves."

In 1728 he was elected a member of the Royal Academy of Sciences in Paris, and in 1730 a member of the Royal Society.

He accumulated an immense fortune, estimated by some at two millions of florins, and yet through life no one appealed in vain to his generosity. "The poor," he said, "were his best patients, for God paid for them."

About the middle of the year 1737 he began to suffer from cardiac disturbances, from dyspnœa, and from dropsy. If for a moment he fell asleep, the respiration was interrupted, and rest was prevented by a terrible sensation as of strangling. Yet in a letter he writes, "I have lived to upward of sixty-eight years, and always cheerful."



In the library of the Faculty of Medicine in Paris there were found in 1877 ninety letters from Boerhaave to his friend Baron Bassand, physician to the Duke of Lorraine, afterward the Emperor Francis I. In one of these, written two weeks before his death, and intended for private eyes only, he says: "My malady gathers in force. The cardiac oppression due to polypi is constant, and of the last degree of cruelty. God wishes it thus. His perfect and sovereign will be glorified by the submission of his creature, who loves and adores only the infinitude of the eternal." *

He died on the 27th of September, 1738. His monument in the St. Peter Church, where his body was interred, bears the inscription "Salutifero Boerhaavii Genio."

* Article by Chireau, L'Union Médicale, 1877, p. 584.

CORRESPONDENCE.

STEEL ENGRAVINGS AS WORKS OF ART.

Editor Popular Science Monthly:

In the article on bank-note engraving, published in your March issue, the writer classes the engraving of bank notes among the fine arts, and describes it as the last and highest step in a long series, beginning with the wood and metal engravings of Albrecht Dürer. Just what analogy the writer finds between the metal engraving of Dürer and modern bank-note work is by no means obvious, although his statements in regard to this artist are doubtless authoritative, as they are taken entire, with scarcely the change of a word, from Philip Gilbert Hamerton's article on Engraving in the eighth volume of the Encyclopædia Britannica, page 441. But, as Dürer was an artist and not an animated cycloidal lathe, he is scarcely to be compared with the modern engraver of bank notes. There is not even similarity between the materials used, for Dürer's medium was copper or wood, while the modern bank-note plate is of steel. I can not forbear slight criticism, because, in an article otherwise instructive and valuable, the writer manifests a complete and utter misapprehension of the meaning of art as such. Mr. Dickinson hopelessly confounds steel engraving and etching, and deplores the lack of "original artists" in these lines of work, for, says he, "steel engravings have found a place in the hearts of the people of this country that no other class of art can ever replace." It is somewhat ludicrous to think of placing Seymour Haden, Rajon, or the immortal Whistler on the level of the producers of steel engravings, which are, in general, the most inartistic and lifeless things ever allowed to masquerade under the name of art. Of copperplate, the scroll and papyrus of our etchers, Mr. Dickinson speaks disparagingly because it wears out "in one thousand impressions, while ten or fifteen thousand can be taken from steel." He generously adds that it is "still used to a considerable extent for visiting cards," and "in some cases for the cheaper classes of picture work, such as book-illustrations," evidently ignorant of the fact that numbers of our greatest artists—Reinhardt, Gibson, Frederic Remington, Irving R. Wiles, and W. T. Smedley, among others—consider their art in no wise cheapened or degraded when turned into the enormously profitable channel of "picture work, such as book illustrations."

Says Mr. Dickinson, "Here [in a bank-note portrait] we have a beautiful specimen of pure line engraving, much better than most of that done by some of the old masters and now considered classic." Now, it is not the fault of the bank-note portrait that scarcely anything more mechanical, more uninteresting from an artistic point of view, has ever been produced, but it is doubtful if ever before it has been looked upon as possessing genuinely artistic value. And this difference between mechanism and art is just what Mr. Dickinson has utterly failed to perceive. A work of art lays claim to that title only when the means of expression remain subordinate to the thought which is expressed. Technique alone will not save any work of art from more or less speedy oblivion, while a serious thought, even though inadequately expressed, will remain a dominant tone in the chord of the world's art for all time. The technically faulty works of the early Italian artists, and even of Dürer himself, give ample proof of this. Then, too, a work of art is never more than merely suggestive—never, as in the case of the bank note, is it elaborated to painful completeness. A mechanical draughtsmanship, such as is displayed in the bank note, crams the same conclusion down the consciousness of each and every onlooker. The genuine work of art remains obstinately silent, or else pours out its wealth of color and song lavishly, according to whether the spectator be a poet at heart or a dolt.

In a bank-note engraving, on the other hand, the sole interest aroused is in the process, and this interest is heightened in proportion as the process involves greater intricacy of detail and more rigid and unvarying evenness of line. Since that so-called perfection is due chiefly to the accuracy of machinery, "the ruling machine, and cycloidal and geometrical lathes," a bank note can have no other than a purely mechanical interest. The engraving of it is doubtless a valuable factor in the commercial world, but to compare it to the work of Dürer, crown and flower of the German Renaissance, is quite like comparing a lathe-turned table leg to the Moses of Michael Angelo.

Grace Green Bohn.

Chicago, *March* 2, 1895.

EDITOR'S TABLE.

PUBLIC EDUCATION AND PUBLIC OPINION.

THE editor of the Revue des Deux Mondes contributes to a recent number of that periodical an article entitled Education and Instruction, in which are some things with which we heartily agree and others from which we are compelled to dissent. The article as a whole, however, is of undoubted value, inasmuch as it sets forth the true theory of education, while what we regard as errors are in matters of detail. M. Brunetière remarks at the outset that formerly the ideas of education and of instruction were but little distinguished from each other. True, to instruct meant "to furnish," and to educate meant "to lead forth" or "develop" and so "to mold"; but it was always assumed that the furnishings provided for the mind would be of such a nature, and would be so imparted, as to promote development and favor true culture; and thus the words were to a great extent used interchangeably. In the present day we are compelled to separate their meanings, owing to the fact that, in our modern systems of so-called "education," while much effort is concentrated on fitting up the mind with an equipment of knowledge. the right direction of mental growth, and, above all, the right development of character, receive but little attention, and indeed are almost left out of sight. Our children are *instructed* in the schools of to-day; but, he maintains, they are not *educated* in the true sense. Personally, he expresses his regret that education was not allowed to remain a private matter; but seeing that it has passed into the hands of the state, we have simply to see what we can do to get the maximum of good out of the huge mechanism which the state has set up.

Now it might readily have been supposed by any one speculating before the event, that when state education became general it would at least have one strong point: it would aim at fitting the rising generation for social and political life; it would aim at overcoming or at least tempering in the interest of the community the natural selfishness of the individual. The error in this calculation would have lain in imagining that the state, as represented by individuals, has any consciousness of its own interests. The individuals in question have a consciousness of their own interests; the best among them have, in addition, some sense of public duty; but the state can not, through the officers and teachers it appoints, study and strive after its own interests as the individual studies and strives after his. Hence, in any system of public education, the claims of the state never get more than a partial and fitful recognition: the whole drift of the work done is in the direction of an intensified individualism, or, as M. Brunetière expresses it, "*la culture intensive du Moi*"—the intensive culture of the Ego. Referring to the statement made by Sir John Lubbock that the progress of education and that of morality kept pace in England, M. Brunetière exclaims: "Happy England! and most fortunate accident! for statistics have brought nothing similar to light in France or anywhere else, in Germany or in America. In these countries, on the contrary, we see that quite ignorant people, who know neither antiquity, nor the sciences, nor languages, nor even orthography, are nevertheless very worthy folk; while inversely we find that all their instruction has not preserved a number of unfortunates from the worst lapses; and neither certificates nor diplomas have prevented them from succumbing to the most vulgar temptations." As applied to this country the writer's language is a little lacking in exactness; for here the conditions are such that it is difficult, for native-born citizens at least, to remain ignorant of the arts of reading and writing except through fault of their own; but it certainly has been the case in the past everywhere that people could be, as he says, "*fort honnêtes gens*" without any tincture of what we now call education. Their knowledge was confined to some useful art by which they earned a living, and the precepts of common morality.

The question M. Brunetière next discusses is how "to put some soul back into the school," or, in his own words, "*rendre une âme à l'école*"; but his observations on this point, referring as they do to a system of education controlled by the national Government, have but a slight application to this country. It is here, however, that we find ourselves disagreeing with some of his incidental remarks. He accuses men of science of being excessively dogmatic in their opinions, and apparently ignoring the modern conception of the relativity of knowledge. Now, some men of science may be dogmatic, but to say, as the learned editor does, that "most of these will not allow their conclusions to be disputed, or so much as criticised," is to fall into great exaggeration. As to the doctrine of the relativity of knowledge, it is a doctrine which science has established. It is earnestly and constantly insisted on by Auguste Comte, and has been illustrated and elaborated in great detail by Herbert Spencer. It is not, however, a doctrine of which much use can be made in imparting scientific or any other knowledge to the young, whose natural philosophic creed is one of simple confidence in the reality of phenomena. M. Brunetière is further of opinion that science should only be given in very small and judicious doses in primary and secondary schools. The important thing, in our opinion, is, that nothing should be done to check the spontaneous activity of youthful minds, or any flow of emotion which may be associated therewith. Science should, therefore, not be imparted to the young in too didactic or formal a manner; it should rather come to them in the form of a constant appeal to investigate, to use their own faculties of sight, touch, hearing, smell, and to draw their own inferences from data thus collected. We quite believe that, in the hands of an inexperienced and unsympathetic teacher, science lessons might be given to youthful students in such a way as simply to check imagination and inspire distrust in the testimony of the senses; but when the right kind of science teaching can be got, there will be no need to deal it out as the dangerous drug which the editor of the Revue des Deux Mondes seems to consider it.

Returning to the question on which, as we have stated, this writer does not give us much help—how to get "soul" into the schools—we must observe that any success in such an effort will depend largely on public opinion. The great mischief of an imperfect educational system is that it creates the public opinion by which itself is judged. The man of thirty-five, who to-day has children of his own at school, was a scholar himself only twenty years ago. Things have not changed much in that time. If the spirit of competition was stamped into him, he will want it stamped into his children. If money is his chief preoccupation, he would not like to hear that a public-school teacher was doing anything to lessen the importance of money in their eyes. He would be willing enough that other children should learn that lesson, but not his own. The case, we are persuaded, is far from being an imaginary one. The average parent sends his children to school with no other view than that they shall be prepared for some money-making occupation; and he expects that that object shall be kept uppermost by the school authorities. This being the case, the "soul" that M. Brunetière desiderates runs a great risk of being contraband of our modern school systems; because it can not enter without coming at once into conflict with the spirit of money-worship, and also with that of selfish ambition. Of course, if we had every reason to be satisfied with the moral progress of our people and the signs of the times generally, there would be no need to raise this question; we might assume that the schools were doing all that was required of them: but such is not the case; the signs of the times are in many respects unsatisfactory. The state has wrenched education from private hands, and now we have to consider what can be done to humanize the teaching which it is bestowing on the millions of our youth. Very many individual teachers are doubtless occupying themselves with the problem, but their efforts will not make up for general public indifference to it. A nation can not thrive on love of money, nor live on the virtues of a small minority. We must have "soul," or, to speak with more precision, the spirit of social duty and of moral responsibility, at the very base of our educational systems; otherwise education itself becomes a fraud and a snare, and the very agencies which should consolidate the social fabric will work for its disruption.

THE ALLEGED DOGMATISM OF SCIENCE.

In the above article we have touched, in passing, upon a charge very frequently and very carelessly made against men of science that they are intolerant of opposition to their scientific theories, and in effect set up a kind of orthodoxy to which all must bow who desire to be considered rational and intelligent beings. The charge is utterly frivolous, as the most obvious facts attest. Consider first how it applies to some of the most prominent scientific workers of the century. Surely nothing of this kind could truthfully have been said of such men as Sir Humphry Davy and Michael Faraday, of Sir Charles Lyell or of Agassiz, of our own geologist Dana or our great botanist Gray. As to Darwin, all the world knows that candor and modesty were of the very essence of his character. We might pass rapidly in review a number of other eminent names the very mention of which would be a vindication from the charge, but it would be superfluous. When dogmatism appears it is nearly always on the part of men who have adopted their opinions at secondhand, and who have either ignored altogether, or paid little attention to, those elements of uncertainty which were not only fully present to the minds of the originators of the theories in question, but also fully expressed in their published works. This simply means that scientific leaders have the same experience that other leaders have had, and need to join in the classic prayer, "Save us from our friends!"

There is one feature in the case, however, which is not to be overlooked, and that is that the representatives of science have been in the past, and still are to some extent, required to put up with a kind of opposition that is very annoying to men who have worked their way by patient labor. in appropriate fields of observation, to certain well-demonstrated conclusions. We refer to the opposition of those who have not labored at all in those fields, but who, on the strength of the most extraneous considerations, insist that certain scientific conclusions must be all wrong. Such was the opposition made by the Catholic Church to the modern system of astronomy, and such the opposition made by all Christian churches, more or less, to modern geological science. What is the use of inquiring into the origin of language and the affinities of different families of speech if the stories of the Garden of Eden and the Tower of Babel are to dominate all speculation on these subjects? The indignation used to be all on the side of the theologians, when their opinions were traversed by considerations drawn from the study of Nature. Nowadays scientific men allow themselves occasionally a little indignation, or at least impatience, when theories, which they have carefully founded on facts, are traversed on the strength of other men's interpretations of a book. Time brings about these changes, and it would be harsh to find much fault with the champions of science for not being wholly above the infirmities of human nature.

It should, of course, be clearly understood that dogmatism, in so far as it exists, does no good to science. True theories will vindicate themselves in the end; and, even when the grounds for certainty seem ample, it is well not to be too confident or too absolute. Then if people who simply *adopt* other people's opinions would only learn not to be more dead-sure than the authors and sponsors of those opinions, a great point would be gained and much trouble avoided. Science wants all the friends it can get, seeing that is a friend to all; but its path would be smoothed if ardent converts would temper their zeal with discretion.

SPENCER ON PROFESSIONAL INSTITUTIONS.

When we wrote, in March, concerning the series of articles by Mr. Spencer with which this magazine began its career we had no thought that we should be so fortunate as to have the first of another series by the same master hand for the opening number of our twenty-fourth year. Nor had Mr. Spencer; for that editorial itself suggested to him the advisability of issuing serially the chapters on Professional Institutions which he had nearly completed. There will be eleven or twelve papers in the present series. These papers will show how the several professions have been differentiated from the functions of the priest or medicine-man, who is the only professional man of primitive society. They will demonstrate that in these affairs—although subject to human will and caprice—the grand principle of evolution operates just as surely and completely as in the derivation of an animal species from its ancestral form.

A peculiar element of value in the evolutionary philosophy, of which Mr. Spencer is the original and most eminent expositor, is the power of understanding the present and predicting the future which is afforded by its explanation of the past. To take the present subject as an illustration, from the division of functions that has taken place in the past we may infer a still further specialization in the future. Higher achievements in the several professions may be expected as a result of this process, the men of different professions will become more and more necessary to one another, and the solidarity of society will be increased.

The Professional Institutions will form the last portion but one of the only volume remaining uncompleted in Mr. Spencer's systematic series of philosophical works. It therefore makes probable the successful completion of the series, and, together with the division on Industrial Institutions which is to follow, will be sure to throw much light upon the puzzling industrial problems of the day. A few days ago Mr. Spencer completed three quarters of a century of life and about half a century of productive labor in the field of thought. For twenty years past there have been times when the close of his labors seemed imminent, but, mainly as a result of prudent care, his physical strength has lasted till this time, while the articles of which we print the first this month adequately demonstrate that his mental grasp and acumen are in no wise impaired.

LITERARY NOTICES.

The Great Ice Age and its Relation to the Antiquity of Man. By James Geikie. Third edition. Largely rewritten. New York: D. Appleton & Co. Pp. 850. With Maps and Illustrations. Price, $7.50.

Geikie's Great Ice Age, when it appeared in 1877, took a position at once as one of the standard treatises in geological science. It has held that place ever since, although the department of geology with which it is concerned has been more actively and scrutinizingly studied, perhaps, than any other. With so much research as has been bestowed upon glacial phenomena, much knowledge has been accumulated that was not within the author's reach eighteen years ago, and some new views have prevailed; yet Prof. Geikie's arguments so ably set forth in the first edition of his work have not lost their force, and his main conclusions have not been successfully assailed in their essentials. A revision of the book had, however, become necessary, in order that it might enjoy the benefit of the acquired knowledge, and that the new views might receive just discussion and the old ones be re-examined in the light of them. Yet in the immense bulk of the literature that has accumulated, and its scattered condition among many nationalities and in multitudes of periodicals and monographs, the author has not attempted to discuss all the interesting questions mooted and canvassed in it, but, to keep his sketch within reasonable limits, has been compelled to follow more or less strictly the lines laid down in the first edition, in which his endeavor was represented to be to give a systematic account of the Glacial period, with special reference to its climatic conditions. All the more important features of the evidence, however, have been considered, and few references are given to original sources of information. The chapters dealing with the phenomena of existing glacial action in Alpine and arctic regions have been touched up, and the glacial geology of Scotland has been thoroughly revised. Some rearrangements of other matter have been made; but nearly three fourths of the volume have been entirely rewritten. The glacial and interglacial deposits of the European continent are treated more fully than was possible ten or fifteen years ago. The purpose of the book being to sketch the present position of glacial geology rather than to write the history of its rise and progress, no great notice has been taken of the opinions held by its pioneers. In dealing with questions still under discussion the author has endeavored to avoid a controversial tone, preferring as a rule to set forth the evidence as clearly and impartially as he could, and then to point out what seemed the most reasonable interpretation. To avail himself as fully as possible of the results of glacial investigation in America, where some of the fullest researches have been made, the author engaged Prof. T. C. Chamberlin to prepare a summary of the American evidence, which is presented in the forty-first and forty-second chapters of the book. An interesting confirmation of the author's conclusions, drawn most largely from observations of British geology, is afforded by those of Prof. Peunck, of Vienna, which are similar, though derived from the study of a different field—the Alpine lands.

Geological Survey of New Jersey. Annual Report of the State Geologist for the Year 1893. By John C. Smock, State Geologist. Trenton: John L. Murphy Publishing Company. Pp. 457.

The survey for 1893 was engaged in the continuation of the work on the surface formations of the State, on the greensand marl beds and the associated bed of the Cretaceous and Tertiary ages, on the study of stream flow and the general questions of water supply and water power, and on the examination of the clays of the State; and the collection of artesian or deep-bored well records was continued. The study of the surface geology by Prof. Rollin D. Salisbury was carried on mostly in the northern and central parts of the State. One of its fruits is the preparation of maps of the surface formations, separate from that of the underlying strata, in the beginning of the publication of which New Jersey leads. These maps may be said to make a new series, distinct from the topographic maps by their geology, and from the older geological maps in the absence of any representation of the older and underlying rock formations, except where they crop out and make the surface. They show the nature of the soils and subsoils in general, and the deposits of sands, gravel, peat, shell marls, and other earthy beds, and also the bowlder-covered areas of the glacial drift. The work in the greensand marl belt and in the newer formations of the Tertiary age overlying the marl beds was continued, in co-operation with the United States Geological Survey, under the charge of Prof. William B. Clark. The survey of the crystalline rocks of the Highlands was carried on by the United States Survey, and was in charge of Dr. J. E. Wolff. The subjects of water supply and water power were further investigated and studied by Mr. C. C. Vermeule, and the collection and tabulation of data for the volume of water supply were carried forward. Mr. Vermeule has prepared a map of the State showing the water sheds which are utilized for public water systems and those which are still available. Mr. Lewis Woolman has continued to collect the records of artesian wells put down in the southern part of the State; and his report contains, in addition, historical notes of wells and important generalizations on the water-bearing beds or horizons. Progress is reported in drainage surveys, and surveys for the reclamation of tide-marsh lands. Attention has been given to the adaptation of the trap ridges and highland regions to the purpose of natural parks and forest reservations. The last part of the report is devoted to a list of the useful minerals and mineral subtances which occur naturally in the State, and to notes on the localities and modes of occurrence. The volume contains the map showing water sheds, and is accompanied by a tube containing maps illustrating the distribution of intra-morainic and extra-morainic drift; of the extinct Lake Passaic; showing glacial striæ on the Palisade range; and of the vicinity of Hibernia, in the ore district.

General Hancock. By General Francis A. Walker. Great Commanders Series. New York: D. Appleton & Co. Pp. 332. Price, $1.50.

In telling the story of Hancock's life and military career General Walker draws attention to the fact that Hancock never commanded a separate army, and hence was never responsible for the plan, but only for the execution of the part intrusted to him, in the operations of the army with which he was connected. Hence he is to be estimated as an executive officer and not as a strategist. In two chapters his life is brought down to the great rebellion. Winfield Scott Hancock was the son of a lawyer who practiced a few miles out of Philadelphia. He went through West Point with the class of 1844, and served in the Mexican War, which began a couple of years after he graduated. From the evacuation of the city of Mexico until the civil war Hancock served much of the time as a quartermaster, the last two years being chief quartermaster on the Pacific coast. In this service he won distinction for his care, foresight, and good management. General Walker represents him as having the almost incompatible qualities of loving "papers," rejoicing in forms and regulations and requisitions, while at the same time he had the temperament that enjoys the clash of battle with its excitement and danger. His experience had prepared him most admirably to cope with material obstacles, and very often it is material obstacles quite as much as the efforts of the enemy that defeat armies. In his first battle, Williamsburg, he was sent with five regiments to execute a movement, which he accomplished with consummate skill. His conduct led McClellan to say in his telegraphic report, "Hancock was superb," and the adjective clung to him. By what the author calls "one of those curious fortunes which mark the course of war," the brigade and its commander that had acted so brilliantly and steadily at Williamsburg were given scarcely anything to do in the seven days' battles and other fighting that followed on the peninsula, nor were they more actively employed at Antietam. But when Richardson fell on the last-named field, Hancock was advanced to the command of his division.

The account follows Hancock through Fredericksburg, Chancellorsville, and the three days of Gettysburg, setting forth the tactics employed by the Union army on each day and freely criticising them. The severe wound received by Hancock on the third day at Gettysburg took him away from the Second Corps, which he then commanded, for six months. After his return came the severe campaign of 1864, in which Hancock bore a prominent part, Grant being now his chief. In the spring of 1865, after a winter of recruiting service, Hancock was placed in command of the Middle Military Division whose operations were to begin from Winchester. The final crash at Petersburg came earlier than Grant expected, so that Hancock had no share in the operations which brought it about. A single chapter is given to the events of Hancock's life after the war. The position that General Walker occupied on Hancock's staff, of assistant adjutant general, makes him exceptionally well qualified for the work he has here performed. It is no eulogy that he has produced, for he does not conceal the deficiencies nor the specific mistakes of his subject. His incidental criticism of other generals is equally outspoken, and adds much to the interest of the volume.

Meteorology. Weather, and Methods of Forecasting, Descriptions of Meteorological Instruments, and River Flood Predictions in the United States. By Thomas Russell. New York: Macmillan & Co. Pp. 277, with Plates. Price, $4.

The main object of this book is to explain the use of the weather map, where it can be of service for the purpose of making predictions; but the author's expressions as to the feasibility of making successful predictions, even with the use of the weather map, are not hopeful. There are not more than from six to twelve occasions in the year when they can be made, and for some places they are never possible. The kinds of weather that can be foretold are the great changes. A fall of temperature as great as forty degrees can be foreseen to a certainty for most parts of the country east of the Mississippi River. The northeast rainstorms along the Atlantic coast can be successfully predicted in most cases. Floods along the lower Ohio and Mississippi Rivers can be foreseen from one to three weeks in advance of their occurrence, and the height the water will reach can be assigned within a foot or two. The course of rains, which agrees as a rule with that of the areas of low pressure that cross the country from west to east and from southwest to northeast, can be inferred in a general way, but is subject to many irregularities. The reader being thus warned of the uncertainties connected with the matter, a summary of what is known about the weather, its apparent laws, and its somewhat erratic movements, is given in a series of chapters which are broken up into crisp, pertinent, and intelligible paragraphs distinguished by their conspicuous headings. First, the influence of the moon, sun spots, and periodicity are discussed; we have no satisfactory knowledge on either point. Next, the properties and functions of the air are described, with more definite conclusions. Then meteorological instruments are enumerated, and the principles involved in their construction and their uses are explained. The succeeding chapters are devoted, with numerous subheadings, to the discussion of temperature and pressure and their variations, evaporation, clouds, rain, and snow; winds, thunderstorms, and tornadoes, and optical appearances. A full chapter is given to the exposition of the construction and meaning of weather maps, and another chapter to the consideration of the import of weather predictions. A short account of river floods is given, and the method of predicting river heights for a number of points along the lower Mississippi River and its tributaries. In all this a general view is taken of meteorology, while climatology is treated of only in its broad, general features. The principal weather changes are described as they occur in various parts of the world in different seasons on land and sea, and their causes are narrated as far as is known. A collection of facts is given useful in forming a conception of the phenomena of the atmosphere as a whole, so as to enable those with little time for consulting a multitude of books to form a notion of the science of meteorology as it is at present.

The Birds of Eastern Pennsylvania and New Jersey. With Introductory Chapters on Geographical Distribution and Migration. Prepared under the Direction of the Delaware Valley Ornithological Club. By Witmer Stone. Philadelphia: Delaware Valley Ornithological Club. Pp. 185, with Two Maps.

The object of this volume—which has been prepared by a special committee appointed to collate the field notes of members of the club—is to provide these members and ornithologists with a summary of our present knowledge of the birds of the district included, with regard to their abundance, distribution, and time of occurrence. Description of the birds and their habits does not come within the scope of the work. In the preliminary pages are given notes on the geographical distribution of birds; the faunal areas of the region; their physical features and characteristic birds; the distribution of winter birds; a general discussion of bird migration; migration in the vicinity of Philadelphia; and birds found within ten miles of Philadelphia—conveying copious information. The region is crossed by the three faunal zones: the Carolinian, occupying the southeastern corner of Pennsylvania and the whole of southern New Jersey, to the Hudson and beyond, with a bay up the Susquehanna Valley; the Alleghanian, occuping the rest of the region, except the tops of the higher mountain ranges and portions of the elevated table land in the north central part of Pennsylvania, where the Canadian zone is represented. The passage from the Alleghanian to the Canadian zone is, as a rule, remarkably distinct, as the more northern birds keep strictly to the virgin forest. Where the forest has been removed, the Canadian species for the most part disappear. These three faunal zones are divided into several well-defined regions which differ more or less in their physical features, and consequently in the character of their bird life; and these are described.

Proceedings of the International Conference on Aërial Navigation, held in Chicago, August 1, 2, and 3, 1893. New York: The American Engineer and Railroad Journal. Pp. 429.

The proposal to hold the conference of which the proceedings are recorded in this book originated with Prof. A. F. Zahm, of Notre Dame University, who communicated with Mr. C. C. Bonney, President of the World's Congress Auxiliary, and interested several other persons in the project. The principal objects of the conference were to bring about the discussion of some of the scientific principles involved in the scheme of aërial navigation; to collate the results of the latest researches; to procure an interchange of ideas; and to promote concert of action among the students of this inchoate subject. The programme involved, first, a discussion of the general principles of the subject, and more special discussions in Sections A and B, under the heads of Aviation and Ballooning. Letters of co-operation were received from experts or students of the subject, and from the British Aëronautical Society, the Aërial Navigation Society of France, the Aviation Society of Munich, the Imperial Aëronautical Society of Russia, and the Aviation Society of Vienna. The sessions were attended by about one hundred persons, who seemed to take great interest in the proceedings, and the discussions brought out several investigators who had been studying the subject or trying interesting experiments without making it publicly known. The opening address was by Mr. O. Chanute, and it is followed in the book by thirty-six other papers, on the work of the wind, propelling devices, sailing flight, soaring flight, the machines of flight and aspiration, forms of flying machines, aëroplanes, kites, balloons, explorations of the upper air, and discussions.

The Ills of the South. By Charles H. Atken, LL. D. New York: G. P. Putnam's Sons. Pp. 277.

Demoralized labor, lost fortunes, a ruinous credit system, and the indirect consequences of Southern lien laws, are the chief subjects dealt with in this volume.

The book is penned in no hostile spirit to any one State or class of people, while to the student of modern history it forms a valuable adjunct to his historic knowledge of the Southern States. In all, the work contains fourteen chapters, each imparting a succinct view of the various needs of the Southern people from 1865 to the present time.

Psychologie des Grands Calculateurs et Joueurs d'Échecs. Par Alfred Binet. (Psychology of Great Calculators and Chess-players. By Alfred Binet.) Paris: Librairie Hachette et Cie. 1894.

The author of this work has made his investigations in these unusual forms of memory with the fundamental desire to discover something that might be utilized in pedagogics. The investigation of the mental processes of mathematical prodigies was made at the suggestion of the late Prof. Charcot. The investigation of chess-players' memories was made at the suggestion of M. Taine.

Mathematical prodigies form a natural class, and their ability is independent of heredity or environment. They manifest their talents precociously, and the familiarity with figures is at the expense of general intelligence. Furthermore, their aptitude is developed by exercise and is decreased by non-usage. It is largely a matter of auditory and visual mnemonics.

In blindfold chess the ability depends upon knowledge, memory, and imagination. The ability to recall so complex a mental image as one or more chessboards containing thirty-two or less pieces, in a variety of positions, constitutes what Binet designates as a visual geometrical memory, associated with which is a memory of recapitulation or faculty of repeating all the moves in the order in which they were played.

The work is an interesting study of curious phases of mentality.

The Pygmies. By A. de Quatrefages. New York: D. Appleton & Co. (The Anthropological Series.) Pp. 255. Price, $1.75.

This work of one of the most eminent anthropologists of the century, translated by Prof. Frederick Starr expressly for the Anthropological Series, relates to a race, or rather a group of races, of men, concerning which speculation and tradition were rife for many centuries, but of which little or nothing was definitely known till very recently. They were mentioned by Homer, they were described by Aristotle, and were referred to as a historical fact by Herodotus. These authors placed them in Africa. Pliny, a more recent writer than they, speaks of them as living in different countries. The African pygmies remained substantially unknown, except from these ancient references, until a few years ago explorers of the heart of Africa brought home accounts given of them by neighboring tribes. Schweinfurth saw them and obtained an individual Akka, and specimens were brought to Europe; since then acquaintance has been direct. Besides these, M. de Quatrefages classified with the pygmies other "small black races" which had attracted his attention and interest in a special manner, and made frequent references to them in his writings. "These little blacks," he says, "are to-day almost everywhere scattered, separated, and often hunted by races larger and stronger; nevertheless, they have had in the past their time of prosperity," and have played a very real ethnological part. The principal purpose of this book is to make known the scientific truth in regard to the ancient fables, and to show what the pygmies of antiquity really were. He finds that the ancients had informatiou "more or less inexact, more or less incomplete, but also more or less true," concerning five populations of little stature from whom they made their pygmies. Two were located in Asia; a third to the south, toward the sources of the Nile;

a fourth to the east, not far from these; and the fifth in Africa, to the southwest. Two of these groups, more or less modified by crossing, are still located in Asia. The African groups are farther away than the traditions represent, but nearly in the same direction. All of them are fragments of two human races well characterized as blacks, occupying considerable areas in Africa and in Asia respectively, and both including tribes, distinct peoples, and subraces. The name of *Negritos* is suggested for the dwarf black populations of Asia, Malaysia, and Melanesia, as distinguished from the larger negroes, or *Papuans*, and *Negrillos* for the dwarf African tribes, taken collectively. These definitions and distinctions having been made clear, the author proceeds to detail the general history of the eastern pygmies, of whom the Mincopies of the Andaman Islands appear a conspicuous type, their physical and special characteristics, and of other negroes than the Mincopies; and next of the Negrillos, or pygmies of Africa; closing with a discussion of the religion of the Hottentots and Bushmen. The conclusion is drawn from the study of the Negritos, which have been regarded as very low in the scale of humanity, and by some as related to the "missing link," that "this is not so; and that where they have lived most outside of movement and mixture—which alone elevate societies—the Negritos show themselves true men in all things and for all things."

Economic Geology of the United States. By Ralph S. Tarr, B. S., F. G. S. A. New York: Macmillan & Co. Pp. 509. Price, $4.

In the presentation of this text-book on economic geology the author has extended his primary plan from the issuance of printed notes to accompany a series of lectures delivered before the Economic Geological Class at Cornell University. Hence, a far wider field is destined for a work which will necessarily take the place of books that treat too exclusively of those branches of the subject having little or least importance for more thorough students.

Throughout the volume the reader's attention is directed to the mineral products of the United States, while only those of special importance from foreign localities are dealt with. Apart from the ample reports of State and national geologic surveys, the author has consulted and employs with effect special articles and data selected from leading scientific journals of the day. Also Ore Deposits, by Phillips, the Reports of the Director of the Mint, Day's Mineral Resources of the United States, the Census Reports, Mineral Industries, etc. Tables and illustrations add to the usefulness of the work.

About Mushrooms. The Study of Esculent and Poisonous Fungi. By Julius A. Palmer, Jr. Boston: Lee & Shepard. Pp. 100. Price, $2.

This is a pleasant little book, that will interest both the amateur and the trained naturalist. The classification, or key to the principal forms of large and fleshy fungi, is original with the author, and promises to facilitate the work of those commencing the study of the subject.

Systematic Survey of the Organic Coloring Matters. By Drs. G. Schultz and P. Julius. Translated and edited by Arthur G. Green, F. I. C., F. C. S. New York: Macmillan & Co. Pp. 205. Price, $5.

A thorough knowledge of the chemistry and technology of coal-tar products has within recent years become a necessity with those engaged in the color industry.

The work before us is a technical one, and appears to be thoroughly well suited to the needs of the analyst, the dyer, patent agent, merchant, or others concerned with coal-tar colors.

The editor and translator has carried out the fundamental idea of the authors, and has given us, in as precise a form as possible, all the essential details, including items of the most recent knowledge. There have also been added full tables for the analysis and identification of the various coloring materials.

The *Report on the Mound Explorations of the Bureau of Ethnology*, an extract from the twelfth annual report of the bureau, by *Cyrus Thomas*, is based almost exclusively upon the results of explorations carried on by the bureau since 1881. A thorough investigation of all the mounds could not be made with the means at the disposal of the bureau; a superficial examination was not to be thought of. The problem was solved by making thorough examinations of single mounds and single groups, selecting such as were most typical, over the whole area; so that, by a careful examination of these typical structures in the various districts, the end, it was thought, might be secured of collecting the data necessary to an understanding of the more general and more important problems relating to the mounds and the mound-builders. The exhaustive examination of many single groups and the study of local problems are left to the future. Accurate and full descriptions and measurements are given of all the mounds and groups examined. The collections made include pottery of most of the known varieties, and some that are new, showing most of the known types of textile impressions and some that are unusual; polished and pecked celts from mounds; stone pipes, which so supplement others that the whole evolution of forms may be traced from the earliest known; copper articles, including two new types, "decidedly the most important yet discovered"; engraved shells; specimens of textile fabrics and mattings; and chipped flint implements, stone axes, discoidal stones, gorgets, etc. (Published at the Government Printing Office, Washington.)

In the preparation of his *Elements of Mechanical Drawing* the author, *Gardner C. Anthony*, has aimed, as in the other numbers of his Technical Drawing Series, to provide a text-book rather than a copy-book, a treatise in which principles should be established and methods suggested, but freedom permitted in their application. It is intended that the student should first thoroughly master the principles, and then, unaided, apply them to the solution of the problems, receiving such instruction as his special case may demand. The system has been successfully applied by the author and others in teaching various classes. The present work concerns geometrical problems, conic sections, projection, the development of surfaces, the intersection of surfaces, screw threads and bolt heads, bolts, and isometric and oblique projection. (Published by D. C. Heath & Co., Boston. Price, $1.50.)

In *The Natural History of Hell*, a discussion of some of the relations of the Christian plan of salvation to modern science, including a chapter on miracles and a scientific examination of the theory of endless punishment, *John Phillipson* undertakes a scientific demonstration of the natural necessity of endless punishment for wrongdoing, inevitable unless arrested by some agency outside of Nature. The argument is based upon the conception of the never-ending endurance and transmission of the picture and the consequences of every action. Under this view there is a necessity for some plan of salvation outside of natural law. Here science stops. (Published by the Industrial Publication Company, New York. Price, 25 cents.)

Expositions of Buddhism have come to us in two works. Of *The Gospel of Buddha*, according to the old records, by *Dr. Paul Carus* (Open Court Publishing Company, Chicago), the bulk of the contents is derived from the old Buddhist canon. Many passages, including the most important ones, are literally copied from translations of the original texts, rendered rather freely in some cases to make them intelligible to the present generation; others have been rearranged; and still others are abbreviated. The few original additions embody ideas for which prototypes may be found somewhere among the traditions of Buddhism, and are given as elucidations of the main principles of the doctrine. For those who want to trace the Buddhism of the book to its foundation a table of references is appended, directing to the sources of the various chapters and pointing out parallelisms with western thought.

A Buddhist Catechism (G. P. Putnam's Sons) is an introduction to the teachings of the Buddha Gotamo, compiled from the holy writings of the southern Buddhists, with explanatory notes for the use of Europeans, by *Subhadra Bhikshu*. It is a concise representation of Buddhism, according to the Ceylonese Pali manuscripts of the Tipitakam, which are regarded as the oldest and most authentic sources. It contains the fundamental outlines of the doctrine, with the omission of the legendary, mystic, and occult accessories with which Buddha's teachings have been adorned or encumbered in the course of centuries.

The third part of the *Elementary Treatise on Theoretical Mechanics* of *Alexander Ziwet* (Macmillan & Co., $2.25) is on kinetics. About half of the volume is devoted to the kinetics of a particle, and the remainder is given to the study of the kinetics of a rigid body and a brief discussion of the fundamental principles of the kinetics of a system. In the discussion of the motion of a particle (impact, rectilinear motion) such fundamental ideas as momentum, impulse, kinetic energy, force, work, potential energy, and power are gradually introduced and illustrated in an elementary way. Then the general equations of motion of a particle are discussed; and the principle of kinetic energy, that of angular momentum, and the principle of d'Alembert are explained and applied—first, to the motion of a free particle, then to constrained motion. In treating of the motion of a rigid body, after the discussion of the fundamental principles and of the theory of moments and ellipsoids of inertia, the action of impulses and the motion under continuous forces are taken up separately. The last chapter, on the motion of a system, is brief, but includes the theory of Lagrange's generalized co-ordinates and of Hamilton's principle.

A suggestive and useful little book prepared by *William C. Connell*, and published by G. P. Putnam's Sons, is *The Currency and the Banking Laws of the Dominion of Canada, considered with Reference to Currency Reform in the United States*. It contains the substance of an address delivered at the American Bankers' Convention held at New Orleans in 1891, in which financial straits that have since occurred were predicted; followed by the Banking Act of Canada, given entire. This act is presented as completely filling all the requirements of the community in which it exists and flourishes, and worthy of consideration in reconstructing our own financial system.

The Dynamics of Life (Blakiston & Son, Philadelphia) presents the substance of an address delivered before the Medical Society of Manchester, England, in October, 1894, by W. R. Gowers, M. D. In it are explained, without the author assuming any claims for novelty in conception, the operations of Latent Chemical Energy, the Dynamics of Muscle, the Dynamics of Nerve, and the Dynamics of Disease. Summing up the results of his inquiry, the author observes that, search as earnestly and thoroughly as we may, that which we call life eludes our search and resists our efforts. "We may, indeed, trace the relations to vitality of matter and of the energy it bears—their entrance into the domain of life, their exit, their effects." But we see them only as shadows in the mist.

In the *Fifth Annual Report of the Missouri Botanical Garden*, for 1893, mention is made of the destructive effects of drought and extreme alternations of winter temperature on the lawns and the evergreens. The Norway spruce has particularly suffered, and it will be only a few years before all the older trees will have disappeared. The old red cedars and the arbor vitæs are also succumbing, and are being gradually removed. A similar experience is recorded at the Harvard Botanic Garden. The year's additions to the herbarium number 19,417 sheets. In addition to the "Shaw Premiums" already awarded annually, a gold medal has been instituted for the introduction of a plant of decided merit for cultivation not previously an article of North American commerce. The Garden and the School of Botany, endowed by Mr. Shaw in Washington University, are working harmoniously together. The volume, including the report, contains the usual anniversary publications and scientific papers on the Venation of Salix, by Dr. N. M. Glatfelter; the Tannoids, by J. C. Beny; the Sugar Maples, by Dr. Trelease; Gayophytum and Boisduvalla, by Dr. Trelease; Pomological Notes for 1892 and 1893, by J. C. Whitten; The Emergence of Pronuba from Yucca Capsules, by J. C. Whitten; Plants collected in Southeastern Missouri, by B. F. Bush; Notes and Observations, by Dr. Trelease; and more than forty plates.

The first of the two volumes of *Lord Rayleigh's* work on *The Theory of Sound*, first issued in 1877, has come to a second edition (Macmillan, $4). The work is a mathematical presentation of the subject, aiming to include the more important of the advances made in modern times by mathematicians and physicists. The present volume includes chapters on the vibrations of systems in general, followed by a more detailed consideration of special systems, such as stretched strings, bars, membranes, and plates. In the second edition are two new chapters, dealing respectively with curved plates or shells and with electrical vibrations. Minor changes and new sections are inserted here and there. The author remarks that the mathematician will complain of deficient rigor in his method of treatment, but he feels that from the point of view of the physicist some slight relaxation is justifiable.

A text-book on *Steam and the Marine Steam Engine* has been prepared by *John Yeo*, R. N., from notes of the lectures given by him as an instructor in steam engineering at the English Royal Naval College (Macmillan, $2.50). The scope of the book includes descriptions of the marine boilers and engines in common use, with their fittings, a statement of the properties of steam, and instruction concerning feed-water, the combustion of fuel, etc. Other matters treated are the construction of double and triple expansion engines and the form of propeller screws. The author's language is notably clear and concise, and the volume is fully illustrated.

Under the title *The Genesis of Water* a speculation as to how the first combination of oxygen and hydrogen took place is presented by *P. W. Dooner*. The pamphlet is printed at Los Angeles.

In the *Report of the State Board of Health* of South Dakota for 1892 we find, besides the usual accounts of the transactions of the board and the conditions of public health, articles for public information on Dangerous Contagious Diseases and Diphtheria, and more general articles on climate and the climatic cure for consumptives. The climate of South Dakota is presented as of special value, from the medical point of view, on account of the peculiar dryness of the atmosphere. "That it is as good as any during the summer is not to be doubted, and that in winter it is far better than the great majority is a fact." Cases of "taking cold" and of pneumonia are much rarer in proportion to the population than in the States farther east; and with the clearness of the atmosphere of the country and its lack of clouds and cloudy weather the sunlight acts as an efficient tonic and destroyer of impurities. The claim is maintained that the climate fulfills to an excellent degree the conditions of one favorable to consumptives.

A new educational journal, devoted to "manu-mental" training, has appeared under the title *Art Education* (J. C. Witter & Co., 853 Broadway, New York; 75 cents a year). It is to be issued bimonthly for the present. Its field is the training of the mind through the use of the hand, and hence comprises drawing, manual training (so called), and writing. In the first number are articles by Francis W. Parker, on Acquiring Forms of Thought Expression; Stella Skinner, on Color Study; Henry T. Bailey, on the Supervisor of Drawing; besides quite a number of biographical notices, with portraits of instructors in drawing, manual training, etc. There is a colored supplement, which it is small praise to say is worth the price of the number. It consists of two lithographic figures printed in several shades of brown, and "illustrates the fact that artistic effect does not depend so much upon an elaborate design as upon correct combination of color." The editors are James C. Witter, Charles P. Zaner, and Rose N. Yawger.

A Stable Money Standard is the title of the address by *Henry Farquhar*, Sectional Vice President, before the Section of Economic Science and Statistics, of the recent Brooklyn meeting of the American Association. The author concludes that while gold has been proved by the experience of the ages to be the best-fitted medium to meet the requirements of such a standard, all interference by Government in defining legal tender is needless and mischievous. Perfect freedom in contracts for methods of payment and for the kind of money should be allowed, the terms of the contract to be interpreted and enforced according to prevalent usage; the Government's part being only to certify to the weight and fineness of its coin.

The Twelfth Annual Report of the Board of Control of the New York Agricultural Experiment Station includes the report of the treasurer, showing the receipts and expenditures on the several accounts, and the reports of the director describing the additions and improvements that have been made to the station and its appurtenances and the work done. Fifteen bulletins were published, containing six hundred and ninety-five pages in all, of each of which fifteen thousand copies were distributed; besides circulars on the Leaf Spot of Chrysanthemums, Preserving Eggs, and the Fertilizer Law of the State. The new experiments undertaken include investigations with a view to determine the relative value of the different breeds of dairy cattle in the production of milk, butter, and cheese, and of the differences in composition and quality of the milk produced; experiments with poultry and in feeding swine; chemical experiments, mostly bearing on the manufacture and qualities of cheese; and experiments with vegetables, various fruits, diseases of fruits and fruit trees, celery diseases, and potato scab.

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POPULAR MISCELLANY.

Doggish Sympathy.—A correspondent of the London Spectator writes that he owned a large dog Rose, and a smaller and less beautiful dog Fan, of different breeds, but both passionately attached to a member of the household who was commonly called their best friend. A shawl of this friend's was especially sacred to Fan, and jealously watched, especially as against Rose; and when the best friend was in bed Fan would lie in her arms, opposing with growls the approach of all intruders. One day Rose in jumping over a gate spiked herself badly and was committed to surgical treatment for ten days. "On her return she was cordially welcomed by Fan and myself; but when she rushed upstairs to the room of her best friend (then confined to her bed), my mind foreboded mischief. We followed, and I opened the door. With one bound Rose rushed into her best friend's arms, taking Fan's very own place, and was lost in a rapture of licking and being caressed. Fan flew after her, but, to my amazement, instead of the fury I expected, it was to join in heart and tongue with the licking and caressing. She licked Rose as if she had been a long-lost puppy instead of an intruder; and then, of her own accord, turned away, leaving Rose in possession, and took up a distant place on the foot of the bed, appealing to me with almost a human expression of mingled feelings—the heroic self-abnegation of newborn sympathy struggling with natural jealousy. The better feelings triumphed (not, of course, unsupported by human recognition and applause) till both dogs fell asleep in their strangely reversed positions. After this, there was a slight temporary failure in Fan's perhaps overstrained self-conquest; but on the next day but one she actually, for the first (and last) time in her life, made Rose welcome to a place beside her on the sacred shawl, where again they slept side by side like sisters. This, however, was the last gleam of the special sympathy called forth by Rose's troubles. From that day Fan decidedly and finally resumed her jealous occupation and guardianship of all sacred places and things, and maintained it energetically to her life's end."

Protoplasm for Hot Stars.—A new subject for speculation has been suggested by Sir Robert Ball's observation that life on the heavenly bodies materially hotter or colder than the earth, or differing in other important respects, is exceedingly improbable if not impossible for beings of the forms and composition which we associate with life. But is protoplasm composed of carbon, hydrogen, oxygen, nitrogen, and a little sulphur the only physical basis on which life can exist? May there not be protoplasms of other compositions adapted to hot stars or to cold stars, upon which life as vigorous as that upon the earth may exist on such bodies? Prof. Emerson remarked two or three years ago that silicon, when the earth was in an intensely hot stage, played much the same part that carbon does now; and that under the conditions then prevailing the silicon compounds, now immobile, may have been active.

In those days, when the temperatures were above the point of decomposition of many of the carbon-nitrogen compounds, a silicon-aluminum series may have presented cycles of complicated syntheses, decompositions, and oxidations essentially parallel to those that underlie our own vital phenomena. The case is at least fascinatingly plausible. If we are to admit the possibility that the chemical accompaniments of life were rehearsed long ago and at far higher temperatures by elements now inert, it is not such a very long step from this, an English essayist suggests, to the supposition that vital, subconscious, and conscious developments may have accompanied such a rehearsal. One is startled toward fantastic imaginings by such a suggestion: Why not silicon-aluminum men at once—wandering through an atmosphere of gaseous sulphur, let us say, by the shores of a sea of liquid iron some thousand degrees or so above the temperature of a blast furnace? But that, of course, is merely a dream. Who will discover a silicon-aluminum fossil?

A Study of Maya Hieroglyphics.—American students have not made as much progress in Central American archæology as those of Europe; and it is only recently that the Peabody Museum of Harvard University has undertaken to carry on extensive and exhaustive researches in what Mr. Marshall H. Saville styles the most prolific source of hieroglyphic inscriptions of which we have knowledge. The ancient inhabitants of Copan, Honduras, Mr. Saville says, in his his paper read before the American Association, appear to have been more literary in character than even those of Palenque. There have been found there twenty-four stelæ, all of which have inscriptions, besides altars, slabs, and hieroglyphic steps in large numbers. Pottery vessels and potsherds have been found bearing glyphs, either painted or engraved. These potsherds have been found in such quantities as to show that thousands of their vessels had hieroglyphic inscriptions. The inscriptions are intimately connected with the symbolism almost invariably found with them, and an understanding of the symbolic marks and ornaments will largely aid in deciphering the glyphs. One glyph is found so often repeated on the potsherds as to become significant, and this is the special subject of the author's present study. It is at the head of most of the graven inscriptions of Copan, Palenque, Quirigua, Jikul, and Menche, and of the three tablets of Palenque, and is named by the author the Pax glyph. The heading indicated by this glyph is found on analysis to represent the month Pax, surmounted either by a serpent's head, a mask, or a human face, associated with a vegetal form, or rarely a fish, above the whole of which is a scroll. Having in view the ideas and the nature of the festivals associated with this month, the author concludes that the inscriptions beginning with this heading relate to ceremonies taking place at that time to the god Kukulcan. The occurrence of the Pax glyph in the text, with the hand sowing seed, and again with a flower with seeds, also bears out this conclusion, and it may be inferred that the inscriptions, so far as these single glyphs are concerned, relate to the ceremonies of planting.

Chinese Ideas of War.—M. Léon de Remy has made a curious communication respecting the ideas of the Chinese concerning war. Although it has often been necessary for the Chinese to engage in war, the military art has never been in good repute among them. In their view, every war is a misfortune, if not a sin. They avoid talking to their children of laurels, crowns, and triumphs won in war, but teach in their schools that the most glorious battles are at bottom simply homicides, abominable disasters to both parties. An emperor who decides to sacrifice numerous existences on a field of slaughter is reputed an unwise and unjust prince. A general who has won a battle ought to wear mourning for the quantity of blood his success has cost. These doctrines are not gross or immoral, but in the existing conditions of society generous thoughts are not without some inconveniences; and it is easy to understand how, with such ideas concerning war, the Middle Kingdom has been conquered sometimes by peoples of no great importance and not very well armed. Nevertheless, it is a curious ethnographical fact that whenever the Chinese people have been conquered they have absorbed their conquerors to their almost entire disappearance.

The successors of the Manchu conquerors are now reigning in China, and it can hardly be said that any Manchus exist in Asia. Those who serve are treated at the court like slaves, while the powers are very careful not to show any lack of respect to the Chinese. The Manchu language, in spite of efforts to give it some literary and political importance, has been thrown into the background, and is hardly more than one of the rude jargons of central Asia.

The Baskets of Lichtenfels.—One of the largest basket markets in the world is situated in the little town of Lichtenfels, in the mountains of upper Franconia, Bavaria. The industry was introduced there toward the close of the last century by a citizen who, desiring to take advantage of the fine growth of willow trees in the neighboring valley of the chain, began weaving baskets on a small scale corresponding with his means. The business gradually developed in extent and in variety and artistic character of the designs; the products were sent to the larger markets, and even France was almost exclusively supplied from Lichtenfels till the war of 1870, and is still supplied thence to a considerable extent. The gradually increasing demands soon made it necessary to procure foreign raw material. The finer varieties of willow reeds had to be imported from Hungary and France and from countries beyond the sea. Straw for the finer woven articles was ordered from Spain and Italy, and the palm leaves used for ornamenting the better class of wares from the tropics. In this manner the evolution of the house industry, as it is called, of Lichtenfels proceeded, and has resulted in the employment at this time of about sixteen thousand men, women, and children, who produce every variety of basket from the simplest to the most elegant. Factories, as usually spoken of, are few. The manufacturer delivers the raw material to the people who are to make the baskets at their own home—that is, he weighs out for them the willow reeds, colored straw, palm leaves, etc., and gives them the designs according to which they are to be made, and at a stated time the workers—who mostly live in neighboring villages—bring their work to the manufacturer and receive their pay. The industry is encouraged through the schools of design that have been established and are supported by the state, in which the young people of the neighborhood are educated in all branches of it.

Fjords, Fjörds, and Fohrden.—Fjords according to a memoir by Herr P. Dinse, of Berlin, are long, narrow bays or sea inlets, penetrating an elevated or mountainous coast; their sides slope steeply both above and below water, giving a troughlike cross-section, while the longitudinal section shows an irregular relief of gentle ridges and shallow troughs. In all true fjords the depth inside is greater than that of the stretch of sea immediately beyond the mouth. There are several varieties of this type. Thus, two fjords entering the coast at an angle may meet, forming a sound separating an island. Again, the bar of the mouth may be slightly elevated so as to become dry land, and a fjord lake or loch results. Minor subdivisions include the fjärd and schären types by the Gulf of Bothnia, differing only in the relative frequency of islands and continuous coast and the föhrden type of the low coasts of Denmark. These are entirely different from the inlets of the *ria* type, which occur on the coasts of Spain, northwestern Ireland, and elsewhere. A *ria* is a more or less wedge-shaped inlet, gradually widening and uniformly deepening from its head to the sea, showing no trace of an included basin. It is noted, however, that prolonged sedimentation might ultimately convert a fjord into a *ria*. The distribution of fjords as distinguished from *rias* is subject to the general statement that there are no fjords except on the coasts of lands which show signs of recent glacial action. The coasts where they occur are those of Scandinavia, the west of Scotland, northwest of Ireland, Iceland, Greenland, Labrador, and the coast of Maine, the west coast of North America from Alaska to Vancouver Island, the west coast of South America from Chiloe to Cape Horn, Kerguelen, the antarctic lands, and the southern part of the west coast of the South Island in New Zealand.

Cave Exploration.—Spelæology is the name given by M. E. A. Martel to the study of caves—a study which he regards as of much greater significance than has hitherto been attached to it. He believes that it may be made to throw light on all the branches of science that deal with the structure of the earth—on geography, geology, paleontology, mineralogy, zoölogy, anthropology, the physics of the globe, agriculture, public works, and hygiene. In his explorations of caves M. Martel has devoted much attention to those openings which form a peculiar feature in the limestone regions of France and eastern Europe, called *gouffres* or pits, which have been regarded hitherto chiefly as curiosities or feeders of superstitious fears, but are almost virgin to scientific exploration. During six years, from 1888 to 1893, he explored two hundred and thirty of these *gouffres* and other cavities, one hundred and sixty-five of which had never been examined before, and made a large number of plans. In this work he had special regard to the hydrology, the origin, location, etc., of subterranean waters, with a view to utilize the lessons of his observations in agriculture, but did not neglect to examine carefully all the other bearings, not letting the most minute features pass unobserved. The results of his investigations have been published in a book, *Les Abîmes*.

Forests and Climate.—Considering the Relation of Forests to Climate and Health, Cleveland Abbe finds that while the forest does not cause increase of rainfall, its tendency is to conserve it. The forest shields the moisture from evaporation and uses less of it for its own growth than would be used for the growth of grasses or herbs, and it also conserves what is left in the soil so as to diminish, or at least regulate, the drainage into the river basins, thereby reducing the danger of destructive floods. The influence of forests extends outside of their boundaries under varying conditions. The effect of forest-covered mountains is to diminish the cold night winds and the hot day breezes in the valleys below, and to favor the formation of local cloud and rain in them. As the air that flows down the mountain side during the night from a forest has a higher dew point and a lower temperature than that which flows down from an unforested surface, therefore a less amount of cooling will cause it to form fog; hence the crops in the valley are more likely to be sheltered by the fog from dangerous frosts. The most interesting influence of the forest on the leeward side is that which it exerts by virtue of its action as a wind-break. A diminished wind means that the sluggish moving air shall be warmed up in the daytime by contact with the ground much more than would be the swift-moving air when the wind-break is absent. This reacts upon the ground, so that as a consequence both soil and air are warmer. The evaporation from the surface of the soil is also greatly diminished, in consequence of which the soil retains more moisture, and is warmer than it would be under the influence of a strong wind. At the same time, the air above the soil acquires a higher percentage of relative humidity. Thus the plant has more water at its disposal stored in the earth, while the leaves, apparently, are in less need of water, and transpire less.

Biological Laboratory at Cold Spring.—The Biological Laboratory of the Brooklyn Institute at Cold Spring Harbor, L. I., aims first at instruction. Each year a course has been given there in elementary systematic zoölogy, adapted both to teachers whose knowledge of elementary zoölogy is not great, and to students of higher institutes who seek a practical study of marine forms. A botanical department was organized in 1893. More advanced courses have been established, and lessons were given last summer on comparative embryology. A course in bacteriology is given by the director. Original investigation is provided for in private rooms for research, and most of the Board of Instruction and others who have been present from time to time have been engaged in personal work in that line. In addition to the regular work of the school, evening semi-popular lectures are given to the students and to attendants from the neighborhood. During the last year a department was started for supplying specimens of the common types of marine life to colleges and schools.

Lord Rayleigh on Waves.—In a lecture at the Royal Institution, on waves of water, Lord Rayleigh said that in such waves the velocity is not independent of the wave length (or distance from crest to crest) as it is in the case of sound waves, but the long waves travel more speedily than the short ones. Waves at sea are mostly generated by wind, though other causes, such as earthquakes, occasionally operate. By blowing the surface of a long trough with a fan, the lecturer showed that the waves produced close to the source of the wind are shorter than those set up farther away. Oil has no effect upon big rollers, but the broken water on which it acts is just what is dangerous to boats in a tempest. A storm in mid-ocean generates waves of all lengths, but a kind of regularity is reached at a distance, where the long waves arrive first. The height of waves at sea has often been exaggerated, owing to the difficulty of measuring them, but the highest authentic observation is about forty feet. Stationary waves, as opposed to the progressive waves of which the lecturer had been speaking, were described as the results of the meeting of two equal sets of progressive waves. In illustration of the effects of waves upon ships, Lord Rayleigh showed a small model boat so weighted as to have the same rolling period as the waves in the tank in which it floated. Its rolling was exceedingly violent, but became comparatively slight when the heights were altered so as to change the rolling period. Warships, in which stability is very essential, are designed so as to have a longer period of roll than any waves they are likely to encounter.

Plymouth School of Applied Ethics.—The School of Applied Ethics at Plymouth, Mass., has had three profitable sessions—in 1891, 1892, and 1894; the session of 1893 having been omitted on account of the congresses at Chicago. At the first session, 1891, H. C. Adams, dean, the faculty numbered twenty-nine, and one hundred and sixteen lectures were given in the three departments of Economics, Ethics, and History of Religions. At the second session, Prof. C. H. Toy, dean, there were twenty-two lecturers and ninety-six lectures, in the three departments as before. At this session the Wednesdays were set apart for conferences and other special meetings—an experiment which was regarded favorably, but was not repeated during the next year. At the third session, 1894, Prof. Felix Adler, dean, there were thirty lecturers and one hundred and one lectures. The general subject in each of the three departments was the labor question, which was treated from various points of view, some of the lecturers being among the foremost political economists of our leading colleges and universities. The fourth session will begin in the second week in July, 1895, and will continue five weeks. An "Auxiliary Society of the School of Applied Ethics" has been formed, for the purpose, among others, of making the school and its work more widely known. Membership is open to all, for five dollars a year, and applications for it may be sent to the Rev. Paul R. Frothingham, New Bedford, Mass.

Indian Bows, Arrows, and Quivers.—In an interesting study of North American Bows, Arrows, and Quivers, published in the Smithsonian Report for 1893, Prof. Otis T. Mason shows how, in respect to either and all these appurtenances of the savage warrior and hunter, the form and material of the instrument and the manner of making it vary with and are dependent upon the kind of material which the local manufacturer had at his disposal. The bow is of hard wood, and simple, but of various forms according to fancy, in those regions where strong, elastic woods are abundant; compound, built up of buffalo or other horns in several pieces skillfully joined, where wood is scarce and the other material plenty; sinew-lined—finely shredded sinew mixed with glue being laid upon it so as to resemble bark—in the regions of the Sierras and as far north as the headwaters of the Mackenzie; sinew-corded, or having a long string or braid of sinew passing to and fro along the back, of which several types are found in the arctic and subarctic regions. The material of bows varies geographically, and the list shows that in some regions some of the apparently most unpromising woods are used in their construction. The strings are of rawhide, the best vegetable fibers of the country, the intestines of animals cut into strings and twisted, or, most frequently, of sinew. The study is continued, with even more minutenes corresponding with the varieties of detail involved—concerning the head, the shaft, nocking, notching, and feathering—with the arrow. The quiver is difficult of study, because collectors have paid little attention to it. Among all the Plains tribes the quivers are objects of beauty. The quiver is largely of the region. The material out of which each example is made must be furnished by Nature: hence it is of sealskin in one place, of cedar wood in another, of soft pelt in another, and in the south land is frequently made of some kind of soft basketry. "Among several of the mountain tribes the squaw lavished all her skill upon her husband's quiver. The costliest beaver, marten, otter, and mountain-lion pelt was invoked. It was lined with soft buckskin, or in after times with red strouding. Beads of every imaginable color were worked upon the border of the arrow case and upon the lining of the long pendant therefrom. Strips of fur, daintily cut in fringes, were sewed about the bottom of the bow case, and every spot capable of rich decoration received it. Between this and the plain salmon-skin capsules into which the Eskimo thrust his arrows there are many gradations of quivers."

Prof. Sergi's Human Classifications.—In studying the varieties of the human species, Prof. Giuseppe Sergi, as he is quoted in a paper by Dr. D. G. Brinton, finds that hybridism is a syncretism or propinquity of characteristics belonging to many varieties; that these do not modify the skeletal forms as do individual variations; and that hybridism may affect different parts of the skeleton, constituting characteristics in themselves distinct. The stature, the thoracic form, the proportion of the long bones may be united with external characteristics differing from each other, as well as from different cranial structures. The cranial form may be associated with different facial forms, and inversely. It happens, however, that the structures taken separately remain in part unvaried in the hybrid constitution. The face preserves its own characteristics in spite of the union of different cranial forms; so also the cranium preserves its structures, associating them with different facial forms. The stature preserves its own proportions in spite of its association with different cranial and facial types, and in spite of the different coloration of the skin and form and color of the hair. All this may be affirmed, particularly of much larger human groups which, according to external characteristics, may be considered much nearer than they really are in geographical position, as the so-called white races in Europe, the negroes in Africa, in Melanesia, and so on. Seeking a criterion of classification, the author finds that external characteristics can not be relied upon. Regarding the internal or skeletal characteristics as presenting greater stability, he chooses the cranium, as at the same time the most important and most useful. He thus impliedly accepts the brain in its various forms. He finds sixteen varieties of the human species, without considering that he has exhausted the number, and fifty-one subvarieties.

A Monkey's Caprices.—The last of the famous group of pets which Frank Buckland collected at his house died January 17th. It was the monkey, Tiny the second, of the species *Cercopithecus mona*. She was a beautiful and graceful creature, covered with a thick coat of handsomely shaded hair, and had been under Mrs. Buckland's care seventeen years and a half. She had the lifelong reputation of being exceedingly mischievous, and was an accomplished thief. She led a gray parrot, which had been an inhabitant of the house for twenty-five years, a terrible life; and when she was let out of her cage she played havoc with her master's papers and manuscripts. She would dash about the room, make a clean sweep of the table, and fill her pouches with anything that appeared especially nice. Her two later companions were a gray parrot and a thoroughbred dachshund, Olga. Every morning Tiny and the dog had a game of romps that invariably ended in the discomfiture of Olga. The dog would run round the monkey's cage, barking loudly; Tiny, inside the wires, would run round also, and when opportunity occurred would seize the dog's ears and keep pulling at them till Olga released herself. Notwithstanding these little disagreements, the dachshund appeared to miss Tiny, and went about the house as if seeking her. The parrot, too, seemed to regret the loss of the monkey, and efforts were made to cheer her drooping spirits, if possible.

Qualities of the Acetylene Light.—The method of producing acetylene, one of the most brilliant constituents of illuminating gas, by the simple action of water on calcium carbide has been mentioned in the Monthly. Great possibilities from the use of this method are foreshadowed by Prof. Vivian B. Lewes. The property possessed by calcic carbide of forming acetylene with water was accidentally discovered while working with the electric furnace to form an alloy of calcium. A mixture containing lime and powdered anthracite was fused down to a semimetallic mass, which, proving not to be desired, was thrown into a bucket containing water, when a rapid effervescence took place, and the escaping gas burned, on the application of a light, with a smoky but luminous flame. This source of light can be produced by the exposure to the electric furnace of finely ground chalk or lime mixed with powdered carbon in any form. When the calcic carbide is placed in a glass flask and water is allowed slowly to drip upon it from a dropping tube, the decomposition begins at once with considerable rapidity, and the acetylene pours off in a continuous stream; as the decomposition continues, the solid mass in the flask swells up and is eventually converted into a mass of slacked lime. The value of this useful product may be deducted in computing the cost of the acetylene. For commercial purposes the carbide may be cast direct from the electric furnace into rods or cylindrical cartridges, which, when twelve inches long and an inch and a quarter in diameter, will weigh one pound and will give five cubic feet of gas. Acetylene is a clear, colorless gas, with an intensely penetrating odor which somewhat resembles garlic. The strong smell is a great safeguard in its use, and, when the quantity of the gas is dangerous, can not be endured. Hence, while poisonous like carbon monoxide, its use, on account of its odor, is much more safe. When burned it emits a light greater than that given by any known gas, its illuminating power, calculated to a consumption of five cubic feet an hour, being two hundred and forty candles. It being liquefiable with comparative ease, enormous volumes of it may be compressed in small wrought-iron or steel cylinders, in which it may be stored and from them burned as wanted. It should not be used with silver or copper, as it forms explosive compounds with their ammoniacal solutions. Advantage may be taken of the calcic carbide method of forming acetylene by putting sticks of the carbide coated with a slowly soluble glaze into cylinders containing water and attached to portable lamps. As the glaze dissolves from the surface of the stick of carbide, acetylene is generated, and the five cubic feet furnished by the stick are compressed by their own pressure, so as to supply through a suitable burner a light of more than twenty candles for about ten hours. The most immediate use contemplated by Prof. Lewes for acetylene is for enriching ordinary illuminating gas.

Cycling and the Heart.—Dr. B. W. Richardson represents cycling as differing from other exercises in that it tells primarily and most distinctly upon the heart. It produces at once a quickened circulation, though the riders may not be conscious of it; and this accounts for the astonishing journeys a cyclist can undertake, and his endurance as against sleep. Although the heart increases in action and sometimes undergoes enlargement, the author has never seen a rider embarrassed by overstrain of it, faintness, breathlessness, angina, or vertigo, so as to oblige him to dismount. Indeed, he had known a practiced rider who could climb a hill on his machine, but could not mount a flight of stairs on his feet without breathlessness and a slight palpitation; he had never seen a sudden death from cycling. He had met with instances in which, after several years of cycling, there was evidence of heart disease, with general languor and inability to sustain fatigue if exercise were again tried on the machine; and, on the other hand, he had known examples in which even an octogenarian had kept up the exercise in a moderate degree apparently with benefit to the circulation. He had seen in some cases apparent benefit arising from cycling even where there was an indication of some disease affecting the circulation, and had known good to arise from it in cases of varicose veins and of fatty degeneration, and in conditions of anæmia. In other cases excessive cycling had been a definite cause of injury to the circulation. The author believes that cycling in moderation may be permitted and even recommended to persons with healthy hearts; that it is not necessary to exclude it in all cases of heart disease, while it may be even useful where the action of the heart is feeble and signs of fatty degeneration are found; that, as the action of cycling tells directly upon the motion of the heart, the effect it produces on that organ is phenomenally and unexpectedly great compared with the work it gets out of it; that the ultimate action of severe cycling is to increase the size of the heart, to render it irritable and hypersensitive to motion; that the overdevelopment of the heart affects in turn the arterial resilience, modifies the natural blood pressure, and favors degenerative structural changes in the organs of the body generally; that in persons of timid and nervous natures the fear incidental to cycling is often creative of disturbance and palpitation of the heart, and should be taken account of; that, in giving advice, it is often more important to consider the peripheral conditions of the circulation than the central; that venous enlargement is often rather benefited than injured by cycling; and that straining to climb hills and meet head winds, excessive fatigue, and alcoholic stimulants should be avoided, and the proper number of meals of light, suitably selected food should not be neglected.

NOTES.

The leaves of pine and fir trees are inflammable—in strong contrast with the leaves of deciduous trees, which can not be made to burn at all while green—because of the pitch they contain, which consists of fats and ethereal oils, and compared with which the proportion of water is small. When the leaves burn, the water is at once converted into steam, and causes the explosions, snapping, and spitting of fire for which burning coniferous trees are remarkable. Dry fir leaves, although they burn very rapidly, do not exhibit these explosions, because there is no water in them. The rending of tree trunks struck by lightning is in like manner supposed to be caused by the steam evolved from the sap suddenly heated by the electric force.

M. Saccado, a botanist of some fame, computes the number of known species of plants to be 175,700, including 105,251 phanerogams, 2,819 ferns, 565 other vascular cryptogams, 4,609 mosses, 3,041 liverworts, 5,600 lichens, 39,603 fungi, and 12,178 algæ; and he guesses that the whole number of fungi is perhaps as much as 250,000, and that of other plants 135,000. It is proper to observe that the author is a specialist in fungi, and is therefore perhaps predisposed to make a liberal estimate of their number.

The International Meteorological Committee, at its recent meeting in Upsala, Sweden, decided upon the publication of a cloud atlas, to be in English, French, and German.

The educational conference of a week, held last summer at the Summer School of Applied Ethics, Plymouth, Mass., was so successful that it has been decided to transform it into a department of the school. The special direction of the department has been assigned to a committee of three experienced teachers, and the sessions will begin near the end of July and close about August 12th. This new department does not enter into competition directly with existing summer schools, for the aim is neither to give instruction in the school subjects nor in the theory, history, and art of education, but to consider education as a social force and its relation to other social forces.

The Deseret professorship of geology in the University of Utah has been endowed, as we learn in a note from Dr. James E. Talmage, the incumbent of it, with sixty thousand dollars by the liberality of the Salt Lake Literary and Scientific Association—not by the city, as was stated in a recent note in the Monthly. The Literary and Scientific Association is a body incorporated for scientific pursuits which has existed for several years in Salt Lake City.

Recent dispatches from Europe state that argon, the newly discovered element in the air, has been found by Prof. Ramsay in combination in a mineral containing the extremely rare elements yttrium and erbium; associated with it was another gas which under Prof. Crookes's spectroscope gave a spectrum identical with that of the hypothetical element helium, which has been found in the spectrum of the sun and of the aurora borealis, but, till this time, nowhere else. M. Berthelot has, by means of the electric spark, effected a combination of argon with benzene.

A new weed has become common and abundant through a large part of the central Southwestern States. It is described by J. C. Arthur, of Purdue University Agricultural Experiment Station, under the name of *Lactuca scariola*—wild or prickly lettuce—as an annual, related to the garden lettuce, but bearing prickles on parts of the leaf and stem, and blossoming in July and August. It has all the qualities needed to insure its survival—producing many seeds, feathered for wind-carriage and ready to grow, sprouting abundantly when cut, and tenacious in its root hold. It is of curious botanical interest as having, like the *silphium* or compass plant, the property of twisting its stem leaves into a vertical position, with the edge directed north and south. It is one of two well-marked compass plants. It is not likely to be exterminated, and can at most be kept down by timely mowing and uprooting.

The result of an inquiry by Dr. J. S. Cameron, of Huddersfield, England, into the conditions of the dwelling as affecting recovery from measles, points to the conclusion that fresh air provided by a through draught tends to produce recovery when measles has attacked the family; while overcrowding, dirt, and structural or other insanitary conditions assist in bringing about a fatal result.

OBITUARY NOTES.

Dr. W. S. W. Ruschenberger, President of the Philadelphia Academy of Natural Sciences from 1869 to 1891, and medical director, United States Navy, retired, died in Philadelphia, March 24th, aged eighty-eight years. He served in the navy from 1826 to 1869, and was successively fleet surgeon of the East India squadron, 1835–'37 and 1847–'50; the Pacific squadron, 1854–'57; and the Mediterranean squadron, 1860–'61. During the civil war he was surgeon at the Naval Hospital, Brooklyn, and there organized the laboratory for supplying the service with unadulterated drugs. He was President of the College of Physicians and Surgeons in Philadelphia, 1879–'83. His literary and scientific publications include Three Years in the Pacific (1834); A Voyage Around the World (1835–'37); Elements of Natural History (1850); A Lexicon of Terms used in Natural History (1850); A Notice of the Origin, Progress, and Present Condition of the Academy of Natural Sciences of Philadelphia (1852); Notes and Commentaries during Voyages to Brazil and China, 1848 (1854). He also contributed many papers to scientific journals; published articles on Naval Rank and Organization, and edited the American edition of Mrs. Somerville's Physical Geography.

Sir Henry Rawlinson, of much fame as a British general and statesman and of greater fame as the first decipherer of the cuneiform inscriptions, died in London, March 5th. He was born in 1810; went to Bombay as a military cadet of the East India Company in 1827; studied Oriental languages, and served as an interpreter. In 1833 he was transferred to Persia, whence he was recalled to India on the breaking out of the Afghan difficulty in 1838–'39, and there won distinction in military service. He began copying the cuneiform inscriptions on the rock tablets at Behistun as far back as 1835. Mastering the old Persian character in these inscriptions, he found the key, by the aid of which the deciphering of the other cuneiform languages was achieved. The years 1844 and 1845 were specially devoted to this task, and in 1846 Rawlinson's first work on the cuneiform inscriptions was published. The next year he obtained complete copies of all the Behistun inscriptions, standing, to do the work, on a ladder placed on a shelf of rock jutting from the precipice three hundred feet above the plain. Since then he has been one of the foremost in furthering the work of decipherment he had so well begun.

M. Jules Regnauld, Professor of the Paris Faculty of Medicine, has recently died, ninety years old.

Dr. F. Schmitz, Professor of Botany at Greifswald, who died January 28th, was best known by his studies of algæ, and particularly of the red seaweeds, of which he added much to our knowledge of the life history. He published an account of the formation of auxospores in the diatoms in 1877, and a description of the green algæ of the Gulf of Athens in 1877.

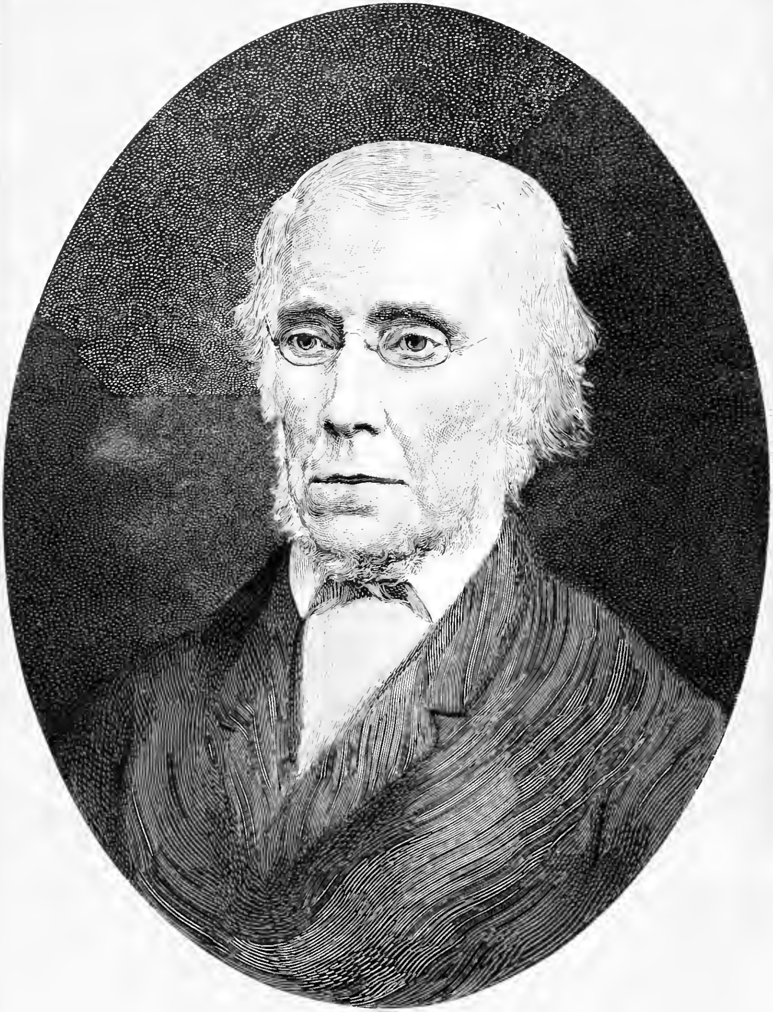
The Rev. J. Owen Dorsey, the ethnologist, who died in Washington February 5th, had been connected with the United States Bureau of Ethnology since 1877, and was President of the Anthropological Section of the American Association in 1893.

The death is reported of Dr. Gerhard Krüss, Extraordinary Professor of Chemistry in the University of Munich. He was perhaps best known in connection with researches concerning the metals of the rare earths.

Dr. D. Hack Tuke, editor of the Journal of Mental Science and President of the Medico-Psychological Association of Great Britain, died in London, March 5th, in the sixty-eighth year of his age. He was author of several standard works on mental diseases, including such subjects as Sleep-walking and Hypnotism, Insanity, Psychological Medicine, the Influence of the Mind on the Body, etc., and of several valuable essays for a Dictionary of Psychological Medicine.

George Newbold Lawrence, one of the oldest and most eminent American ornithologists, died in this city, January 17th, aged ninety-five years. He was the contemporary of all American ornithologists, from Audubon and Nuttall down. The list of his published writings contains one hundred and twenty-one titles. The earliest appeared in 1844 and the latest in 1891. He was associated with Baird and Cassin in the authorship of Baird's work on the birds of North America, which was published in 1858. His special field was in tropical American birds, of which he described more than three hundred new species. One genus and twenty species were named in his honor.

The Rev. T. P. Kirkman, a mathematician of considerable reputation, died February, 1895, eighty-eight years old.



TIMOTHY ABBOTT CONRAD.

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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XX.—FROM THE DIVINE ORACLES TO THE HIGHER CRITICISM.

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I. THE OLDER INTERPRETATION.

THE great sacred books of the world are the most precious of human possessions. They embody the deepest searchings into the most vital problems of humanity in all its stages, the naïve guesses of the world's childhood, the opening conceptions of its youth, the more fully rounded beliefs of its maturity.

These books, no matter how unhistorical in parts and at times, are profoundly true. They mirror the evolution of man's loftiest aspirations, hopes, loves, consolations, and enthusiasms; his hates and fears; his views of his origin and destiny; his theories of his rights and duties; and these not merely in their lights but in their shadows. Therefore it is that they contain the germs of truths most necessary in the evolution of humanity, and give to these germs the environment and sustenance which best insure their growth and strength.

With wide differences in origin and character, all this sacred literature has been developed and has exercised its influence in obedience to certain general laws. First of these in time, if not in importance, is that which governs its origin: in all civilizations we find that the Divine Spirit working in the mind of man shapes his sacred books first of all out of the chaos of myth and legend, and of these books, when life is thus breathed into them, the fittest survive.

So broad and dense is this atmosphere of myth and legend enveloping them that it lingers about them after they have been brought forth full-orbed; and, sometimes, from it are even produced secondary mythical and legendary concretions, satellites about these greater orbs of early thought. Of these secondary growths one may be mentioned as showing how rich in myth-making material was the atmosphere which enveloped our own earlier sacred literature.

In the third century before Christ there had been elaborated among the Jewish scholars of Alexandria, then the great center of human thought, a Greek translation of the main books constituting the Old Testament. Nothing could be more natural at that place and time than such a translation; yet the growth of explanatory myth and legend around it was none the less luxuriant. There was indeed a twofold growth. Among the Jews favorable to the new version a legend rose which justified it. This legend in its first stage was to the effect that Ptolemy, then on the Egyptian throne, had, at the request of his chief librarian, sent to Jerusalem for translators; that the high priest Eleazar had sent to the king a most precious copy of the Scriptures from the temple, and six most venerable, devout, and learned scholars from each of the twelve tribes of Israel; that the number of translators thus corresponded with the mysterious seventy-two appellations of God; and that the combined efforts of these seventy-two men produced a marvelously perfect translation.

But, in that atmosphere of myth and marvel, the legend continued to grow, and soon we have it blooming forth yet more gorgeously in the statement that King Ptolemy ordered each of the seventy-two to make by himself a full translation of the entire Old Testament, and shut up each translator in a separate cell on the island of Pharos, secluding him there until the work was done; that the work of each was completed in exactly seventy-two days; and that when, at the end of the seventy-two days, the seventy-two translations were compared, each was found exactly like all the others. This showed clearly Jehovah's *approval.*

But out of all this myth and legend there was also evolved an account of a very different sort. The Jews who remained faithful to the traditions of their race regarded this Greek version as a profanation, and therefore there grew up the legend that on the completion of the work there was darkness over the whole earth during three days. This showed clearly Jehovah's *disapproval.*

These well-known legends, which arose within what—as compared with any previous time—was an exceedingly enlightened period, and which were steadfastly believed by a vast multitude of Jews and Christians for ages, are but single examples among scores which show how inevitably such traditions regarding sacred books are developed in the earlier stages of civilization, when men explain everything by miracle and nothing by law.*

As the second of these laws governing the evolution of sacred literature may be mentioned that which we have constantly seen so effective in the growth of theological ideas—that to which Comte gave the name of the Law of Wills and Causes. In accordance with this, man attributes to the Supreme Being a physical, intellectual, and moral structure like his own; hence it is that the votary of each of the great world religions ascribes to its sacred books what he considers absolute perfection; he imagines them to be what he himself would give the world were he himself infinitely good, wise, and powerful.

A very simple analogy might indeed show him that even a literature emanating from an all-wise, beneficent, and powerful author might not seem perfect when judged by a human standard; for he has only to look about him in the world to find that the work which he attributes to an all-wise, all-beneficent, and all-powerful Creator is by no means free from evil and wrong.

But this analogy long escapes him, and the exponent of each great religion proves, to his own satisfaction and the edification of his fellows, that their own sacred literature is absolutely accurate in statement, infinitely profound in meaning, and miraculously perfect in form. From these premises also he arrives at the conclusion that his own sacred literature is unique; that no other sacred book can have emanated from a divine source; and that all others claiming to be sacred are impostures.

Still another law governing the evolution of sacred literature in every great world religion is that when the books which compose it are once selected and grouped they come to be regarded as a final creation from which nothing can be taken away, and of which even error in form, if sanctioned by tradition, may not be changed.

The working of this law has recently been seen on a large scale.

A few years since a body of chosen scholars, universally acknowledged to be the most fit for the work, at the call of English-speaking Christendom undertook to revise the authorized English version of the Bible.

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* For the legend regarding the Septuagint, especially as developed by the letters of Pseudo-Aristeas, and for quaint citations from the fathers regarding it, see The History of the Seventy-two Interpretators, from the Greek of Aristeas, translated by Mr. Lewis, London, 1715; also, Clement of Alexandria, in the Ante-Nicene Christian Library, Edinburgh, 1867, p. 448. For interesting summaries showing the growth of the story, see Drummond, Philo-Judæus and the Growth of the Alexandrian Philosophy, London, 1888, vol. i, pp. 231 *et seq.*; also, Rénan, Histoire du Peuple Israel, vol. iv, chap. iv; also, for Philo-Judæus's part in developing the legend, see Rev. Dr. Sanday's Bampton Lectures for 1893, on Inspiration, pp. 86, 87.

Beautiful as was that old version, there was abundant reason for a revision. The progress of biblical scholarship had revealed multitudes of imperfections and not a few gross errors in the work of the early translators, and these, if uncorrected, were sure to bring the sacred volume into discredit.

Nothing could be more reverent than the spirit of the revisers, and the nineteenth century has known few historical events of more significant and touching beauty than the participation in the Holy Communion by all these scholars—prelates, presbyters, ministers, and laymen of churches most widely differing in belief and observance—kneeling side by side at the little altar in Westminster Abbey.

Nor could any work have been more conservative and cautious than theirs; as far as possible they preserved the old matter and form with scrupulous care.

Yet their work was no sooner done than it was bitterly attacked and widely condemned; to this day it is largely regarded with dislike. In Great Britain, in America, in Australia, the old version, with its glaring misconceptions, mistranslations, and interpolations, is still read in preference to the new; the great body of English-speaking Christians clearly preferring the accustomed form of words given by the seventeenth-century translators, rather than a nearer approach to the exact teaching of the Holy Ghost.

Still another law is that when once a group of sacred books has been evolved—even though the group really be a great library of most dissimilar works, ranging in matter from the hundredth Psalm to the Song of Songs, and in manner from the sublimity of Isaiah to the offhand story-telling of Jonah—all come to be thought one inseparable mass of interpenetrating parts; every statement in each fitting exactly and miraculously into each statement in every other; and each and every one, and all together, literally true to fact, and at the same time full of hidden meanings.

The working of these and other laws governing the evolution of sacred literature is very clearly seen in the great rabbinical schools which flourished at Jerusalem, Tiberias, and elsewhere, after the return of the Jews from the Babylonian captivity, and especially as we approach the time of Christ. These schools developed a subtlety in the study of the Old Testament which seems almost preternatural. The resultant system was mainly a jugglery with words, phrases, and numbers, which finally became a "sacred science," with various recognized departments, in which interpretation was carried on sometimes by attaching a numerical value to letters; sometimes by interchange of letters from differently arranged alphabets; sometimes by the making of new texts out of the initial letters of the old; and with ever-increasing subtlety.

Such efforts as these culminated fitly in the rabbinical declaration that each passage in the law has seventy distinct meanings, and that God himself gives three hours every day to their study.

After this the Jewish world was prepared for anything, and it does not surprise us to find such discoveries in the domain of ethical culture as the doctrine that for inflicting the forty stripes save one upon those who broke the law the lash should be braided of ox-hide and ass-hide; and, as warrant for this construction of the lash, the text, "The ox knoweth his owner, and the ass his master's crib, but Israel doth not know"; and, as the logic connecting text and lash, the statement that Jehovah evidently intended to command that "the men who know not shall be beaten by those animals whose knowledge shames them."

By such methods also were revealed such historical treasures as that Og, King of Bashan, escaped the deluge by wading after Noah's ark.

There were, indeed, noble exceptions to this kind of teaching. It can not be forgotten that Rabbi Hillel formulated the golden rule, which had before him been given to the extreme Orient by Confucius, and which afterward received a yet more beautiful emphasis from Jesus of Nazareth; but the seven rules of interpretation laid down by Hillel were multiplied and refined by men like Rabbi Ismael and Rabbi Eleazar until they justified every absurd subtlety.*

An eminent scholar has said that while the letter of Scripture became ossified in Palestine, it became volatilized at Alexandria; and the truth of this remark was proved by the Alexandrian Jewish theologians just before the beginning of our era.

This, too, was in obedience to a law of development, which is that, when literal interpretation clashes with increasing knowledge or with progress in moral feeling, theologians take refuge in mystic meanings—a law which we see working in all great religions, from the Brahmans finding hidden senses in the Vedas to Plato and the Stoics finding them in the Greek myths; and from the Sofi reading new meanings into the Koran, to eminent Christian divines of the nineteenth century giving a non-natural sense to some of the plainest statements in the Bible.

The great early master in this evolution was Philo; by him came as never before the use of allegory. The garden of Eden

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* For a multitude of amusing examples of rabbinical interpretations, see an article in Blackwood's Magazine for November, 1882; for a more general discussion, see Archdeacon Farrar's History of Interpretation, lect. i and ii, and Rev. Prof. H. P. Smith's Inspiration and Inerrancy, Cincinnati, 1893, especially chap. iv; also Reuss, History of the New Testament, English translation, pp. 527, 528.

thus becomes virtue; Abraham's country and kindred, from which he was commanded to depart, the human body and its members; the five cities of Sodom, the five senses; the Euphrates, correction of manners. By Philo and his compeers even the most insignificant words and phrases, and those especially, were held to conceal the most precious meanings.

A perfectly natural and logical result of this view was reached when Philo, saturated as he was with Greek culture and nourished on pious traditions of the utterances at Delphi and Dodona, spoke reverently of the Jewish Scriptures as "oracles." Oracles they became, as oracles they appeared in the early history of the Christian Church, and oracles they remained for centuries: eternal life or death, infinite happiness or agony, as well as ordinary justice in this world, being made to depend on certain interpretations of a long series of recondite or doubtful utterances—interpretations frequently given by men who might have been prophets and apostles, but who had become simply oracle-mongers.

Pressing the oracle into the service of science, Philo became the forerunner of that long series of theologians who, from Augustine and Cosmas to Mr. Gladstone, have attempted to extract from scriptural myth and legend profound contributions to natural science. Thus he taught that the golden candlesticks in the tabernacle symbolized the planets, the high priest's robe the universe, and the bells upon it the harmony of earth and water—whatever that may mean. So Cosmas taught, a thousand years later, that the table of showbread in the tabernacle showed forth the form and construction of the world; and Mr. Gladstone hinted, more than a thousand years later still, that Neptune's trident had a mysterious connection with the Christian doctrine of the Trinity.*

These methods, in spite of the resistance of Tertullian and Irenæus, were transmitted to the early Church; as applied to the

* For Philo Judæus, see Yonge's translation, Bohn's edition; see also Sanday on Inspiration, pp. 78–85. For admirable general remarks on this period in the history of exegesis, see Bartlett, Bampton Lectures, 1888, p. 29. For efforts in general to save the credit of myths by allegorical interpretation, and for those of Philo in particular, see Drummond, Philo-Judæus, London, 1888, vol. i, pp. 18, 19 and notes. For interesting samples of Alexandrian exegesis and for Philo's application of the term "oracle" to the Jewish Scriptures, see Farrar, History of Interpretation, p. 147 and note. For his discovery of symbols of the universe in the furniture of the tabernacle, see Drummond, as above, vol. i, pp. 269 *et seq.* For the general subject, admirably discussed from a historical point of view, see the Rev. Edwin Hatch, D. D., The Influence of Greek Ideas and Usages upon the Christian Church, Hibbert Lectures for 1888, chap. iii. For Cosmas, see my chapters on Geography and Astronomy. For Mr. Gladstone's view of the connection between Neptune's trident and the doctrine of the Trinity, see his Juventus Mundi.

Old Testament, they had appeared at times in the New; in the work of the early fathers they bloomed forth luxuriantly.

Justin Martyr and Clement of Alexandria vigorously extended them. Typical of Justin's method is his finding, in a very simple reference by Isaiah to Damascus, Samaria, and Assyria, a clear prophecy of the three wise men of the east who brought gifts to the infant Saviour, and in the bells on the priest's robe a prefiguration of the twelve apostles. Any difficulty arising from the fact that the number of bells is not specified in Scripture, Justin overcame by insisting that David referred to this prefiguration in the nineteenth Psalm: "Their sound is gone forth through all the earth and their words to the end of the world."

Working in this vein, Clement of Alexandria found in the form, dimensions, and color of the Jewish tabernacle a whole wealth of interpretation—the altar of incense representing the earth placed at the center of the universe, the high priest's robe the visible world, the jewels on the priest's robe the zodiac, and Abraham's three days' journey to Mount Moriah the three stages of the soul in its progress toward the knowledge of God. Interpreting the New Testament, he lessened any difficulties involved in the miracle of the barley loaves and fishes by suggesting that what this really means is that Jesus gave mankind a preparatory training for the gospel by means of the law and philosophy, because, as he says, barley, like the law, ripens sooner than wheat, which represents the gospel, and because, just as fishes grow in the waves of the ocean, so philosophy grew in the waves of the Gentile world.

Out of reasonings like these, those who followed, especially Cosmas, developed, as we have seen, a complete theological science of geography and astronomy.*

But the instrument in exegesis which was used with most cogent force was the occult significance of certain numbers. The Chaldean and Egyptian researches of our own time have revealed the great source of this line of thought; the speculations of Plato upon it are well known; but among the Jews and in the early Church it grew into something far beyond the wildest imaginings of the priests of Memphis and Babylon.

Philo had found for the elucidation of Scripture especially deep meanings in the numbers 4, 6, and 7; but other interpreters

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* For Justin, see the Dialogue with Trypho, chaps. xlii, lxxvi, and lxxxiii. For Clement of Alexandria, see his Miscellanies, Book V, chaps. vi and xi, and Book VII, chap. xvi, and especially Hatch, Hibbert Lectures, as above, pp. 76, 77.

As to the loose views of the canon held by these two fathers and others of their time see Ladd, Doctrine of the Sacred Scriptures, vol. ii, pp. 86, 88; also Diestel, Geschichte des alten Testaments.

soon surpassed him. At the very outset this occult power was used in ascertaining the canonical books of Scripture. Josephus argued that, since there were twenty-two letters in the Hebrew alphabet, there must be twenty-two sacred books in the Old Testament; other Jewish authorities thought that there should be twenty-four books, on account of the twenty-four watches in the temple. St. Jerome wavered between the argument based upon the twenty-two letters in the Hebrew alphabet and that suggested by the twenty-four elders in the Apocalypse. Hilary of Poitiers argued that there must be twenty-four books, on account of the twenty-four letters in the Greek alphabet. Origen found an argument for the existence of exactly four gospels in the existence of just four elements. Irenæus insisted that there could be neither more nor fewer than four gospels, since the earth has four quarters, the air four winds, and the cherubim four faces; and he denounced those who declined to accept this reasoning as "vain, ignorant, and audacious." *

But during the first half of the third century came one who exercised a still stronger influence in this direction—a great man who, while rendering precious services, did more than any other to fasten upon the Church a system which has been one of its heaviest burdens for more than sixteen hundred years: this was Origen. Yet his purpose was noble and his work based on profound thought. He had to meet the leading philosophers of the pagan world and to reply to their arguments against the Old Testament, and especially to their taunts against its imputation of human form, limitations, passions, weaknesses, and even immoralities to the Almighty.

Starting with a mistaken translation of a verse in the book of Proverbs, Origen presented as a basis for his main structure the idea of a threefold sense of Scripture: the literal, the moral, and the mystic—corresponding to the Platonic conception of the threefold nature of man. As results of this we have such masterpieces as his proof, from the fifth verse of chapter xxv of Job, that the stars are living beings, and from the well-known passage in the nineteenth chapter of St. Matthew his warrant for self-mutilation. But his great triumphs were in the allegorical method. By its use the Bible was speedily made an oracle indeed, or, rather, a book of riddles. A list of kings in the Old Testament thus be-

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* For Jerome and Origen, see notes on pages following. For Irenæus, see Irenæus adversus Heres., lib. iii, cap. xi, § 8. For the general subject, see Sanday on Inspiration, p. 115; also Farrar and H. P. Smith as above. For a recent very full and very curious statement from a Roman Catholic authority regarding views cherished in the older Church as to the symbolism of numbers, see Detzel, Christliche Iconographie, Freiburg im Breisgau, 1894, Band i, Einleitung, p. 4.

comes an enumeration of sins; the waterpots of stone, "containing two or three firkins apiece," at the marriage of Cana, signify the literal, moral, and spiritual sense of Scripture; the ass upon which the Saviour rode on his triumphal entry into Jerusalem becomes the Old Testament, the foal the New Testament, and the two apostles who went to loose them the moral and mystical senses; blind Bartimeus, throwing off his coat while hastening to Jesus, opens a whole treasury of oracular meanings.

The genius and power of Origen made a great impression on the strong thinkers who followed him. St. Jerome called him "the greatest master in the Church since the apostles," and Athanasius was hardly less emphatic.

The structure thus begun was continued by leading theologians during the centuries following. St. Hilary of Poitiers—"the Athanasius of Gaul"—produced some wonderful results of this method; but St. Jerome, inspired by the example of the man whom he so greatly admired, went beyond him. A triumph of his exegesis is seen in his statement that the Shunamite woman, who was selected to cherish David in his old age, signified heavenly wisdom.

The great mind of St. Augustine was drawn largely into this kind of creation, and nothing marks more clearly the vast change which had come over the world than the fact that this greatest of the early Christian thinkers turned from the broader paths opened by Plato and Aristotle into that opened by Clement of Alexandria.

In the mystic power of numbers to reveal the sense of Scripture Augustine found especial delight. He tells us that there is deep meaning in sundry scriptural uses of the number forty, and especially as the number of days required for fasting. Forty, he reminds us, is four times ten. Now, four is the number especially representing time, the day and the year being each divided into four parts; while ten, being made up of three and seven, represents knowledge of the Creator and creature, three referring to the three persons in the triune Creator, and seven referring to the three elements, heart, soul, and mind, taken in connection with the four elements, fire, air, earth, and water, which go to make up the creature. Therefore this number ten, representing knowledge, being multiplied by four, representing time, admonishes us to live during time according to knowledge—that is, to fast for forty days.

Referring to such misty methods as these, which lead the reader to ask himself whether he is sleeping or waking, St. Augustine remarks that "ignorance of numbers prevents us from understanding such things in Scripture." But perhaps the most amazing example is to be seen in his notes on the hundred and fifty and three fishes which, according to St. John's Gospel, were caught by St. Peter and the other apostles. Some points in his long development of this subject may be selected to show what the older theological method can be made to do for a great mind. He tells us that the hundred and fifty and three fishes embody a great mystery; that the number ten, evidently as the number of the commandments, indicates the law; but, as the law without the spirit only kills, we must add the seven gifts of the spirit, and we thus have the number seventeen, which signifies the old and new dispensations; then, if we add together every several number which seventeen contains from one to seventeen inclusive, the result is a hundred and fifty and three—the number of the fishes.

With this sort of reasoning he finds profound meanings in the number of furlongs mentioned in the sixth chapter of St. John. Referring to the fact that the disciples had rowed about "twenty-five or thirty furlongs," he declares that "twenty-five typifies the law, because it is five times five, but the law was imperfect before the gospel came; now perfection is comprised in six, since God in six days perfected the world, hence five is multiplied by six that the law may be perfected by the gospel, and six times five is thirty."

But Augustine's exploits in exegesis were not all based on numerals; he is sometimes equally profound in other modes. Thus he tells us that the condemnation of the serpent to eat dust typifies the sin of curiosity, since in eating dust he "penetrates the obscure and shadowy"; and that Noah's ark was "pitched within and without with pitch" to show the safety of the Church from the leaking in of heresy.

Still another exploit—one at which the Church might well have stood aghast—was his statement that the drunkenness of Noah prefigured the suffering and death of Christ. It is but just to say that he was not the original author of this interpretation; it had been presented long before by St. Cyprian. But this was far from Augustine's worst. Perhaps no interpretation of Scripture has ever led to more cruel and persistent oppression, torture, and bloodshed than his reading into one of the most beautiful parables of Jesus of Nazareth—into the words "compel them to come in"—a warrant for religious persecution: of all unintentional blasphemies since the world began possibly the most appalling.

Another strong man follows to fasten these methods on the Church: St. Gregory the Great. In his renowned work on the book of Job, the Magna Moralia, given to the world at the end of the sixth century, he lays great stress on the deep mystical meanings of the statement that Job had seven sons. He thinks the seven sons typify the twelve apostles, for "the apostles were selected through the sevenfold grace of the Spirit; moreover, twelve is produced from seven—that is, the two parts of seven, four and three, when multiplied together give twelve." He also finds deep significance in the number of the apostles; this number being evidently determined by a multiplication of the number of persons in the Trinity by the number of quarters of the globe. Still, to do him justice, it must be said that in some parts of his exegesis the strong sense which was one of his most striking characteristics crops out in a way very refreshing. Thus, referring to a passage in the first chapter of Job, regarding the oxen which were plowing and the asses which were feeding beside them, he tells us pithily that these typify two classes of Christians: the oxen, the energetic Christians who do the work of the Church; the asses, the lazy Christians who merely feed.*

Thus began the vast theological structure of oracular interpretation applied to the Bible. As we have seen, the men who prepared the ground for it were the rabbis of Palestine and the Hellenized Jews of Alexandria; and the four great men who laid its foundation courses were Origen, St. Augustine, St. Jerome, and St. Gregory.

During the ten centuries following the last of these men, this structure continued to rise steadily above the plain meanings of Scripture. The Christian world rejoiced in it, and the few great thinkers who dared bring the truth to bear upon it were rejected. It did indeed seem at one period in the early Church that a better system might be developed. The School of Antioch, especially as represented by Chrysostom, appeared likely to lead in this better way, but the dominant forces were too strong; the passion for myth and marvel prevailed over the love of real knowledge, and the reasonings of Chrysostom and his compeers were neglected.†

In the ninth century came another effort to present the claims of right reason. The first man prominent in this was St.

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* For Origen, see the De Principiis, Book IV, chaps. i–vii *et seq.*, Crombie's translation; also the Contra Celsum, vi, 70; vii, 20, etc.; also various citations in Farrar. For Hilary, see his Tractatus super Psalmos, cap. ix, li, etc., in Migne, tom. ix, and De Trinitate, lib. ii, cap. ii. For Jerome's interpretation of the text relating to the Shunamite woman, see Epist. lii, in Migne, tom. xxii, pp. 527, 528. For Augustine's use of numbers, see the De Doctrina Christiana, lib. ii, cap. xvi, and for the explanation of the draught of fishes, see Augustine in Johan. Evangel., Tractat. cxxii, and on the twenty-five to thirty furlongs, ibid., xxv, sect. 6; and for the significance of the serpent eating dust, ibid., ii, 18. For the view that the drunkenness of Noah prefigured the suffering of Christ, as held by SS. Cyprian and Augustine, see Farrar, as above, pp. 181, 238. For St. Gregory, see the Magna Moralia, lib. i, cap. xiv.

† For the work of the School of Antioch, and especially of Chrysostom, see the eloquent tribute to it by Farrar, as above.

Agobard, Bishop of Lyons, whom an eminent historian has well called the clearest head of his time. With the same insight which penetrated the fallacies and follies of image worship, belief in witchcraft, persecution, the ordeal, and the judicial duel, he saw the futility of this vast fabric of interpretation, protested against the idea that the Divine Spirit extended its inspiration to the mere words of Scripture, and asked a question which has resounded through every generation since: "If you once begin such a system, who can measure the absurdity which will follow?"

During the same century another opponent of this dominant system appeared: John Scotus Erigena. He contended that "reason and authority come alike from the one source of Divine Wisdom"; that the fathers, great as their authority is, often contradict each other; and that, in last resort, reason must be called in to decide between them.

But the evolution of unreason continued: Agobard was unheeded, and Erigena placed under the ban by two councils, his work being condemned by a synod as a "*Commentum Diaboli.*" Four centuries later Honorius III ordered it to be burned, as "teeming with the venom of heretical depravity"; and finally, after eight centuries, Pope Gregory XIII placed it on the Index, where it remains to this day. Nor did Abélard, who, three centuries after Agobard and Erigena, made an attempt in some respects like theirs, have any better success: his fate at the hands of St. Bernard and the Council of Sens the world knows by heart. Far more consonant with the spirit of the universal Church was the teaching in the twelfth century of the great Hugo of St. Victor, conveyed in these ominous words: "Learn first what is to be believed" (*Disce primo quod credendum est*), meaning thereby that one should first accept doctrines, and then find texts to confirm them.

These principles being dominant, the accretions to the enormous fabric of interpretation went steadily on. Typical is the fact that the Venerable Bede contributed to it the doctrine that, in the text mentioning Elkanah and his two wives, Elkanah means Christ and the two wives the Synagogue and the Church; even such men as Alfred the Great and St. Thomas Aquinas were added to the forces at work in building above the sacred books this prodigious mass of sophistry.

Perhaps nothing shows more clearly the tenacity of the old system of interpretation than the sermons of Savonarola. During the last decade of the fifteenth century, just at the close of the mediæval period, he was engaged in a life-and-death struggle at Florence. No man ever preached more powerfully the Gospel of Righteousness; none ever laid more stress on conduct; even Luther was not more zealous for reform or more careless of traditionalism; and yet we find the great Florentine apostle and martyr absolutely tied fast to the old system of allegorical interpretation. The autograph notes of his sermons, still preserved in his cell at San Marco, show this abundantly. Thus we find him attaching to the creation of grasses and plants on the third day an allegorical connection with the "multitude of the elect" and with the "sound doctrines of the Church"; and to the creation of land animals on the sixth day a similar relation to "the Jewish people" and to "Christians given up to things earthly." *

The revival of learning in the fifteenth century seemed likely to undermine the older structure.

Then it was that Lorenzo Valla brought to bear on biblical research, for the first time, the spirit of modern criticism. By truly scientific methods he proved the famous Letter of Christ to Abgarus a forgery; the Donation of Constantine, one of the great foundations of the ecclesiastical power in temporal things, a fraud; and the creed attributed to the apostles a creation which post-dated them by several centuries. Of even more permanent influence was his work upon the New Testament, in which he initiated the modern method of comparing manuscripts to find what the sacred text really is. At an earlier or later period he would doubtless have paid for his temerity with his life; fortunately, just at that time, the ruling pontiff and his contemporaries cared much for literature and little for orthodoxy, and from their palaces he could bid defiance to the Inquisition.

While Valla thus initiated biblical criticism south of the Alps, a much greater man began a more fruitful work in northern Europe. Erasmus, with his edition of the New Testament, stands at the source of that great stream of modern research and thought which is doing so much to undermine and dissolve away the vast fabric of patristic and scholastic interpretation.

Yet his efforts to purify the scriptural text seemed at first to encounter insurmountable difficulties, and one of these may stimulate reflection. He had found, what some others had found before him, that the famous verse in the first chapter of the First

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* For Agobard, see the Liber adversus Fredigisum, cap. xii; also Reuter's Relig. Aufklärung im Mittelalter, i, 24; also Poole, Illustrations of the History of Mediæval Thought, London, 1884, pp. 38 *et seq.* For Erigena, see his De Divisione Naturæ, lib. iv, cap. v, also i, cap. lxvi–lxxi, and for general account see Ueberweg, History of Philosophy, New York, 1871, vol. i, pp. 358 *et seq.*, and for the treatment of his work by the Church, see the edition of the Index under Leo XIII, 1881. For Abélard, see the Sic et Non, Prologue, Migne, tom. clxxviii, and, on the general subject, Milman, Latin Christianity, vol. iii, pp. 371–377. For Hugo of St. Victor, see Erudit. Didask., lib. vii, vi, 4, in Migne, clxxvi. For Savonarola's interpretations, see various references to his preaching in Villari's Life of Savonarola, English translation, London, 1890, and especially the exceedingly interesting table in the appendix to vol. i, chap. vii.

General Epistle of St. John, regarding the "three witnesses," was an interpolation. Careful research through all the really important early manuscripts showed that it appeared in none of them. Even after the Bible had been corrected in the eleventh and twelfth centuries by Lanfranc, Archbishop of Canterbury, and by Nicholas, cardinal and librarian of the Roman Church, "in accordance with the orthodox faith," the passage was still wanting in the more authoritative Latin manuscripts. There was not the slightest tenable ground for believing in the authenticity of the text; on the contrary, it has been demonstrated that, after a universal silence of the orthodox fathers of the Church, of the ancient versions of the Scriptures, and of all really important manuscripts, the verse first appeared in a Confession of Faith drawn up by an obscure zealot toward the end of the fifth century. In a very mild exercise, then, of critical judgment, Erasmus omitted this text from the first two editions of his Greek Testament as evidently spurious. A storm arose at once. In England, Lee, afterward Archbishop of York; in Spain, Stunica, one of the editors of the Complutensian Polyglot; and in France, Budé, Syndic of the Sorbonne, together with a vast army of monks in England and on the Continent, attacked him ferociously. He was condemned by the University of Paris, and various propositions of his were declared to be heretical and impious. Fortunately, the worst persecutors could not reach him; otherwise they might have treated him as they treated his disciple, Berquin, whom they burned at Paris in 1529.

The fate of this spurious text throws light into the workings of human nature in its relations to sacred literature. Although Luther omitted it from his translation of the New Testament, and kept it out of every copy published during his lifetime, and although at a later period the most eminent Christian scholars showed that it had no right to a place in the Bible, it was, after Luther's death, replaced in the German translation, and has been incorporated into all important editions of it, save one, since the beginning of the seventeenth century. So essential was it found in maintaining the dominant theology that, despite the fact that Sir Isaac Newton, Richard Porson, the nineteenth-century revisers, and all other eminent authorities have rejected it, the Anglican Church still retains it in its Lectionary, and the Scotch Church continues to use it in the Westminster Catechism, as a main support of the doctrine of the Trinity.

Nor were other new truths, presented by Erasmus, better received. His statement that "some of the Epistles ascribed to St. Paul are certainly not his," which is to-day universally acknowledged as a truism, also aroused a storm. For generations, then, his work seemed vain.

On the coming in of the Reformation the great structure of belief in the literal and historical correctness of every statement in the Scriptures, in the profound allegorical meanings of the simplest texts, and even in the divine origin of the vowel punctuation, towered more loftily and grew more rapidly than ever before. The reformers, having cast off the authority of the Pope and of the universal Church, fell back all the more upon the infallibility of the sacred books. The attitude of Luther toward this great subject was characteristic. As a rule he adhered tenaciously to the literal interpretation of the Scriptures; his argument against Copernicus is a fair example of his reasoning in this respect; but, with the strong good sense which characterized him, he from time to time broke away from the received belief. Thus, he took the liberty of understanding certain passages in the Old Testament in a different sense from that given them by the New Testament, and declared St. Paul's allegorical use of the story of Sarah and Hagar "too unsound to stand the test." He also emphatically denied that the Epistle to the Hebrews was written by St. Paul, and he did this in the exercise of a critical judgment upon internal evidence. His utterance as to the Epistle of St. James became famous. He announced to the Church: "I do not esteem this an apostolic epistle; I will not have it in my Bible among the canonical books," and he summed up his opinion in his well-known allusion to it as "an epistle of straw."

Emboldened by him, the gentle spirit of Melanchthon, while usually taking the Bible very literally, at times revolted; but this was not due to any want of loyalty to the old method of interpretation: whenever the wildest and most absurd system of exegesis seemed necessary to support any part of the reformed doctrine, Luther and Melanchthon unflinchingly developed it. Both of them held firmly to the old dictum of Hugo of St. Victor, which, as we have seen, was virtually that one must first accept the doctrine, and then find scriptural warrant for it. Very striking examples of this were afforded in the interpretation by Luther and Melanchthon of certain alleged marvels of their time, and one out of several of these may be taken as typical of their methods.

In 1523 Luther and Melanchthon jointly published a work under the title Der Papstesel, interpreting the significance of a strange, ass-like monster which, according to a popular story, had been found floating in the Tiber some time before. This book was illustrated by startling pictures, and both text and pictures were devoted to proving that this monster was "a sign from God," indicating the doom of the papacy. This treatise by the two great founders of German Protestantism pointed out that the ass's head signified the Pope himself, "for," said they, "as well as an ass's head is suited to a human body, so well is the Pope suited to be head over the Church." This argument was clinched by a reference to Exodus. The right hand of the monster, said to be like an elephant's foot, they made to signify the spiritual rule of the Pope, since "with it he tramples upon all the weak": this they proved from the book of Daniel and the Second Epistle to Timothy. The monster's left hand, which was like the hand of a man, they declared to mean the Pope's secular rule, and they found passages to support this view in Daniel and St. Luke. The right foot, which was like the foot of an ox, they declared to typify the servants of the spiritual power, and proved this by a citation from St. Matthew. The left foot, like a griffin's claw, they made to typify the servants of the temporal power of the Pope, and the highly developed breasts and various other members, cardinals, bishops, priests, and monks, "whose life is eating, drinking, and unchastity": to prove this they cited passages from Second Timothy and Philippians. The alleged fish-scales on the arms, legs, and neck of the monster they made to typify secular princes and lords, "since," as they said, "in St. Matthew and Job the sea typifies the world, and fishes men." The old man's head at the base of the monster's spine they interpreted to mean "the abolition and end of the papacy," and proved this from Hebrews and Daniel. The dragon which opens his mouth in the rear and vomits fire, "refers to the terrible, virulent bulls and books which the Pope and his minions are now vomiting forth into the world." The two great reformers then went on to insist that, since this monster was found at Rome, it could refer to no person but the Pope, "for," they said, "God always sends his signs in the places where their meaning applies." Finally, they assured the world that the monster in general clearly signified that the papacy was then near its end. To this development of interpretation Luther and Melanchthon especially devoted themselves; the latter by revising this exposition of the prodigy, and the former by making additions to a new edition.

So great was the success of this kind of interpretation that Luther, hearing that a monstrous calf had been found at Freiburg, published a treatise upon it, showing, by citations from the books of Exodus, Kings, the Psalms, Isaiah, and Daniel, and the Gospel of St. John, that this new monster was the especial work of the devil, but full of meaning in regard to the questions at issue between the reformers and the older Church.

The other great branch of the reformed Church appeared for a time to establish a better system. Calvin's strong logic seemed at one period likely to tear his adherents away from the older method; but the evolution of scholasticism continued, and the great influence of the German reformers prevailed. At every theological center came an amazing development of interpretation. Eminent Lutheran divines in the seventeenth century, like Gerhard, Calovius, Cocceius, and multitudes of others, wrote scores of quartos to further this system, and the other branch of the Protestant Church emulated their example. The pregnant dictum of St. Augustine—"Greater is the authority of Scripture than all human capacity"—was steadily insisted upon, and toward the close of the seventeenth century Voetius, the renowned professor at Utrecht, declared, "Not a word is contained in the Holy Scriptures which is not in the strictest sense inspired, the very punctuation not excepted." But unfortunately it was very difficult to find what the "authority of Scripture" really was. To the greater number of Protestant ecclesiastics it meant the authority of any meaning in the text which they had the wit to invent and the power to enforce.

To increase this vast confusion came, in the older branch of the Church, the idea of the divine inspiration of St. Jerome's Latin translation of the Bible—the Vulgate. It was insisted by leading Catholic authorities that this was as completely a product of divine inspiration as was the Hebrew original. Strong men arose to insist even that, where the Hebrew and the Latin differed, the Hebrew should be altered to fit Jerome's mistranslation, as the latter, having been made under the new dispensation, must be better than that made under the old. Even so great a man as Cardinal Bellarmine exerted himself in vain against this new tide of unreason.*

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* For Valla, see various sources already named; and, for an especially interesting account, Symonds's Renaissance in Italy, the Revival of Learning, pp. 260–269; and, for the opinion of the best contemporary judge, see Erasmi Opera, Leyden, 1703, tom. iii, p. 98. For Erasmus and his opponents, see Life of Erasmus, by Butler, London, 1825, pp. 179–182; but especially, for the general subject, Bishop Creighton's History of the Papacy during the Reformation.

For the attack by Budé and the Sorbonne and the burning of Berquin, see Drummond, Life and Character of Erasmus, vol. ii, pp. 220–223; also pp. 230–239. As to the text of the Three Witnesses, see Gibbon, Decline and Fall of the Roman Empire, chap. xxxvii, notes 116–118; also Dean Milman's note thereupon. For a full and learned statement of the evidence against the verse, see Porson's Letters to Travis, London, 1790, in which an elaborate discussion of all the MSS. is given. See also Jowett in Essays and Reviews, p. 307. For a very full and impartial history of the long controversy over this passage, see Charles Butler's Horæ Biblicæ, reprinted in Jared Sparks's Theological Essays and Tracts, vol. ii. For Luther's ideas of interpretation, see his Sämmtliche Schriften, Walch edition, vol. i, p. 1199, vol. ii, p. 1758, vol. viii, p. 2140; for some of his more free views, vol. xiv, p. 472, vol. vi, p. 121, vol. xi, p. 1448, vol. xi, p. 1089; also, Tholuck, Doctrine of Inspiration, Boston, 1867, citing the Colloquia, Frankfort, 1571, vol. ii, p. 102; also, the Vorreden zu der deutschen Bibelübersetzung, in Walch's edition, as above, vol. xiv, especially pp. 94, 98, and 146–150. As to Melanchthon, see especially his Loci Communes, 1521; and, as to the enormous growth of commentaries in the generations immediately following, see Charles Beard, Hibbert Lectures for 1883, on the Reformation, especially the admirable chapter on Protestant Scholasticism; also Archdeacon Farrar, History of Interpretation. For the Papstesel, etc., see Luther's Sämmtliche Schriften, edit. Walch, vol. xiv, pp. 2403 *et seq.*; also Melanchthon's

Nor was a fanatical adhesion to the mere letter of the sacred text confined to western Europe. About the middle of the seventeenth century, in the reign of Alexis, father of Peter the Great, Nikon, Patriarch of the Russian Greek Church, attempted to correct the Slavonic Scriptures and service-books. They were full of interpolations due to ignorance, carelessness, or zeal, and in order to remedy this state of the texts Nikon procured a number of the best Greek and Slavonic manuscripts, set the leading and most devout scholars he could find at work upon them, and caused Russian Church councils in 1655 and 1666 to promulgate the books thus corrected.

Straightway great masses of the people, led by monks and parish priests, rose in revolt. The fact that the revisers had written in the New Testament the name of Jesus correctly, instead of following the old wrong orthography, aroused the wildest fanaticism. The monks of the great convent of Solovetsk, when the new books were sent them, cried in terror: "Woe, woe! what have you done with the Son of God?" They then shut their gates, defying patriarch, council, and Czar, until, after a struggle lasting seven years, their monastery was besieged and taken by an imperial army. Hence arose the great sect of the "Old Believers," lasting to this day, and fanatically devoted to the corrupt readings of the old text.*

Opera, edit. Bretschneider, vol. xx, pp. 665 *et seq.* In the White Library of Cornell University will be found an original edition of the book with engravings of the monster. For the Mönchkalb, see Luther's works as above, vol. xix, pp. 2416 *et seq.* For the spirit of Calvin in interpretation, see Farrar, and especially H. P. Smith, D. D., Inspiration and Inerrancy, chap. iv, and the very brilliant essay forming chap. iii of the same work, by L. J. Evans, pp. 66 and 67, note. For the attitude of the older Church toward the Vulgate, see Pallavicini, Histoire du Concile de Trente, Montrouge, 1844, tom. i, pp. 19, 20; but especially Symonds, The Catholic Reaction, vol. i, pp. 226 *et seq.* As to a demand for a revision of the Hebrew Bible to correct its differences from the Vulgate, see Emanuel Deutsch's Literary Remains, New York, 1874, p. 9. For the work and spirit of Calovius and other commentators immediately following the Reformation, see Farrar, as above; also Beard, Schaff, and Hertzog, Geschichte des alten Testaments in der Christlichen Kirche, pp. 527 *et seq.* As to extreme views of Voetius and others, see Tholuck, as above.

* The present writer, visiting Moscow in the spring of 1894, was presented by Count Leo Tolstoi to one of the most eminent and influential members of the sect of "Old Believers," which dates from the reform of Nikon. Nothing could exceed the fervor with which this venerable man, standing in the chapel of his superb villa, expatiated upon the horrors of making the sign of the cross with three fingers instead of with two. His argument was that the *two* fingers, as used by the "Old Believers," typify the divine and human nature of our Lord, and hence that the use of them is strictly correct; whereas, signing with *three* fingers, representing the blessed Trinity, is "virtually to crucify all three persons of the Godhead afresh."

Not less cogent were his arguments regarding the immense value of the old text of Scripture as compared with the new.

For the revolt against Nikon and his reformers, see Rambaud, History of Russia, vol. i, pp. 414–416; also Wallace, Russia, vol. ii, pp. 307–309; also Leroy Beaulieu, L'Empire des Tsars, vol. iii, livre iii.

Strange to say, on the development of Scripture interpretation, largely in accordance with the old methods, wrought, about the beginning of the eighteenth century, Sir Isaac Newton.

It is hard to believe that from the mind which produced the Principia, and which broke through the many time-honored beliefs regarding the dates and formation of scriptural books, could have come his discussions regarding the prophecies; still, at various points even in this work, his power appears. From internal evidence he not only discarded the text of the Three Witnesses, but he decided that the Pentateuch must have been made up from several books; that Genesis was not written until the reign of Saul; that the books of Kings and Chronicles were probably collected by Ezra; and, in a curious anticipation of modern criticism, that the book of Psalms and the prophecies of Isaiah and Daniel were each written by various authors at various dates. But the old belief in prophecy as prediction was too strong for him, and we find him applying his great powers to the elucidation of the details given by the prophets and in the Apocalypse to the history of mankind since unrolled, and tracing from every statement in prophetic literature its exact fulfillment even in the most minute particulars.

By the beginning of the eighteenth century the structure of scriptural interpretation had become enormous. It seemed destined to hide forever the real character of our sacred literature and to obscure the great light which Christianity had brought into the world. The Church, Eastern and Western, Catholic and Protestant, was content to sit in its shadow, and the great divines of all branches of the Church reared every sort of fantastic buttress to strengthen or adorn it. It seemed to be founded for eternity; and yet, at this very time when it appeared the strongest, a current of thought was rapidly dissolving away its foundations, and preparing that wreck and ruin of the whole fabric which is now, at the close of the nineteenth century, going on so rapidly.

The account of the movement thus begun is next to be given.*

HYDROGEN has at last been liquefied in quantities susceptible of examination, by Prof. Olzewski, of Cracow, who finds that its critical point—the temperature at which it passes from a liquid to a vapor—is —233° C., and its boiling point at normal pressure —343° C. Thus the last gas that has resisted liquefaction has yielded.

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* For Newton's boldness in textual criticism, compared with his credulity as to the literal fulfillment of prophecy, see his Observations upon the Prophecies of Daniel and the Apocalypse of St. John, in his works, edited by Horsley, London, 1785, vol. v, pp. 297–491.

PROFESSIONAL INSTITUTIONS.

II.—PHYSICIAN AND SURGEON.

By HERBERT SPENCER.

ALREADY, in Chapter II of the preceding part, have been given illustrations of the general truth that in rude tribes it is difficult to distinguish between the priest and the medicine-man. Their respective functions are commonly fulfilled by the same person. In addition to the instances there given, here are some others. According to Humboldt, "the Caribbee *marirris* are at once priests, jugglers, and physicians." Among the Tupis "the Payes, as they were called, were at once quacks, jugglers, and priests." Passing from South America to North, we read that the "Carriers know little of medicinal herbs. Their priest or magician is also the doctor;" and, of the Dakotahs, Schoolcraft says—"The Priest is both prophet and doctor." In Asia we meet with a kindred connection. In Southern India, the Kurumbas act as doctors to the Badagas, and it is said of them—"The Kurumbas also officiate as priests at their marriages and deaths." So is it among peoples further north. "Native doctors swarm in Mongolia. . . . They are mostly lamas. There are a few laymen who add medical practice to their other occupations, but the great majority of doctors are priests." It is the same on the other great continent. Reade tells us that in Equatorial Africa the fetish-man is doctor, priest, and witch-finder; and concerning the Joloffs and Eggarahs, verifying statements are made by Mollien and by Allen and Thomson.

This evidence, re-enforcing evidence given in the preceding part, and re-enforced by much more evidence given in the first volume of this work, shows that union of the two functions is a normal trait in early societies.

The origin of this union lies in the fact before named that the primitive priest and the primitive medicine-man both deal with supposed supernatural beings; and the confusion arises in part from the conceived characters of these ghosts and gods, some of which are regarded as always malicious, and others of which, though usually friendly, are regarded as liable to be made angry and then to inflict evils.

The medicine-man, dealing with malicious spirits, to which diseases among other evils are ascribed by savages, subjects his patients partly to natural agencies, but chiefly to one or other method of exorcism. Says Keating of the Chippewas, "their mode of treatment depends more upon the adoption of proper spells than the prescription of suitable remedies." Among the Nootka Sound people,—

"Natural pains and maladies are invariably ascribed to the absence or other irregular conduct of the soul, or to the influence of evil spirits, and all treatment is directed to the recall of the former and to the appeasing of the latter."

So, too, of the Okanagans we read :—

"But here, as elsewhere, the sickness becoming at all serious or mysterious, medical treatment proper is altogether abandoned, and the patient committed to the magic powers of the medicine-man."

Sequent upon such beliefs in the supernatural origin of diseases are various usages elsewhere. It is said of the Karens that "when a person is sick, these people [medicine-men], for a fee, will tell what spirit has produced the sickness, and the necessary offering to conciliate it." Among the Araucanians, the medicine-man having brought on a state of trance, real or pretended, during which he is supposed to have been in communication with spirits, declares on his recovery—

"the nature and seat of the malady, and proceeds to dose the patient, whom he also manipulates about the part afflicted until he succeeds in extracting the cause of the sickness, which he exhibits in triumph. This is generally a spider, a toad, or some other reptile which he has had carefully concealed about his person."

Speaking of the Tahitian doctors, who are almost invariably priests or sorcerers, Ellis says that in cases of sickness they received fees, parts of which were supposed to belong to the gods: the supposition being that the gods who had caused the diseases must be propitiated by presents. A more advanced people exhibit a kindred union of ideas. Says Gilmour—

"Mongols seldom separate medicine and prayers, and a clerical doctor has the advantage over a layman in that he can attend personally to both departments, administering drugs on the one hand, and performing religious ceremonies on the other."

Hence the medical function of the priest. When not caused by angry gods diseases are believed to be caused by indwelling demons, who have either to be driven out by making the body an intolerable residence, or have to be expelled by superior spirits who are invoked.

But there is often a simultaneous use of natural and supernatural means, apparently implying that the primitive medicine-man, in so far as he uses remedies acting physically or chemically, foreshadows the physician; yet the apparent relationship is illusive, for those which we distinguish as natural remedies are not so distinguished by him. In the first volume, in the chapter on

Plant-Worship, it was shown that powerful effects wrought on the body by plants, and the product of plants, are supposed to be due to spirits dwelling in the plants. Hence the medicine-man, or "mystery-man," being concerned solely with supernatural causation of one or other kind, foreshadows the physician only to the extent of using some of the same means, and not as having the same ideas.

As we shall presently see, it is rather from the priest properly so called, who deals with ghosts not antagonistically but sympathetically, that the physician originates.

While the medicine-man is distinctive of small and undeveloped societies, the priest proper arises along with social aggregation and the formation of established government. In the preceding division of this work, Chapters III, IV, and V, we saw that since originally propitiation of the ghosts of parents and other members of each family is at first carried on by relatives, implying that the priestly function is generally diffused; and since this priestly function presently devolves on the eldest male of the family; and since, when chieftainship becomes settled and inheritable, the living chief makes sacrifices to the ghost of the dead chief, and sometimes does this on behalf of the people; there so arises an official priest, and it results that with enlargement of societies by union with subjugated tribes and the spread of the chieftain's power, now grown into royal power, over various subordinated groups, and the accompanying establishment of deputy rulers in these groups, who take with them the worship that arose in the conquering tribe, there is initiated a priesthood which, growing into a caste, becomes an agency for the dominant cult; and, from causes already pointed out, becomes the seat of culture in general.

From part of this culture, having its origin in preceding stages, comes greater knowledge of medicinal agents, which gradually cease to be conceived as acting supernaturally. Early civilizations show us the transition. Says Maspéro of the ancient Egyptians:—

> "The cure-workers are . . . divided into several categories. Some incline toward sorcery, and have faith in formulas and talismans only. . . . Others extol the use of drugs; they study the qualities of plants and minerals . . . and settle the exact time when they must be procured and applied. . . . The best doctors carefully avoid binding themselves exclusively to either method . . . their treatment is a mixture of remedies and exorcisms which vary from patient to patient. They are usually priests."

Along with this progress, there had gone on a differentiation of functions. Among the lower classes of the priesthood were the "pastophors, who . . . practiced medicine."

Respecting the state of things in Babylonia and Assyria, the evidence is not so clear. Says Lenormant of the Chaldæans:

"Il est curieux de noter que les trois parties qui composaient ainsi le grand ouvrage magique dont Sir Henry Rawlinson a retrouvé les débris, correspondent exactement aux trois classes de docteurs chaldéens que le livre de Daniel (i, 20 ; ii, 2 et 27 ; v, 11) énumère à côté des astrologues et des divins (*kasdim* et *gazrim*), c'est-à-dire les *khartumin* ou conjurateurs, les *hakamin* ou médecins, et les *asaphin* ou théosophes."

With like implications Prof. Sayce tells us that—

"The doctor had long been an institution in Assyria and Babyonia. It is true that the great bulk of the people had recourse to religious charms and ceremonies when they were ill, and ascribed their sickness to possession by demons instead of to natural causes. But there was a continually increasing number of the educated who looked for aid in their maladies rather to the physician with his medicine than to the sorcerer or priest with his charms."

But from these two statements taken together it may fairly be inferred that the doctors had arisen as one division of the priestly class.

Naturally it was with the Hebrews as with their more civilized neighbors. Says Gauthier—

"Chez les Juifs la médecine a été longtemps sacerdotale comme chez presque tous les anciens peuples ; les Lévites étaient les seuls médecins. . . . Chez les plus anciens peuples de l'Asie, tels que les Indiens et les Perses, l'art de guérir était également exercé par les prêtres."

In later days this connection became less close, and there was a separation of the physician from the priest. Thus in Ecclesiasticus we read:—

"My son, in thy sickness be not negligent : but pray unto the Lord, and he will make thee whole. Leave off from sin, and order thine hands aright, and cleanse thy heart from all wickedness. Give a sweet savor, and a memorial of fine flour ; and make a fat offering. Then give place to the physician, for the Lord hath created him ; let him not go from thee, for thou hast need of him." (xxxviii, 15.)

Facts of congruous kinds are remarked on by Draper:—

"In the Talmudic literature there are all the indications of a transitional state, so far as medicine is concerned ; supernatural seems to be passing into the physical, the ecclesiastical is mixed up with the exact : thus a rabbi may cure disease by the ecclesiastical operation of laying on of hands ; but of febrile disturbances, an exact, though erroneous explanation is given, and paralysis of the hind legs of an animal is correctly referred to the pressure of a tumor on the spinal cord."

Concerning the origin of the medical man among the Hindus, whose history is so much complicated by successively superposed governments and religions, the evidence is confused. Accounts agree, however, in the assertion that medicine was of divine origin: evidently implying its descent through the priesthood. In the introduction to Charaka's work, medical knowledge is said to have indirectly descended from Brahma to Indra, while "Bhâradvâja learned it from Indra, and imparted it to six Rishis, of whom Agnivâsa was one." The association of medical practice with priestly functions is also implied in the statement of Hunter that "the national astronomy and the national medicine of India alike derived their first impulses from the exigencies of the national worship." The same connection was shown during the ascendancy of Buddhism. "The science was studied in the chief centers of Buddhist civilization, such as the great monastic university of Nalanda, near Gayá."

Similar was the genesis of the medical profession among the Greeks. "The science [of medicine] was of divine origin, and the doctors continued, in a certain sense, to be accounted the descendants of Asklepios." As we read in Grote—

> "The many families or gentes called Asklêpiads, who devoted themselves to the study and practice of medicine, and who principally dwelt near the temples of Asklêpius, whither sick and suffering men came to obtain relief—all recognized the god [Asklêpius] not merely as the object of their common worship, but also as their actual progenitor."

In later times we see the profession becoming secularized.

> "The union between the priesthood and the profession was gradually becoming less and less close; and, as the latter thus separated itself, divisions or departments arose in it, both as regards subjects, such as pharmacy, surgery, etc., and also as respects the position of its cultivators."

Miscellaneous evidence shows that during early Roman times, when there existed no medical class, diseases were held to be supernaturally inflicted, and the methods of treating them were methods of propitiation. Certain maladies ascribed to certain deities prompted endeavor to pacify those deities; and hence there were sacrifices to Febris, Mephitis, Ossipaga, and Carna. An island in the Tiber, which already had a local healing god, became also the seat of the Æsculapius cult: that god having been appealed to on the occasion of an epidemic. Evidently, therefore, medical treatment at Rome, as elsewhere, was at first associated with priestly functions. Throughout subsequent stages the normal course of evolution is deranged by influences from other societies. Conquered peoples, characterized by actual or supposed medical skill, furnished the medical practitioners. For a long time these were dependents of patrician houses. Say Guhl and Koner—"Physicians and surgeons were mostly slaves or freedmen." And the medical profession, when it began to develop, was of foreign origin. Mommsen writes:—

"In 535 the first Greek physician, the Peloponnesian Archagathus, settled in Rome and there acquired such repute by his surgical operations, that a residence was assigned to him on the part of the state and he received the freedom of the city; and thereafter his colleagues flocked in crowds to Rome . . . the profession, one of the most lucrative which existed in Rome, continued a monopoly in the hands of the foreigners."

Opposed to paganism as Christianity was from the beginning, we might naturally suppose that the primitive association between the priestly and medical functions would cease when Christianity became dominant. But the roots of human sentiments and beliefs lie deeper than the roots of particular creeds, and are certain to survive and bud out afresh when an old creed has been superficially replaced by a new one. Everywhere pagan usages and ideas are found to modify Christian forms and doctrines, and it is so here. The primitive theory that diseases are of supernatural origin still held its ground, and the agency of the priest consequently remained needful. Of various hospitals built by the early Christians we read:—

"It was commonly a priest who had charge of them, as, at Alexandria, S. Isidore, under the Patriarch Theophilus; at Constantinople, St. Zoticus, and after him St. Samson."

Concerning the substitution of Christian medical institutions for pagan ones, it is remarked:—

"The destruction of the Asclepions was not attended by any suitably extensive measures for insuring professional education. . . . The consequences are seen in the gradually increasing credulity and imposture of succeeding ages, until, at length, there was an almost universal reliance on miraculous interventions."

But a more correct statement would be that the pagan conceptions of disease and its treatment re-asserted themselves. Thus, according to Sprengel, after the sixth century the monks practiced medicine almost exclusively. Their cures were performed by prayers, relics of martyrs, holy water, etc., often at the tombs of martyrs. The state of things during early mediæval times, of which we know so little, may be inferred from the fact that in the twelfth century the practice of medicine by priests was found to interfere so much with their religious functions that orders were issued to prevent it; as by the Lateran Council in 1123, the Council of Reims in 1131, and again by the Lateran Council in 1139. But the usage survived for centuries later in France and probably elsewhere; and it seems that only when a papal bull permitted physicians to marry, did the clerical practice of medicine begin to decline. Says Warton, "The physicians of the University of Paris were not allowed to marry till the year 1452."

In our own country a parallel relationship similarly survived.

In 1456 "the practice of medicine was still, to some extent, in the hands of the clergy." That ecclesiastics exercised authority over medical practice in the time of Henry VIII, is shown by a statute of his third year, which reads:—

"It is enacted that no person in London, or seven miles thereof, shall practice as a physician or surgeon without examination and license of the Bishop of London, or of the Dean of Paul's, duly assisted by the faculty; or beyond these limits, without license from the bishop of the diocese, or his vicar-general, similarly assisted."

And it is alleged that down to the early part of our own century there remained with the Archbishop of Canterbury a latent power of granting medical diplomas. So that the separation between "soul-curer and body-curer," which goes on as savage peoples develop into civilized nations, has but very gradually completed itself even throughout Christian Europe.

This continuity of belief and of usage is even still shown in the surviving interpretations of certain diseases by the Church and its adherents; and it is even still traceable in certain modes of medical treatment and certain popular convictions connected with them.

In the minds of multitudinous living people there exists the notion that epidemics are results of divine displeasure; and no less in the verdict "Died by the visitation of God," than in the vague idea that recovery from, or fatal issue of, a disease, is in part supernaturally determined, do we see that the ancient theory lingers. Moreover, there is a predetermination to preserve it. When, some years ago, it was proposed to divide hospital patients into two groups, for one of which prayers were to be offered and for the other not, the proposal was resented with indignation. There was a resolution to maintain the faith in the curative effect of prayer, whether it was or was not justified by the facts; to which end it was felt desirable not to bring it face to face with the facts.

Again, down to the present day epilepsy is regarded by many as due to the possession by a devil; and the prayer-book contains a form of exorcism to be gone through by a priest to cure maladies supernaturally caused. Belief in the demoniacal origin of some diseases is indeed a belief necessarily accepted by consistent members of the Christian Church; since it is the belief taught to them in the New Testament—a belief, moreover, which survives the so-called highest culture. When, for example, we see a late Prime Minister, deeply imbued with the university spirit, publicly defending the story that certain expelled devils entered into swine, we are clearly shown that the theory of the demoniacal origin of some disorders is quite consistent with the current creed. And we are shown how, consequently, there yet remains a place for priestly action in medical treatment.

Let me add a more remarkable mode in which the primitive theory has persisted. The notion that the demon who was causing a disease must be driven out, continued, until recent times, to give a character to medical practice, and even now influences the conceptions which many people form of medicines. The primitive medicine-man, thinking to make the body an intolerable habitat for the demon, exposed his patient to this or that kind of alarming, painful, or disgusting treatment. He made before him dreadful noises and fearful grimaces, or subjected him to an almost unbearable heat, or produced under his nose atrocious stenches, or made him swallow the most abominable substances he could think of. As we saw in the case cited from Ecclesiasticus, the idea, even among the semi-civilized Hebrews, long remained of this nature. Now there is abundant proof that, not only during mediæval days but in far more recent days, the efficiency of medicines was associated in thought with their disgustingness: the more repulsive they were the more effectual. Hence Montaigne's ridicule of the monstrous compounds used by doctors in his day—"dung of elephant, the left foot of a tortoise, liver of a mole, powdered excrement of rats, etc." Hence a receipt given in Vicarie's Treasure of Anatomy (1641)—"Five spoonfuls of knave child urine of an innocent." Hence "the beliefs that epilepsy may be cured by drinking water out of the skull of a suicide or by tasting the blood of a murderer;" that "moss growing on a human skull, if dried, powdered, and taken as snuff, will cure the headache;" and that the halter and chips from the gibbet on which malefactors have been executed or exposed have medicinal properties. And there prevails in our own days among the uncultured and the young a similarly-derived notion. They betray an ingrained mental association between the nastiness of a medicine and its efficiency: so much so, indeed, that a medicine which is pleasant is with difficulty believed to be a medicine.

As with evolution at large, as with organic evolution, and as with social evolution throughout its other divisions, secondary differentiations accompany the primary differentiation. While the medical agency separates from the ecclesiastical agency, there go on separations within the medical agency itself.

The most pronounced division is that between physicians and surgeons. The origin of this has been confused in various ways, and seems now the more obscure because there has been of late arising not a further distinction between the two but a fusion of them. All along they have had a common function in the treatment of ordinary disorders and in the uses of drugs; and the "general practitioner" has come to be one who avowedly fulfills the functions of both. Indeed in our day it is common to take degrees in both medicine and surgery, and thus practically to unite these sub-professions. Meanwhile the two jointly have become more clearly marked off from those who carry out their orders. Down to recent times it was usual not only for a surgeon to compound his own medicines, but a physician also had a dispensary and sometimes a compounder: an arrangement which still survives in country districts. Nowadays, however, both medical and surgical practitioners in large places depute this part of their business to chemists and druggists.

But the apparent nonconformity to the evolutionary process disappears if we go back to the earliest stages. The distinction between doctor and surgeon is not one which has arisen by differentiation, but is one which asserted itself at the outset. For while both had to cure bodily evils, the one was concerned with evils supposed to be supernaturally inflicted, and the other with evils that were naturally inflicted—the one with diseases ascribed to possessing demons, the other with injuries inflicted by human beings, by beasts, and by inanimate bodies. Hence we naturally find in the records of early civilizations more or less decided distinctions between the two.

> "The Brahmin was the physician; but the important manual department of the profession could not be properly exercised by the pure Brahmin; and to meet this difficulty, at an early period, another caste was formed, from the offspring of a Brahmin with a daughter of a Vaishya."

There is evidence implying that the division existed in Egypt before the Christian era; and it is alleged that the Arabians systematically divided physics, surgery, and pharmacy into three distinct professions. Among the Greeks, however, the separation of functions did not exist: "the Greek physician was likewise a surgeon"—was likewise a compounder of his own medicines. Bearing in mind these scattered indications yielded by early societies, we must accept in a qualified way the statements respecting the distinctions between the two in mediæval times throughout Europe. When we remember that during the dark ages the religious houses and priestly orders were the centers of such culture and skill as existed, we may infer that priests and monks acted in both capacities; and that hence, at the beginning of the fifth century, surgery "was not yet a distinct branch of the practice of medicine." Still, it is concluded that clerics generally abstained from practicing surgery, and simply superintended the serious operations performed by their assistants: the reason being perhaps, as alleged, that the shedding of blood by clerics being interdicted, they could not themselves use the operating knife. And this may have been a part cause for the rise of those secular medical practitioners who, having been educated in the monastic schools, were, as barber-surgeons, engaged by the larger towns in the public service. Probably this differentiation was furthered by the papal edicts forbidding ecclesiastics from practicing medicine in general; for, as is argued, there may hence have arisen that compromise which allowed the clergy to prescribe medicines while they abandoned surgical practice into the hands of laymen.

Along with this leading differentiation, confused in the ways described, there have gone on, within each division, minor differentiations. Some of these arose and became marked in early stages. In ancient India—

"A special branch of surgery was devoted to rhinoplasty, or operations for improving deformed ears and noses, and forming new ones."

That the specialization thus illustrated was otherwise marked, is implied by the statement that "no less than a hundred and twenty-seven surgical instruments were described in the works of the ancient surgeons;" and by the statement that in the Sanskrit period—

"The number of medical works and authors is extraordinarily large. The former are either systems embracing the whole domain of the science, or highly special investigations of single topics."

So was it, too, in ancient Egypt. Describing the results, Herodotus writes:—

"Medicine is practiced among them [the Egyptians] on a plan of separation; each physician treats a single disorder, and no more: thus the country swarms with medical practitioners, some undertaking to cure diseases of the eye, others of the head, others again of the teeth, others of the intestines, and some those which are not local."

Though among the Greeks there was for a long period no division even between physician and surgeon, yet in later days "the science of healing became divided into separate branches, such as the arts of oculists, dentists, etc."

Broken evidence only is furnished by intermediate times; but our own times furnish clear proofs of progress in the division of labor among medical men. We have physicians who devote themselves, if not exclusively, still mainly, to diseases of the lungs, others to heart diseases, others to disorders of the nervous system, others to derangements of digestion, others to affections of the skin; and we have hospitals devoted some to this and some to that kind of malady. So, too, with surgeons. Besides such specialists as oculists and aurists, there exist men noted for skillful operations on the bladder, the rectum, the ovaria, as well as men whose particular aptitudes are in the treatment of breakages and dislocations, to say nothing of the quacks known as "bone-setters," whose success, as has been confessed to me by a surgeon, is often greater than that of men belonging to his own authorized class.

In conformity with the normal order of evolution, integration has accompanied this differentiation. From the beginning have been shown tendencies toward unions of those who practiced the healing art. There have arisen institutions giving a certain common education to them; associations of those whose kinds of practice were similar; and, in later times, certain general, though less close, associations of all medical men. In Alexandria—

"The temple of Serapis was used for a hospital, the sick being received into it, and persons studying medicine admitted for the purpose of familiarizing themselves with the appearance of disease, precisely as in such institutions at the present time."

In Rome, along with the imported worship of Æsculapius, there went the communication of knowledge in the places devoted to him. During early mediæval times the monasteries, serving as centers of instruction, gave some embodiment to the medical profession, like that which our colleges give. In Italy there later arose institutions for educating physicians, as the medical school of Salerno in 1140. In France before the end of the thirteenth century the surgeons had become incorporated into a distinct college, following, in this way, the incorporated medical faculty; and while thus integrating themselves they excluded from their class the barbers who, forbidden to perform operations, were allowed only to dress wounds, etc. In our own country there have been successive consolidations. The barber-surgeons of London were incorporated by Edward IV, and in the fifteenth century the College of Physicians was founded, and "received power to grant licenses to practice medicine—a power which had previously been confined to the bishops." Progress in definiteness of integration was shown when, in Charles I's time, persons were forbidden to exercise surgery in London and within seven miles, until they had been examined by the company of barbers and surgeons; and also when, by the 18th of George II, excluding the barbers, the Royal College of Surgeons was formed. At the same time there have grown up medical schools in various places which prepare students for examination by these incorporated medical bodies: further integrations being implied. Hospitals, too, scattered throughout the kingdom, have become places of clinical instruction, some united to colleges and some not. Another species of integration has been achieved by medical journals, weekly and quarterly, which serve to bring into communication educational institutions, incorporated bodies, and the whole profession.

Two additional facts should be noted before closing the chapter. One is the recent differentiation by which certain professors of anatomy and physiology have been made into professors of biology. In them the study of human life has developed into the study of life at large. And it is interesting to see how this specialization, seemingly irrelevant to medical practice, eventually becomes relevant; since the knowledge of animal life obtained presently extends the knowledge of human life and so increases medical skill. The other fact is that along with incorporation of authorized medical men there has arisen jealousy of the unincorporated. Like the religious priesthood, the priesthood of medicine persecutes heretics and those who are without diplomas. There has long been, and still continues, denunciation of unlicensed practitioners, as also of the "counter-practice" carried on by chemists and druggists. That is to say, there is a constant tendency to a more definite marking off of the integrated professional body.

TWO-OCEAN PASS.

By BARTON WARREN EVERMANN, Ph. D.,
ICHTHYOLOGIST OF THE UNITED STATES FISH COMMISSION.

IT was while the Great Ice King still ruled over all America from the pole to the middle United States that Lake Lahontan and Lake Bonneville spread their waters over hundreds of square miles of our western territory; Lahontan where we now have the sage plains and alkali sinks of Nevada, and Bonneville covering the greater part of Utah west of the Wasatch Mountains, but now reduced to Sevier, Utah, and Great Salt Lakes, the last shallow remnants of a once mighty inland sea. It was probably long before these great lakes had dried up, while their waters were yet fresh and sweet, that occurred an event which wrought a vast change in the physical geography of that region. Somewhere, but no one is yet certain *exactly where*, one or more great fissures opened in the earth, and there poured out an incredible amount of lava which covered not less than one hundred and fifty thousand square miles with one vast sheet of rhyolite hundreds, in some places thousands, of feet in thickness. Northern California, northwestern Nevada, nearly all of Oregon, Washington, and Idaho, and parts of Wyoming, the Yellowstone Park, Montana, and British Columbia were all covered by this stupendous flow.

The effect of this lava flow upon the present distribution of the fishes of that region is known to have been very great, and we are now beginning to understand some of the most important factors of that distribution—a distribution which, until recently, presented many anomalies.

It has been my good fortune to make explorations in Montana, Wyoming, Idaho, and the Yellowstone Park which have cleared up some of these difficulties. The presence of trout in Yellowstone Lake and the total absence of all fish from the other large lakes of the park was one of the most interesting of these anomalies, and it is to its explanation that this article is devoted.

It is certain that all the streams and lakes of the territory covered by the lava flow were wiped out of existence by the fiery flood, and all terrestrial and aquatic life destroyed. Many long years must have passed before this lava sheet became sufficiently cooled to permit the formation of new streams; but a time finally came when the rains, falling upon the gradually cooling rock, were no longer converted into steam and thrown back into the air, only to condense and fall again, but, being able to remain in liquid form upon the rock, sought lower levels, and thus new streams began to flow. And then the fishes in the connecting streams below, which had not been destroyed by the lava flow, began to invade the desolated region and repeople its waters.

The rhyolite, obsidian, and trachyte were very hard and eroded slowly, but when the streams reached the edge of the lava field they encountered rock which was comparatively soft and which wore away rapidly. The result is that every stream leaving the Yellowstone Park has one or more great waterfalls in its course where it leaves the lava sheet. Notable among these streams are Lewis River, the outlet of Lewis and Shoshone Lakes; Yellowstone River, the outlet of Yellowstone Lake; Gardiner, Gibbon, and Firehole Rivers, and Lava, Lupine, Glen, Crawfish, Tower, and Cascade Creeks, all leaving the lava sheet in beautiful falls, varying from thirty feet to over three hundred feet in vertical descent. The following is a list of the principal waterfalls in the streams in and about the park, each one of which is supposed to form an insurmountable barrier to the ascent of fish:

Great Falls of the Yellowstone	308	feet.
Upper Falls of the Yellowstone	109	"
Crystal Falls in Cascade Creek	129	"
Tower Falls in Tower Creek	132	"
Undine Falls in Lava Creek	60	"
Lower Falls in Lava Creek	50	"
Wraith Falls in Lupine Creek	100	"
Osprey Falls in Gardiner River	150	"
Rustic Falls in Glen Creek	70	"
Virginia Cascades in Gibbon River	60	"
Gibbon Falls in Gibbon River	80	"
Keppler Cascade in Firehole River	80	"
Upper Falls in Lewis River	50	"
Lower Falls in Lewis River	30	"
Moose Falls in Crawfish Creek	30	"

Two-Ocean Pass, looking East.

Besides these, there are almost innumerable falls in the smaller streams and brooks, but of them we take no account. When it is remembered that nearly all these falls are within the limits of an area fifty-five by sixty-five miles, one can get some idea of the grandeur and beauty of the Yellowstone National Park. It is doubtful if any other similar area in the world affords so many magnificent waterfalls, beautiful cascades, seething torrents, and abysmal gorges as are found here. But these are among the least of the strange and wonderful things in this wonderland, where geysers great and small, mud springs and boiling paint-pots, and petrified forests so abound. With scarcely an exception all these streams and lakes are of the best of pure, clear, cold water, well supplied with insect larvæ, the smaller crustacea, and various other kinds of the smaller animal and plant forms sufficient in amount to support an immense fish life. But it is a strange and interesting fact that, with the exception of Yellowstone Lake and River, these waters were wholly barren of fish life until recently stocked by the United States Fish Commission. The river and lake just named are well filled with the Red-throated trout (*Salmo mykiss lewisi*), and this fact is the more remarkable when it is remembered that the falls in the lower Yellowstone River are one hundred and nine and three hundred and eight feet, respectively—by far the greatest found in the park.

The total absence of fish from Lewis and Shoshone Lakes and the numerous other small lakes and streams of the park is certainly due to the various falls in their lower courses, which have proved impassable barriers to the ascent of fishes from below; for in every one of these streams, just below the falls, trout and in some cases other species of fishes are found in abundance. But to account for the presence of trout in Yellowstone Lake was a matter of no little difficulty. If a fall of thirty to fifty feet in Lewis River has prevented trout from ascending to Lewis and Shoshone Lakes, why have not the much greater falls in the Yellowstone proved a barrier to the ascent of trout to Yellowstone Lake? Certainly no fish can ascend these falls, and we must look elsewhere for the explanation.

Many years ago the famous old guide, Jim Bridger, told his incredulous friends that he had found, on the divide west of the upper Yellowstone, a creek which flowed in both directions—one end flowing east into the Yellowstone, the other west into Snake River. But, as he also told about many other strange and to them impossible things which he had seen—among which were a glass mountain, and a river which ran down hill so fast that the water was made boiling hot—they were not disposed to acknowledge the existence of his "Two-Ocean Creek." Subsequent events

Upper Falls of the Yellowstone River. One hundred and nine feet.

however, showed that the strange stories of Jim Bridger were not without some elements of truth.

Two-Ocean Pass was visited by Captain Jones in 1873, by Dr. F. V. Hayden in 1878, and by Mr. Arnold Hague in 1884. The observations made by these various explorers seemed to indicate that Two-Ocean Pass is a nearly level meadow, near the center of which is a marsh, which, in times of wet weather, becomes a small lake, and that "a portion of the waters from the surrounding mountains accumulates in the marshy meadows and gradually gravitates from either side into two small streams, one of which flows to the northeast, the other to the southwest" (Hayden).

From these reports it began to be suspected that trout, ascending Pacific Creek from Snake River, might, in time of high water, pass through the lake in Two-Ocean Pass and descend Atlantic Creek and the upper Yellowstone to Yellowstone Lake, and thus would the origin of the trout of that lake be explained. Dr. Jordan, who spent some time in the park in 1889, was impressed with the probable correctness of this explanation, but did not visit Two-Ocean Pass.

In 1891, while carrying on certain investigations in Montana and the Yellowstone Park, under the direction of the United States Commissioner of Fish and Fisheries, Colonel Marshall McDonald, I was instructed to visit Two-Ocean Pass and determine definitely the conditions which obtain there.

On August 7th, with Billy Hofer, that prince of mountaineers, as our guide, we started out from the Mammoth Hot Springs with a pack train of ten pack horses and eight saddle horses. Our route led us through all the geyser basins of the park, and we reached Two-Ocean Pass August 17th, where we remained long enough to make a careful examination.

This pass is a high mountain meadow, about eight thousand two hundred feet above the sea, and situated just south of the park, in longitude 110° 10′, latitude 44° 3′. It is surrounded on all sides by rather high mountains, except where the narrow valleys of Atlantic and Pacific Creeks open out from it. Running back among the mountains to the northward are two small cañons, down which come two small streams. On the opposite side is another cañon, down which comes another small stream. The extreme length of the meadow from east to west is about a mile, while the width from north to south is not much less. The larger of the streams coming in from the north is Pacific Creek, which, after winding along the western side of the meadow, turns abruptly westward, leaving the pass through a narrow gorge. Receiving numerous small affluents, Pacific Creek soon becomes a good-sized stream, which finally unites with Buffalo Creek a few miles above where the latter stream flows into Snake River.

Shoshone Lake, North Shore.

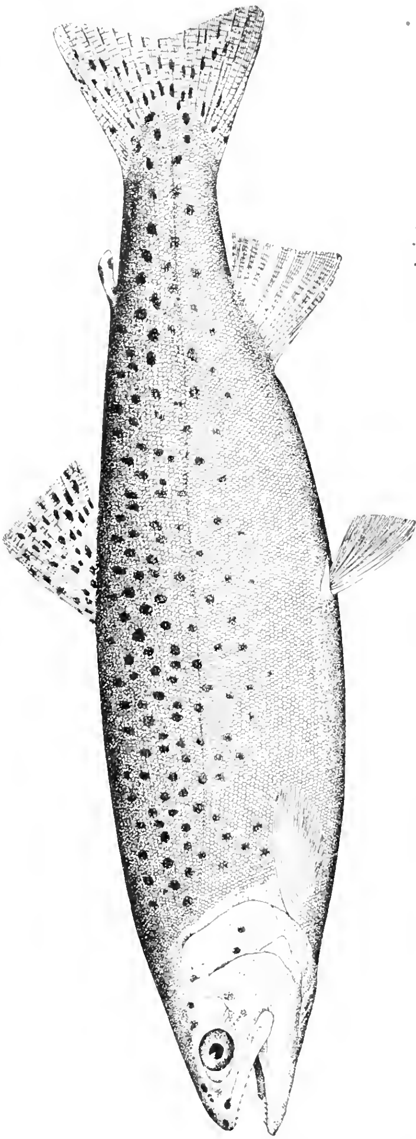
Yellowstone Lake.

Atlantic Creek was found to have two forks entering the pass. At the north end of the meadow is a small wooded cañon, down which flows the North Fork. This stream hugs the border of the flat very closely. The South Fork comes down the cañon on the south side, skirting the brow of the hill a little less closely than does the North Fork. The two, coming together near the middle of the eastern border of the meadow, form Atlantic Creek, which, after a course of a few miles, flows into the Upper Yellowstone. But the remarkable phenomena exhibited here remain to be described.

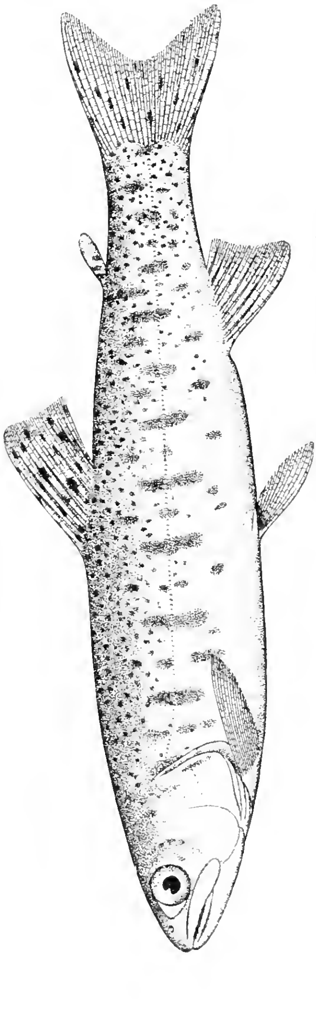
Each fork of Atlantic Creek, just after entering the meadow, divides as if to flow around an island; but the stream toward the meadow, instead of returning to the portion from which it had parted, continues its westerly course across the meadow. Just before reaching the western border the two streams unite, and then pour their combined waters into Pacific Creek; thus are Atlantic and Pacific Creeks united, and a continuous water way from the mouth of the Columbia, *via* Two-Ocean Pass, to the Gulf of Mexico is established. Two-Ocean Creek is not a myth but a verity, and Jim Bridger is vindicated. We stood upon the bank of either fork of Atlantic Creek, just above the place of the "parting of the waters," and watched the stream pursue its rapid but dangerous and uncertain course along the *very crest* of the "*Great Continental Divide.*" A creek flowing along the ridge-pole of a continent is unusual and strange, and well worth watching and experimenting with. So we waded to the middle of the North Fork, and, lying down upon the rocks in its bed, we drank the pure icy water that was hurrying to the Pacific, and, without rising, but by simply bending a little to the left, we took a draught from that portion of the stream which was just deciding to go east, *via* the Missouri-Mississippi route, to the Gulf of Mexico. And then we tossed chips, two at a time, into the stream. Though they would strike the water within an inch or so of each other, not infrequently one would be carried by the current to the left, keeping in Atlantic Creek, while the other might be carried a little to the right and enter the branch running across the meadow to Pacific Creek; the one beginning a journey which will finally bring it to the great gulf, the other entering upon a long voyage in the opposite direction to Balboa's ocean.

Pacific Creek is a stream of good size long before it enters the pass, and its course through the meadow is in a definite channel; but not so with Atlantic Creek. The west bank of each fork is low, and the water is liable to break through anywhere, and thus send a part of its water across to Pacific Creek. It is probably true that one or two branches always connect the two creeks under ordinary conditions, and that, following heavy rains, or when the snows are melting, a much greater portion of the water of Atlantic Creek finds its way across the meadow to the other.

Besides the channels already mentioned, there are several more or less distinct ones that were dry at the time of our visit. As



Salmo Mykiss Walbaum. Red-throated trout; adult; one half natural size.



Salmo Mykiss. Red throated trout; young; natural size.

already stated, the pass is a nearly level meadow, covered with a heavy growth of grass and many small willows one to three feet high. While it is somewhat marshy in places, it has nothing of the nature of a lake about it. Of course, during wet weather the small springs at the borders of the meadow would be stronger; but the important facts are that there is no lake or even marsh there, and that neither Atlantic nor Pacific Creek has its rise in the meadow. Atlantic Creek, in fact, comes into the pass as two good-sized streams from opposite directions, and leaves it by at least four channels, thus making an island of a considerable portion of the meadow. And it is certain that there is, under ordinary circumstances, a continuous waterway through Two-Ocean Pass of such a character as to permit fishes to pass easily and readily from Snake River over to the Yellowstone, or in the opposite direction. Indeed, it is possible, barring certain falls in

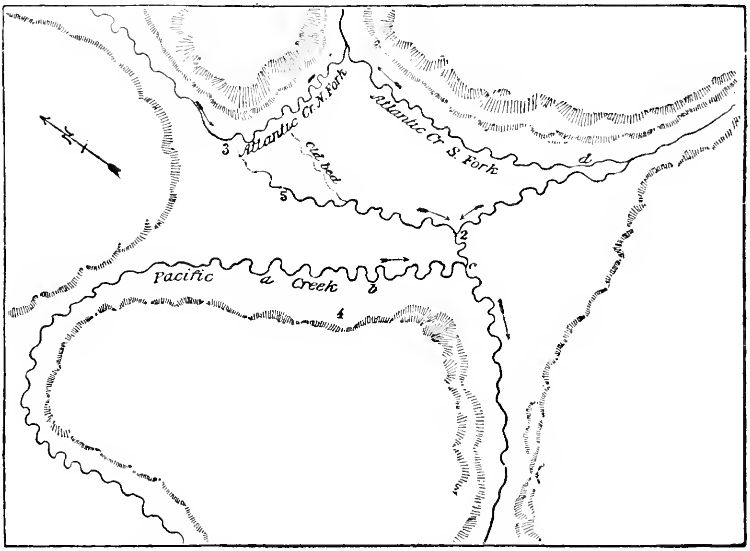


Diagram showing Relation of Streams in Two-Ocean Pass.

Snake River, for a fish so inclined to start at the mouth of the Columbia, travel up that great river to its principal tributary, the Snake, thence on through the long, tortuous course of that stream, and, under the shadows of the Grand Tétons, enter the cold waters of Pacific Creek, by which it could journey on up to the very crest of the Great Continental Divide to Two-Ocean Pass; through this pass it may have a choice of two routes to Atlantic Creek, in which the down-stream journey is begun. Soon it reaches the Yellowstone, down which it continues to Yellowstone Lake, then through the lower Yellowstone out into the turbid waters of the Missouri. For many hundred miles it may continue down this mighty river before reaching the Father of Waters, which will finally carry it to the Gulf of Mexico—a wonderful journey of nearly six thousand miles, by far the longest possible fresh-water journey in the world.

We found trout in Pacific Creek at every point where we examined it. In Two-Ocean Pass we obtained specimens from each of the streams, and in such positions as would have permitted them to pass easily from one side of the divide to the other. We also caught trout in Atlantic Creek below the pass, and in the upper Yellowstone, where they were abundant.

Thus it is certain that there is no obstruction even in dry weather to prevent the passage of trout from the Snake River to Yellowstone Lake; it is quite evident that trout do pass over in this way; and it is almost absolutely certain that Yellowstone Lake was stocked with trout from the west, *via* Two-Ocean Pass.

From the basin of Snake River above Shoshone Falls we know at least twelve different species of fishes, but of all these the trout is the only one which has been able to pass over the Continental Divide and establish itself in Yellowstone Lake and its tributary streams, for no other species is known from those waters. But these twelve species are, as a rule, fishes of intermediate altitudes, rarely ascending into streams so cold as Pacific Creek. The only one which accompanies the trout into Pacific Creek is the blob (*Cottus bairdi punctulatus*), which we found even in Two-Ocean Pass, but it has never been seen on the Yellowstone side of the pass.

THE DECLINE IN RAILWAY CHARGES.

By H. T. NEWCOMB.

THE efficiency of any general system of transportation necessarily depends upon its safety, speed, and cost, and of these the last is clearly of paramount importance, for, unless charges can be made sufficiently moderate, no means of transportation can be generally available to the public, even though it possesses in the highest degree each of the other qualities. The superiority of railways as a means of moving passengers and freight between localities not connected by natural waterways lies primarily in the fact that they furnish transportation at a cost so low when compared with all other means of transportation that even the highest railway charges are relatively insignificant.

Competent authority has stated that, under the best methods of transportation over ordinary highways, wheat, the most valuable of cereal products, would bear transportation only two hundred and fifty miles to markets where it would sell for a dollar and a half per bushel, and that the market for corn at seventy-five cents per bushel must be within a radius of a hundred and fifty miles from the point of production. To-day, both of these products are carried from the great surplus-producing regions west of the Mississippi River and sold at much lower prices than those named, in order to supply the denser populations located in the Eastern States and in Europe. Grain and flour are now carried from Chicago to New York over railway routes ranging from nine hundred and twelve to a thousand and forty-two miles in length, for twenty cents per hundred pounds, or only about four and a third mills per ton per mile for the shorter distance.

Dry goods, such as calicoes, Canton flannel, canvas, linen crash, ginghams, jeans, and sheetings, are taken from Boston to Vicksburg, Miss., about fifteen hundred and seventy miles, for fifty cents per hundred pounds, or a little more than six and a third mills per ton per mile. The rate on canned goods, including fish, fruits, meats, and vegetables, from San Francisco to St. Louis over rail lines from twenty-two hundred and eighty to twenty-nine hundred and fifty miles in length, is seventy-five cents per hundred pounds, or about one half of one cent per ton per mile.

These are merely examples of charges on important articles of commerce selected at random and without any intention of showing the lowest charges in existence, as will be clearly apparent when it is added that the average charge upon all freight traffic carried by rail in the United States during the year ending on June 30, 1894, was only 0·866 cent per ton per mile. The average for the States of Ohio, Indiana, Michigan, and the portions of New York and Pennsylvania situated west of Buffalo and Pittsburg was only 0·682 cent during the same year.

Although the immediate effect of the introduction of railway transportation must have been seen in rates very much lower than any previously available, and the consequent extension of the radii of the areas available for maketing surplus products, the present exceedingly low charges have been reached through a long and steady process during which the tendency toward lower rates has become one of the most generally recognized characteristics of railway development. While the existence of this tendency has been generally remarked, little attempt has been made to trace its extent, and even when the effort is made the investigation is found to be attended with numerous difficulties, owing to the absence of adequate records of the early period of railway development. This is especially to be regretted in view of the paramount importance of complete information regarding our railway system, at a time when its effective regulation by legislative authority is one of the problems of government attracting widest attention, and perhaps even more than others requiring in its solution the co-operation of enlightened public sentiment with ripe experience and skillful statecraft.

Fortunately, many railways have preserved data showing the average charges per ton per mile during each year on all freight carried over their lines, and from these it is possible to present an interesting comparison of present with former charges. Such a comparison has the advantage that it gives the average of all charges, and therefore presents the actual net result of all changes, whether advances or reductions. It has the concurrent disadvantage that it fails to take account of the large increase in long-distance traffic, which is naturally carried at lower average rates per mile, and in consequence may show an apparent decline when charges for exactly similar service have remained stationary. The error from this cause is not, however, believed to be of such importance as to materially influence the result.

According to the last annual report made by the statistician of the Interstate Commerce Commission, the aggregate transportation of freight by the railways of the United States during the year ending on June 30, 1893, was equivalent to moving 93,588,-111,833 tons one mile. Estimating the population at 66,551,571, which allows an annual increase of one and a quarter millions since 1890, this was equal to moving fourteen hundred and six tons one mile *per capita* of population.

Upon this basis the following table has been prepared, showing the average cost of moving fourteen hundred and six tons of freight one mile over important railways in each section of the country during every fifth year from 1852, for which the average rates per ton per mile could be obtained, and during 1893:

Year.	Charge for carrying 1,406 tons of freight one mile at average rate per ton per mile during each year.									
	Fitchburg R. R.	New York, Lake Erie and Western R. R.	Pennsylvania R. R.	Lake Shore and Michigan Southern Ry.	Illinois Central R. R.	Denver and Rio Grande R. R.	Louisville and Nashville R. R.	Chicago, Milwaukee and St. Paul Ry.	Union Pacific Ry.	United States.
1852......	$43 87	$27 42	$76 21							
1857......	55 26	34 59	33 88	$38 52						
1862......	52 73	26 57	28 68	29 53	$27 56					
1867......	59 19	28 68	29 24	34 17	40 77		$58 07	$55 40		
1872......	55 12	21 51	20 53	19 26	30 37	$86 33	32 34	34 17	$32 90	
1877......	29 24	13 50	14 20	12 09	25 59	43 45	24 75	29 24	27 00	
1882......	16 45	10 55	12 23	8 86	19 97	51 32	18 98	20 81	31 07	$17 37
1887......	15 89	9 70	10 26	9 42	15 33	33 60	14 34	15 33	19 97	14 54
1892......	13 01	8 63	9 10	8 46	12 77	26 19	13 33	14 43	15 20	12 63
1893......	12 98	8 87	8 72	8 42	11 88	24 76	12 89	14 43	14 52	12 34

The foregoing statement shows reductions startling in amount and distributed throughout all sections of the country. It is seen that the Fitchburg Railroad now receives only $13.10 for an amount of transportation for which as late as the year 1867 it would have charged $59.19, while other railways show even greater proportionate reductions. Similar data, including all railway traffic, are not available for the years prior to 1882, but reductions since that time are shown to have been extensive.

It should not, however, be understood that the amount paid *per capita* for freight transportation by rail has decreased in the proportion shown by these figures. The most obvious result of declining rates is an extension of the utility of transportation facilities, as is amply shown by the statistics of freight movement. During 1882 the total railway freight service was equal to only 39,302,209,249 ton-miles, or about seven hundred and fifty-two tons carried one mile *per capita*, and the decline in the average charge per ton-mile from 1·236 cent in that year to 0·878 cent in 1893 was accompanied by an increase in the volume of traffic of nearly two hundred and fifty per cent, and in the amount of transportation *per capita* to almost twice that of 1882. The increase in tonnage movement in proportion to population was about eighty-seven per cent, and in the aggregate sum received therefor by the railways only thirty-seven per cent.

It will not be sufficent to abandon the investigation of changes in the charges for moving freight at this stage, nor to remain satisfied with mere general averages of those charges. The more minute inquiry which deals with actual rates upon specific commodities of commercial importance affords quite as interesting and it is confidently believed equally important and significant results. The rate from Chicago to New York on grain and flour,

	WHEAT.		
	Export price per bushel.	Average rate per bushel.	Number of bushels which could be carried from Chicago to New York for export price of one bushel.
1867	$1 27	44·75 cents.	2·84
1872	1 47	34·99 "	4·20
1877	1 17	20·50 "	5·71
1882	1 19	14·47 "	8·22
1887	89	15·75 "	5·65
1892	1 03	13·80 "	7·46
1893	80	14·63 "	5·47
1894	67	12·88 "	5·20

which are nearly always classed together for rate-making purposes, is indisputably the most important single rate that could be selected. It derives its prominence not alone from the fact that it applies to the most important agricultural and food products, when shipped from the greatest grain market in the world to its principal port of export, but also because it is the basis of all charges on grain and flour shipped from the western regions of surplus production to the Eastern States. Any modification of this rate, therefore, effects a corresponding change in the transportation charge on nearly every bushel of grain and barrel of flour produced in the United States, and directly affects the price to producer and consumer of these important commodities.

The preceding table shows the average wheat rate from Chicago to New York, the average export price as compiled by the Bureau of Statistics, and the number of bushels which could be shipped between those points for a sum equal to the export price during each of the years named.

This table shows that the reduction in rates has been considerably in excess of that in the price of wheat, and the same is probably true of the other cereal products and of flour.

The rates charged on the artificial fertilizers so largely used on the cotton plantations of the south are of great importance to the producers of that section. Taking that from Charleston, S. C., to Albany, Ga., as an example, it is found to have been reduced from $4.30 per ton in 1884 to $2.59 in 1894. Equally important changes have taken place in the rates on the product itself, cotton being now shipped from Memphis to Boston *via* rail for fifty-five and a half cents per one hundred pounds, a reduction of about thirty per cent from the rate in force during 1880, which was seventy-nine cents.

Nearly every one is familiar with the importance of the live-stock movement from the southwest to Chicago. Shipments of live cattle are concentrated at the railway centers on the Missouri River and are carried forward to destination in train loads. The rate per car load from 1877 to July, 1881, was $67.50. It was then reduced to $60, but was advanced to $65, remaining at that figure from 1883 to 1887. It is now twenty-three and a half cents per hundred pounds, which is equivalent to $56.40 per car load. The rate on packed meats from Cincinnati to New York city averaged seventy-one and a quarter cents per hundred pounds during 1867; during 1877 the average was 31·93 cents; during 1887, 27·12 cents; and during 1893, 25·43 cents.

Turning to passenger traffic, it is found that the tendency toward increased speed and improved facilities has operated as a limitation upon reductions in charges, though by no means wholly preventing them. The earliest available data give the average charge per passenger per mile during the year 1880 as 2·51 cents, which is higher than any subsequent year. The average for 1893 was 1·976 cents, and the saving upon the traffic of that year over what the public would have paid at the higher rates of 1880 amounted to $80,568,025.

Numerous reductions equal to those given could be cited and to enumerate them all would require a statement showing rates between practically all railway stations and upon nearly every article commonly offered for shipment by rail. As such a mass of detail would be unnecessarily confusing, it is important to endeavor to discover some means for measuring at least with approximate accuracy the aggregate public saving by means of reduced charges for railway transportation. Fortunately, we have such a means which may be made highly satisfactory so far, at least, as relates to the last decade. The entire transportation performed by the railways of the United States during the ten years ending on June 30, 1893, was equal to moving 113,170,723,026 passengers and 681,500,465,282 tons of freight one mile; and had the average rates of 1883 been maintained upon this aggregate, the public would have paid $251,981,813 for passenger and $1,797,078,221 for freight transportation more than was actually received by the railways. The total sum gained by the public by means of reduced charges was therefore $2,049,060,034, an amount equal to one fifth of the present aggregate railway capital, and almost exactly equal to the entire revenue the United States Government derived from customs duties during the same period.

The effect of the decline in the amounts received for similar railway service upon railway revenues can not be neglected by intelligent students of transportation. The following comparisons between the years 1871, 1882, and 1893 are therefore presented:

	PER MILE OF LINE OPERATED.		
	1871.	1882.	1893.
Capitalization—stock and bonds	$59,426	$61,969	$59,729
Gross earnings	9,040	7,189	7,190
Operating expenses	6,863	4,290	4,876
Net earnings	3,177	2,899	2,314
Freight earnings	6,600	4,725	4,883
Passenger earnings	2,441	1,886	1,776
Dividends	1,265	952	594

From the foregoing it is seen that the average railway capitalization has changed but little. Gross earnings per mile decreased during the first half of the period, but have remained without material change during the last; or, in other words, the increased traffic has so far balanced the decrease in charges that the average gross revenue has not changed. Operating expenses have increased during the last eleven years, though during the period from 1871 to 1882 they showed a decline. The explanation is, that during the first period increased density of traffic permitted economies in conducting transportation which had the effect of reducing the average cost to the carriers. It would appear, however, that a point was reached beyond which the institution of new economies could not keep pace with increased traffic at low rates, and that this had its natural effect in the second period. This explanation gains force when the constant decrease in average net earnings per mile is noted. Average freight and passenger earnings are seen to have fallen off considerably since 1871, and the final effect of these changes is summarized by the item of dividends, which are seen to be less than fifty per cent of those paid during 1871.

The more complete statistics of the last ten years afford still more impressive results. The following data are for the year ending on June 30, 1893, and comparisons by means of percentages with 1884 are given:

	1893.	COMPARED WITH 1884.	
		Increase, per cent.	Decrease, per cent.
Tons of freight carried one mile	93,588,111,833	109·25	
Average rate per ton per mile	0·878 cent	......	21·96
Freight revenue	$829,053,861	63·55	
Passengers carried one mile	14,229,101,084	62·09	
Average rate per passenger per mile	2·108 cents	......	10·53
Passenger revenue	$301,491,816	44·74	
Operating expenses	$827,921,299	64·72	
Net earnings	$392,830,575	46·54	
Dividends	$100,929,885	......	1·10

It is thus seen that more than double the freight transportation of 1884 is now performed for a total compensation less than two thirds greater; that passenger transportation has increased eighteen per cent more than the sum paid therefor; and that the capital now invested in the stock of one hundred and seventy-six thousand miles of railway receives in dividends a sum absolutely less than did that invested in the one hundred and twenty-five thousand miles operated during 1884. These figures furnish a key to the reasons which justified Judge Cooley's epigrammatic summary of the financial condition of the railway interest when he declared that it "represents an enormous aggregate of wealth and an increasing aggregate of corporate poverty."

The natural query is, What is to be the result? Are railway rates to go still lower, and the return to invested capital become even less than at present; or are charges to remain stationary, and the public benefit from cheapening transportation be finally or even temporarily suspended?

Probably the best informed among railway managers would declare that their charges are already too low, and that it is highly important to discover some means for preventing further reductions. As to what means would safely accomplish this result there is great diversity of opinion, and not a few managers whose knowledge of the conditions governing the business of transportation has accrued during long years of practical experience are emphatic in the announcement of their belief that the tendency toward lower charges is the result of commercial laws which they have no power to restrain. If the latter opinion is the correct one, as may reasonably be assumed from the history of railway transportation, as well as from a consideration of the competition to which rail carriers are everywhere subject, not only among themselves but from common carriers operating *via* our rivers and lakes, and of the recent impetus which has been given to the construction of artificial waterways by the completion of the Manchester Canal, it is necessary to discover means for further reducing charges without at the same time decreasing net revenue so as to ultimately result in deterioration and bankruptcy of the railways. Obviously, the return to capital must not be much further reduced. With a large portion of the railways of the country in the hands of receivers, the securities of nearly all selling lower than ever before, and being returned in larger quantities from European exchanges, it is evident that the door to further reductions at the expense of capital is closed. Railway transportation, then, must become cheaper by reducing its cost to the corporations conducting it; and as it has been shown that operating expenses per mile of line have increased during the past decade, while gross revenue has remained practically stationary, it is apparent that this can only be accomplished through the introduction of economies not now practiced.

These economies, the nature of which is evident to every experienced railway manager and every intelligent student of transportation, can be effected by the actual or tacit consolidation of railway properties, and their extent and importance will be in direct ratio to the thoroughness of the consolidation and the degree in which the conflicting interests are brought into subjection. The wastes of competition are nowhere more evident nor their detrimental effect upon society as a whole more clearly apparent than in railway transportation.

The legislative restraints upon consolidation should be removed, agreements and contracts between common carriers where not in contravention of public policy should be given legal sanction, in order that the products of farms and factories may be distributed and exchanged at lower cost and with greater freedom. If necessary, the means of governmental regulation should be strengthened, and the operation of the consolidated properties brought more in harmony with public interests. If, as a final result, it should appear that absolute government ownership is safe, practicable, and likely to be productive of much good, it is not unduly optimistic confidently to expect that our institutions will be found perfectly adequate for the new task, and it will certainly be found much easier to deal with a few large corporations than with the multitude of smaller ones now in existence.

PLEASURES OF THE TELESCOPE.

By GARRETT P. SERVISS.

V.—IN SUMMER STAR-LANDS.

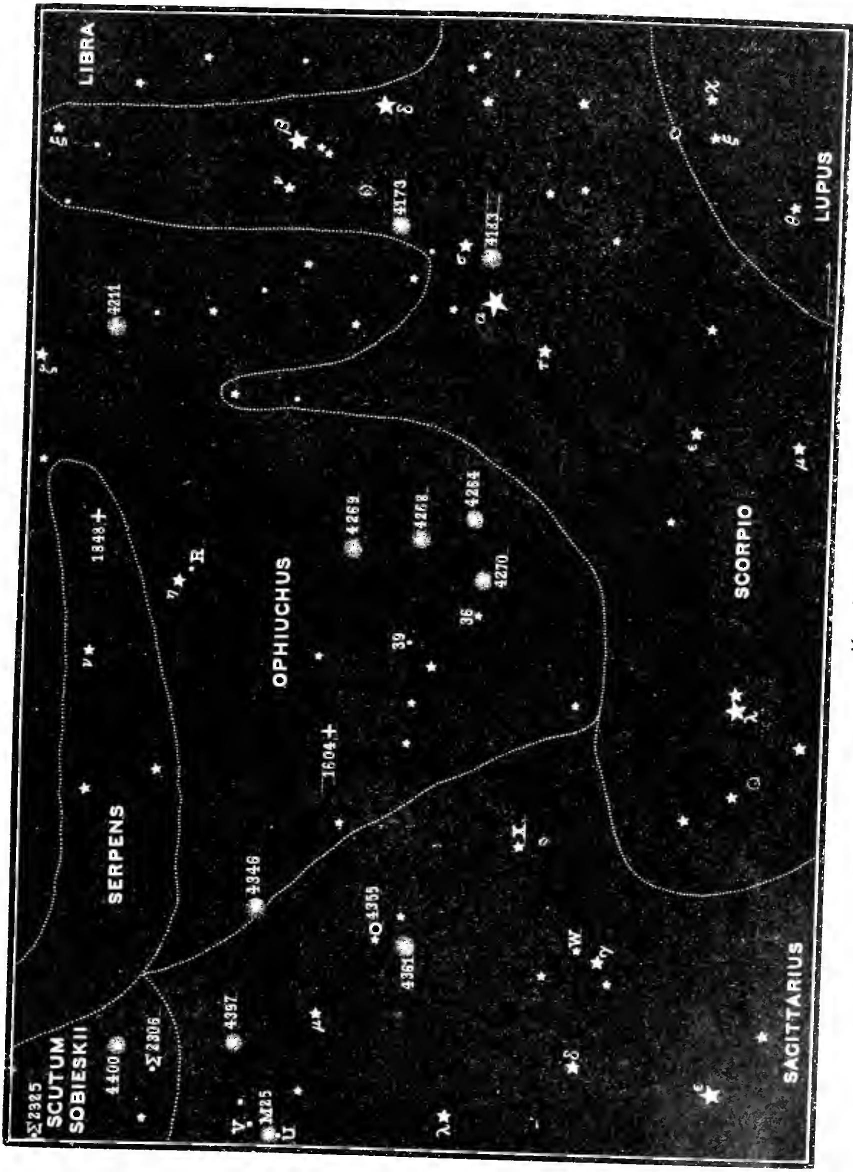
IN the soft air of a summer night, when fireflies are flashing their lanterns over the fields, the stars do not sparkle and blaze like those that pierce the frosty skies of winter. The light of Sirius, Aldebaran, Rigel, and other midwinter brilliants possesses a certain gemlike hardness and cutting quality, while Antares and Vega, the great summer stars, and Arcturus, when he hangs westering in a July night, exhibit a milder radiance, according with the character of the season. This difference is, of course, atmospheric in origin, although it may be partly subjective, depending upon the mental influences of the mutations of Nature.

The constellation Scorpio is nearly as striking in outline as Orion, and its brightest star, the red Antares (α in map No. 12), carries concealed in its rays a green jewel which, to the eye of the enthusiast in telescopic recreation, appears more beautiful and inviting each time that he penetrates to its hiding place.

We shall begin our night's work with this object, and the four-inch glass will serve our purpose, although the untrained observer would be more certain of success with the five-inch. A friend of mine has seen the companion of Antares with a three-inch, but I have never tried the star with so small an aperture. When the air is steady and the companion can be well viewed, there is no finer sight among the double stars. The contrast of colors is beautifully distinct—fire-red and bright green. The little green star has been seen emerging from behind the moon, after an occultation, ahead of its ruddy companion. The magnitudes are one and seven and a half or eight; distance 3″, p. 270°. Antares is probably a binary, although its binary character has not yet been established.

A slight turn of the telescope tube brings us to the star σ, a wide double, the smaller component of which is blue or plum-colored; magnitudes four and nine, distance 20″, p. 272°. From σ we pass to β, a very beautiful object, of which the three-inch gives us a splendid view. Its two components are of magnitudes two and six; distance 13″, p. 30°; colors, white and bluish. It is interesting to know that the larger star is itself double, although none of the telescopes we are using can split it. Burnham discovered that it has a tenth-magnitude companion; distance less than 1″, p. 87°.

And now for a triple, which will probably require the use of our largest glass. Up near the end of the northern prolongation of the constellation we perceive the star ξ. The three-inch shows us that it is double; the five-inch divides the larger star again. The magnitudes are respectively five, five and a half, and seven and a half; distances 1″·23″, p. 208°, and 7″, p. 70°.



Map No. 12

A still more remarkable star, although one of its components is beyond our reach, is ν. With the slightest magnifying this object splits up into two stars, of magnitudes four and seven, situated rather more than 40″ apart. A high power divides the seventh-magnitude companion into two, each of magnitude six and a half; distance 1·8″, p. 42°. But (and this was another of Burnham's discoveries) the fourth-magnitude star itself is double; distance 0·8″, p. about 0°. The companion in this case is of magnitude five and a half.

Next we shall need a rather low-power eyepiece and our largest aperture in order to examine a star cluster, No. 4173, which was especially admired by Sir William Herschel, who discovered that it was not, as Messier had supposed, a circular nebula. Herschel regarded it as the richest mass of stars in the firmament, but with a small telescope it appears merely as a filmy speck that has sometimes been mistaken for a comet. In 1860 a new star, between the sixth and seventh magnitude in brilliance, suddenly appeared directly in or upon the cluster, and the feeble radiance of the latter was almost extinguished by the superior light of the stranger. The latter disappeared in less than a month, and has not been seen again, although it is suspected to be a variable, and, as such, has been designated with the letter T. Two other known variables, both very faint, exist in the immediate neighborhood. According to the opinion that has generally been looked upon with favor, the variable T, if it is a variable, simply lies in the line of sight between the earth and the star cluster, and has no actual connection with the latter. But this opinion may not, after all, be correct. The cluster 4183, just west of Antares, is also worth a glance with the five-inch glass. It is dense, but its stars are very small, so that to enjoy its beauty we should have to employ a large telescope. Yet there is a certain attraction in those far-away glimpses of starry swarms, for they give us some perception of the awful profundity of space. When the mind is rightly attuned for these revelations of the telescope, there are no words that can express its impressions of the overwhelming perspective of the universe.

The southern part of the constellation Ophiuchus is almost inextricably mingled with Scorpio. We shall, therefore, look next at its attractions, beginning with the remarkable array of star clusters 4264, 4268, 4269, and 4270. All of these are small, 2′ or 3′ in diameter, and globular in shape. No. 4264 is the largest, and we can see some of the stars composing it. But these clusters, like those just described in Scorpio, are more interesting for what they mean than for what they show; and the interest is not diminished by the fact that their meaning is more or less of a mystery. Whether they are composed of pygmy suns or of great solar globes like that one which makes daylight for the earth, their association in spherical groups is equally suggestive.

There are two other star clusters in Ophiuchus, and within the limits of map No. 12, both of which are more extensive than those we have just been looking at. No. 4211 is 5′ or 6′ in diameter, also globular, brighter at the center, and surrounded by several comparatively conspicuous stars. No. 4346 is still larger, about half as broad as the moon, and many of its scattered stars are of not less than the ninth magnitude. With a low magnifying power the field of view surrounding the cluster appears powdered with stars.

There are only two noteworthy doubles in that part of Ophiuchus with which we are at present concerned: 36, whose magnitudes are five and seven, distance 4·3″, p. 195°, colors yellow and red; and 39, magnitudes six and seven and a half, distance 12″, p. 356°, colors yellow or orange and blue. The first named is a binary whose period has not been definitely ascertained.

The variable R has a period a little less than three hundred and three days. At its brightest it is of magnitude seven or eight, and at minimum it diminishes to about the twelfth magnitude.

The spot where the new star of 1604 appeared is indicated on the map. This was, with the exception of Tycho's star in 1572, the brightest temporary star of which we possess a trustworthy account. It is frequently referred to as Kepler's star, because Kepler watched it with considerable attention, but unfortunately he was not as good an observer as Tycho was. The star was first seen on October 10, 1604, and was then brighter than Jupiter. It did not, however, equal Venus. It gradually faded and in March, 1606, disappeared. About twelve degrees northwest of the place of the star of 1604, and in that part of the constellation Serpens which is included in map No. 12, we find the location of another temporary star, that of 1848. It was first noticed by Mr. Hind on April 28th of that year, when its magnitude was not much above the seventh, and its color was red. It brightened rapidly, until on May 2d it was of magnitude three and a half. Then it began to fade, but very slowly, and it has never entirely disappeared. It is now of the twelfth or thirteenth magnitude.

In passing we may glance with a low power at ν Serpentis, a wide double, magnitudes four and nine, distance 50″, p. 31°, colors contrasted but uncertain.

Sagittarius and its neighbor, the small but rich constellation Scutum Sobieskii, attract us next. We shall first deal with the western portions of these constellations which are represented on Map No. 12. The star μ in Sagittarius is a wide triple, magnitudes three and a half, nine and a half, and ten, distances 40″, p. 315°, and 45″, p. 114°. But the chief glory of Sagittarius (and the same statement applies to Scutum Sobieskii) lies in its assemblage of star clusters. One of these, No. 4361, also known as M 8, is plainly visible to the naked eye as a bright spot in the Milky Way.

We turn our five-inch telescope, armed with a low magnifying power, upon this object and enjoy a rare spectacle. As we allow it to drift through the field we see a group of three comparatively brilliant stars advancing at the front of a wonderful train of mingled star clusters and nebulous clouds. A little northwest of it appears the celebrated trifid nebula, No. 4355 on the map. There is evidence that changes have occurred in this nebula since its discovery in the last century. Barnard has made a beautiful photograph showing M 8 and the trifid nebula on the same plate, and he remarks that the former is a far more remarkable object than its more famous neighbor. Near the eastern border of the principal nebulous cloud there is a small and very black hole with a star poised on its eastern edge. This hole and the star are clearly shown in the photograph.

Cluster No. 4397 (M 24) is usually described as resembling, to the naked eye, a protuberance on the edge of the Milky Way. It is nearly three times as broad as the moon, and is very rich in minute stars, which are just at that degree of visibility that crowds of them are continually appearing and disappearing while the eye wanders over the field, just as faces are seen and lost again in a vast assemblage of people. This kind of luminous agitation is not peculiar to M 24, although that cluster exhibits it better than most others do on account both of the multitude and the minuteness of its stars.

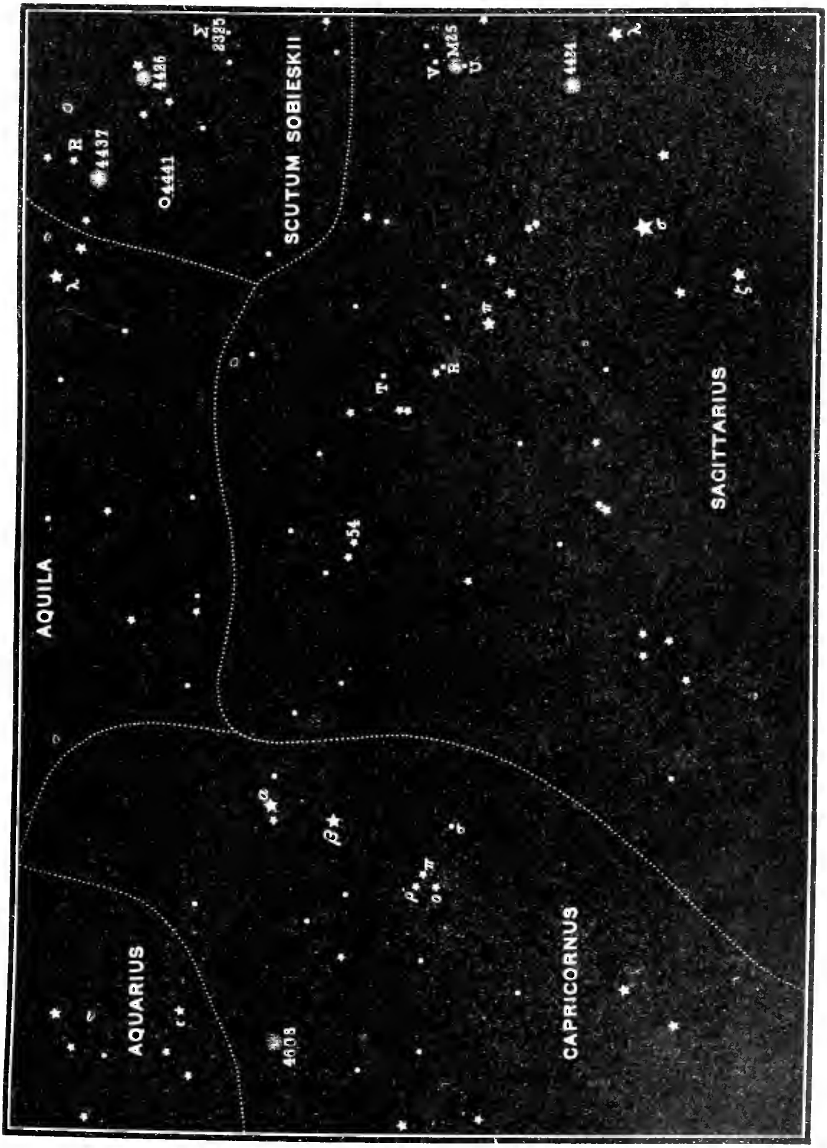
A slight sweep eastward brings us to yet another meeting place of stars, the cluster M 25, situated between the variables U and V. This is brilliant and easily resolved into its components, which include a number of double stars.

The two neighboring variables just referred to are interesting. U has a period of about six days and three-quarters, and its range of magnitude runs from the seventh down to below the eighth. V is a somewhat mysterious star. Chandler removed it from his catalogue of variables because no change had been observed in its light by either himself, Sawyer, or Yendell. Quirling, the discoverer of its variability, gave the range as between magnitudes 7·6 and 8·8. It must, therefore, be exceedingly erratic in its changes, resembling rather the temporary stars than the true variables.

In that part of Scutum Sobieskii contained in map No. 12 we find an interesting double, Σ 2325, whose magnitudes are six and nine, distance 12·3″, p. 260°, colors white and orange. Σ 2306 is a triple, magnitudes seven, eight, and nine, distances 12″, p. 220°, and 0·8″, p. 68°. The third star is, however, beyond our reach. The colors of the two larger are respectively yellow and violet.

The star cluster 4400 is about one quarter as broad as the moon, and easily seen with our smallest aperture.

Passing near to the region covered by map No. 13, we find the remaining portions of the constellations Sagittarius and Scutum Sobieskii. It will be advisable to finish with the latter first.



Map No. 14.

Glance at the clusters 4426 and 4437. Neither is large, but both are rich in stars. The nebula 4441 is a fine object of its kind. It brightens toward the center, and Herschel thought he had resolved it into stars. The variable R is remarkable for its eccentricities. Sometimes it attains nearly the fourth magnitude, although usually at maximum it is below the fifth, while at minimum it is occasionally of the sixth and at other times of the seventh or eighth magnitude. Its period is irregular.

Turning back to Sagittarius, we resume our search for interesting objects there, and the first that we discover is another star cluster, for the stars are wonderfully gregarious in this quarter of the heavens. The number our cluster bears on the map is 4424, corresponding with M 22 in Messier's catalogue. It is very bright, containing many stars of the tenth and eleventh magnitudes, as well as a swarm of smaller ones. Sir John Herschel regarded the larger stars in this cluster as possessing a reddish tint. Possibly there was some peculiarity in his eye that gave him this impression, for he has described a cluster in the constellation Toucan in the southern hemisphere as containing a globular mass of rose-colored stars inclosed in a spherical shell of white stars. Later observers have confirmed his description of the shape and richness of this cluster in Toucan, but have been unable to perceive the red hue of the interior stars.

The eastern expanse of Sagittarius is a poor region compared with the western end of the constellation, where the wide stream of the Milky Way like a great river enriches its surroundings. The variables T and R are of little interest to us, for they never become bright enough to be seen without the aid of a telescope. In 54 we find, however, an interesting double, which with larger telescopes than any of ours appears as a triple. The two stars that we see are of magnitudes six and seven and a half; distance 45″, p. 42°, colors yellow and blue. The third star, perhaps of thirteenth magnitude, is distant 36″, p. 245°.

Retaining map No. 13 as our guide, we examine the western part of the constellation Capricornus. Its leader α is a naked-eye double, the two stars being a little more than 6′ apart. Their magnitudes are three and four, and both have a yellowish hue. The western star is α^1, and is the fainter of the two. The other is designated as α^2. Both are double. The components of α^1 are of magnitudes four and eight and a half; distance 44″, p. 220°. With the Washington twenty-six-inch telescope a third star of magnitude fourteen has been found at a distance of 40″, p. 182°. In α^2 the magnitudes of the components are three and ten and a half; distance 7·4″, p. 150°. The smaller star has a companion of the twelfth or thirteenth magnitude; distance 1·2″, p. 240°. This, of course, is hopelessly beyond our reach. Yet another star of magnitude nine, distance 154″, p. 156°, we may see easily.

Dropping down to β, we find it to be a most beautiful and easy double, possessing finely contrasted colors, gold and blue. The larger star is of magnitude three, and the smaller, the blue one, of magnitude six; distance 205″, p. 267°. Between them there is a very faint star which larger telescopes than ours divide into two, each of magnitude eleven and a half; separated 3″, p. 325°.

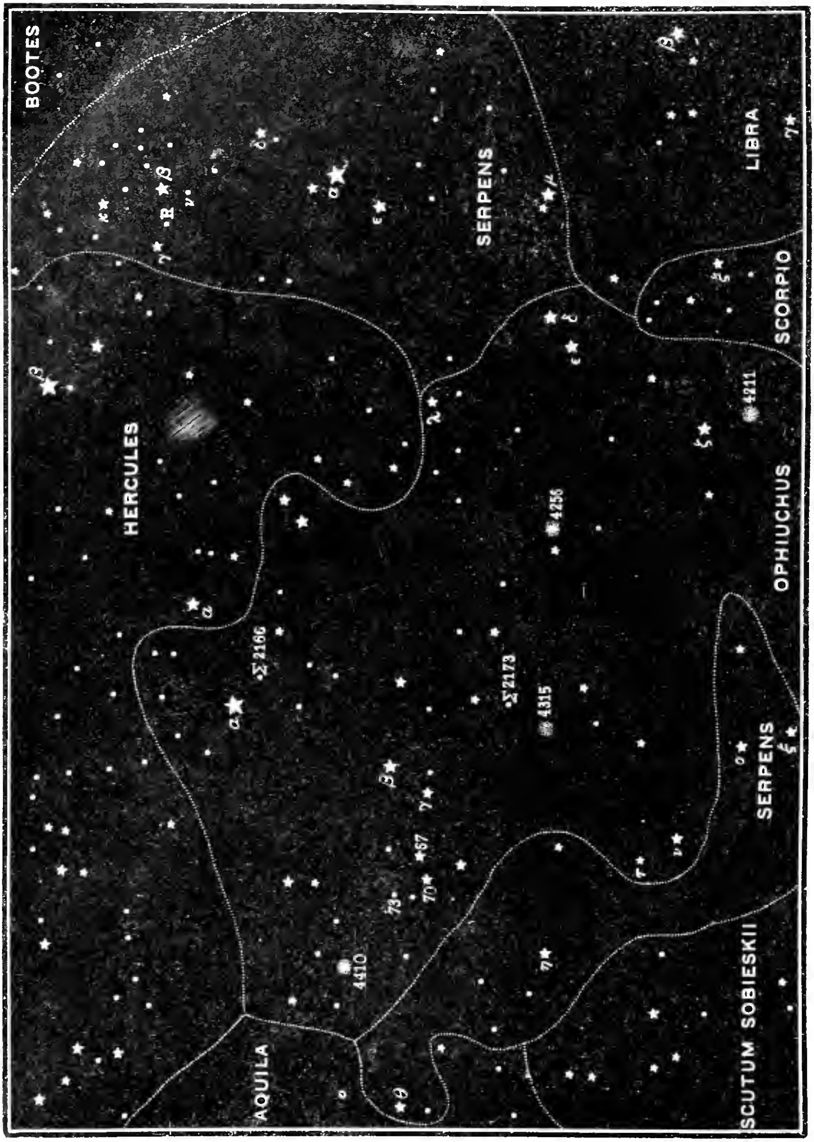
Still farther south and nearly in a line drawn from α through β we find a remarkable group of double stars, σ, π, ρ, and o. The last three form a beautiful little triangle. We begin with σ, the faintest of the four. The magnitudes of its components are six and nine; distance 54″, p. 177°. In π the magnitudes are five and nine, distance 3·4″, p. 145°; in ρ, magnitudes five and eight, distance 3·8″, p. 177° (a third star of magnitude seven and a half is seen at a distance of 4′, p. 150°); in o, magnitudes six and seven, distance 22″, p. 240°.

The star cluster 4608 is small, yet, on a moonless night, worth a glance with the five-inch.

We now pass northward to the region covered by map No. 14, indluding the remainder of Ophiuchus and Serpens. Beginning with the head of Serpens, in the upper right-hand corner of the map, we find that β, of magnitude three and a half, has a ninth-magnitude companion, distance 30″, p. 265°. The larger star is light blue and the smaller one yellowish. The little star ν is double, magnitudes five and nine, distance 50″, p. 31°, colors contrasted but uncertain. In δ we find a closer double, magnitudes three and four, distance 3·5″, p. 190°. It is a beautiful object for the three-inch. The leader of the constellation, α, of magnitude two and a half, has a faint companion of only the twelfth magnitude, distance 60″, p. 350°. The small star is bluish. The variable R has a period about a week short of one year, and at maximum exceeds the sixth magnitude, although sinking at minimum to less than the eleventh. Its color is ruddy.

Passing eastward, we come again into Ophiuchus, and find immediately the very interesting double, λ, whose components are of magnitudes four and six, distance 1·2″, p. 45°. This is å long-period binary, and, notwithstanding the closeness of its stars, our four-inch should separate them when the seeing is fine. We shall do better, however, to try with the five-inch. Σ 2166 consists of two stars of magnitudes six and seven and a half, distance 27″, p. 280°. Σ 2173 is a double of quite a different order. The magnitudes of its components are both six, the distance in 1894 1·14″, p. 357°. It is evidently a binary in rapid motion, as the distance changed from about a quarter of a second in 1881 to more than a second in 1894. The star τ is a fine triple, magnitudes five, six, and nine, distances 1·8″, p. 254°, and 100″, p. 127°. The close pair is a binary system with a long period of revolution, estimated at about two hundred years. We discover another group of remarkable doubles in 67, 70, and 73. In the first-named star the magnitudes are four and eight, distance 55″, p. 144°, colors finely contrasted, pale yellow and red.

Much more interesting, however, is 70, a binary whose components have completed a revolution since their discovery by Sir



Map No. 11

William Herschel, the period being ninety-five years. The magnitudes are four and six, or, according to Hall, five and six, distance in 1891 2.3″. Hall says the apparent distance when the stars are closest is about 1·7″, and when they are widest 6·7″. This star is one of those whose parallax has been calculated with a reasonable degree of probable accuracy. Its distance from us is about 1,260,000 times the distance of the sun, the average distance apart of the two stars is about 2,800,000,000 miles (equal to the distance of Neptune from the sun), and their combined mass is three times that of the sun. Hall has seen in the system of 70 Ophiuchi three stars of the thirteenth magnitude or less, at distances of about 60″, 90″, and 165″ respectively.

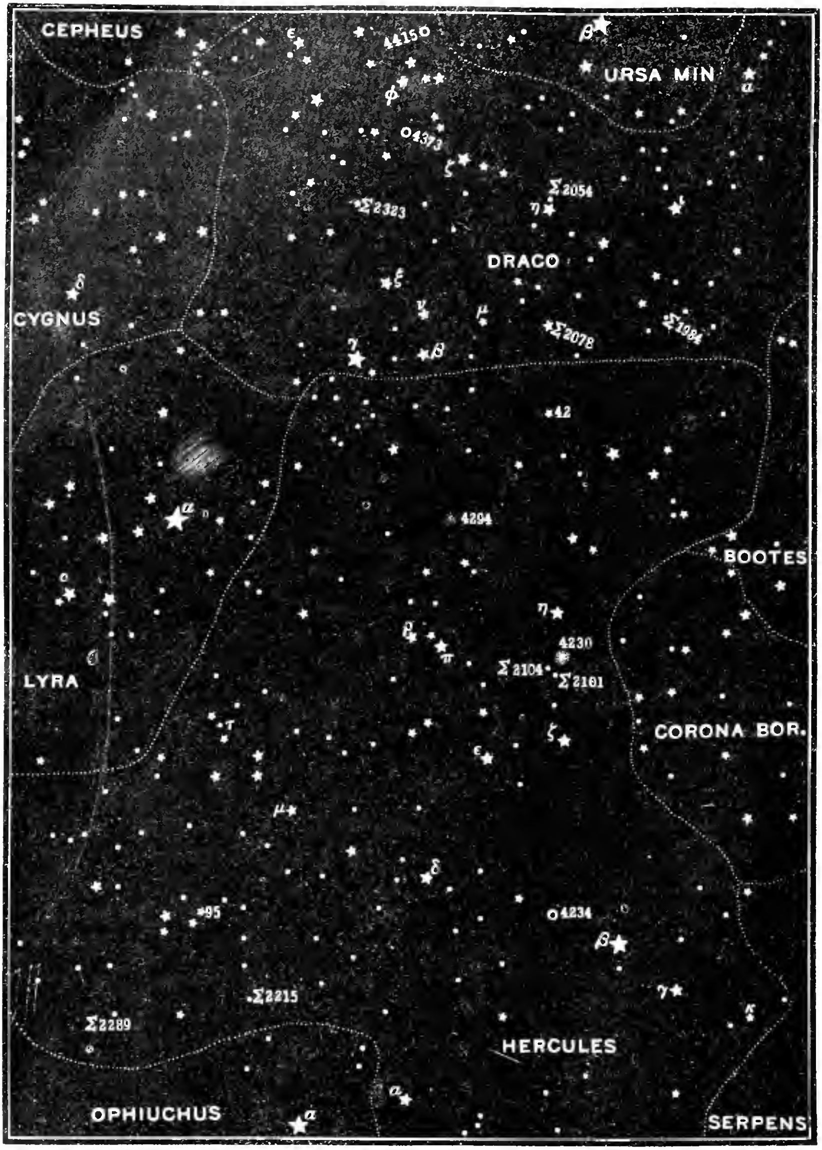
The star 73 is also a close double, and beyond our reach. Its magnitudes are six and seven, distance 0·7″, p. 245°. It is, no doubt, a binary.

Three star clusters in Ophiuchus remain to be examined. The first of these, No. 4256, is partially resolved into stars by the five-inch. No. 4315 is globular, and has a striking environment of bystanding stars. It is about one quarter as broad as the full moon, and our largest aperture reveals the faint coruscation of its crowded components. No. 4410 is a coarser and more scattered star swarm—a fine sight.

Farther toward the east we encounter a part of Serpens again, which contains just one object worth glancing at, the double θ, whose stars are of magnitudes four and four and a half, distance 21″, p. 104°. Color, both yellow, the smaller star having the deeper hue.

Let us next, with the guidance of map No. 15, enter the rich star fields of Hercules, and of the head and first coils of Draco. According to Argelander, Hercules contains more stars visible to the naked eye than any other constellation, and he makes the number of them one hundred and fifty-five, nearly two thirds of which are only of the sixth magnitude. But Heis, who saw more naked-eye stars than Argelander, makes Ursa Major precisely equal to Hercules in the number of stars, his enumeration showing two hundred and twenty-seven in each constellation, while, according to him, Draco follows very closely after, with two hundred and twenty stars. Yet, on account of the minuteness of the majority of their stars, neither of these constellations makes by any means as brilliant a display as does Orion, to which Argelander assigns one hundred and fifteen naked-eye stars, and Heis one hundred and thirty-six.

We begin in Hercules with the star κ, a pretty little double of magnitudes five and a half and seven, distance 31″, p. 10°, colors yellow and red. Not far away we find, in γ, a larger star with a fainter companion, the magnitudes in this case being three and a half and nine, distance 38″, p. 242°, colors white and faint blue or lilac. One of the most beautiful of double stars is α Herculis. The magnitudes are three and six, distance 4·7″, p. 118°, colors orange and green, very distinct. Variability has been ascribed to each of the stars in turn. It is not known that they constitute a binary system, because no certain evidence of motion has been ob-



Map No. 15.

tained. Another very beautiful and easily separated double is δ, magnitudes three and eight, distance 19″, p. 175, colors pale green and purple.

Sweeping northwestward to ζ, we find a celebrated binary, to separate which will require the higher powers of our five-inch glass. The magnitudes are three and six and a half, distance in 1894 1·28″, p. 40°. The period of revolution is thirty-five years, and two complete revolutions have been observed. The apparent distance changes from 0·6″ to 1·6″. They were at their extreme distance in 1884 and are now closing.

Two pleasing little doubles are Σ 2101, magnitudes six and nine, distance 4″, p. 57°, and Σ 2104, magnitudes six and eight, distance 6″, p. 20°. At the northern end of the constellation is 42, a double that requires the light-grasping power of our largest glass. Its magnitudes are six and twelve, distance 20″, p. 94°. In ρ we discover another distinctly colored double, both stars being greenish or bluish, with a difference of tone. The magnitudes are four and five and a half, distance 3·7″, p. 309°. But the double 95 is yet more remarkable for the colors of its stars. Their magnitudes are five and five and a half, distance 6″, p. 262°, colors, according to Webb, "light apple-green and cherry-red." But other observers have noted different hues, one calling them both golden yellow. I think Webb's description is more nearly correct. Σ 2215 is a very close double, requiring larger telescopes than those we are working with. Its magnitudes are six and a half and eight, distance 0·7″, p. 300°. It is probably a binary. Σ 2289 is also close, but our five-inch will separate it: magnitudes six and seven, distance 1·2″, p. 230°.

Turning to μ, we have to deal with a triple, one of whose stars is at present beyond the reach of our instruments. The magnitudes of the two that we see are four and ten, distance 31″, p. 243°. The tenth-magnitude star is a binary of short period (probably less than fifty years), the distance of whose components was 2″ in 1859, 1″ in 1880, 0·34″ in 1889, and 0·54″ in 1891, when the position angle was 25°, and rapidly increasing. The distance is still much less than 1″.

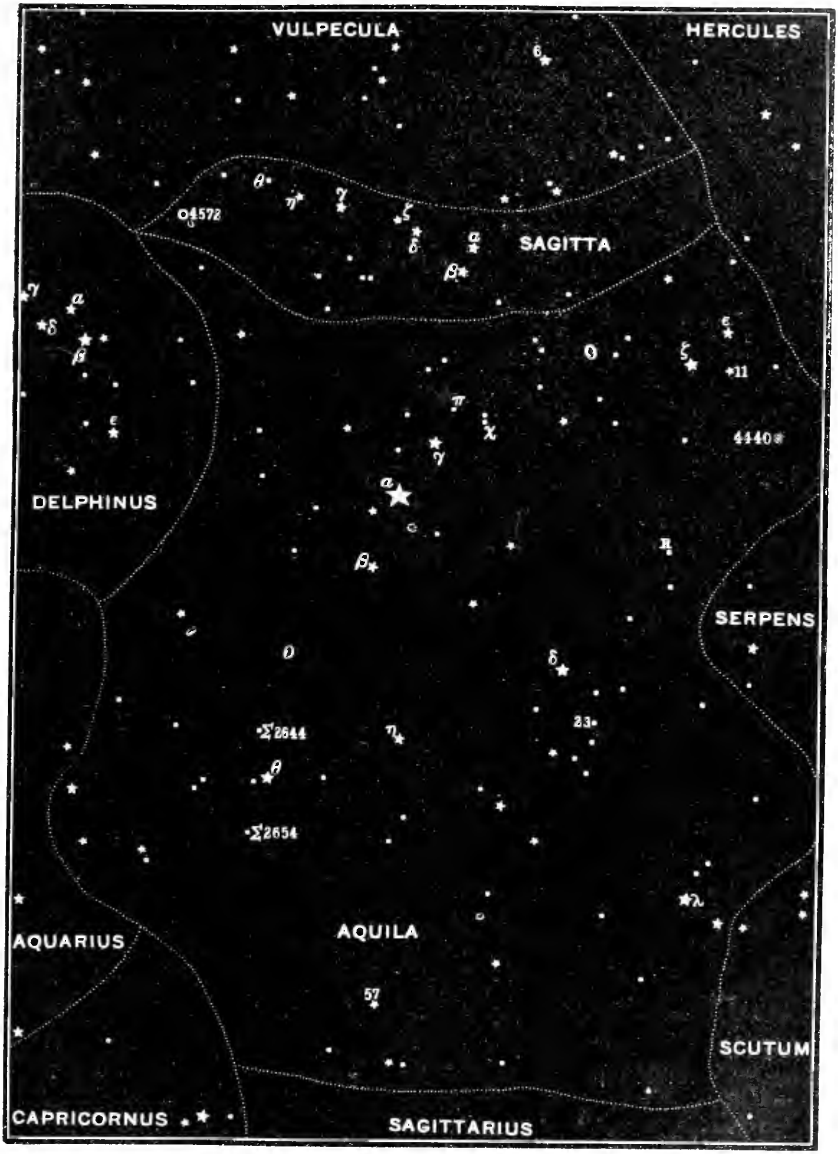
For a glance at a planetary nebula we may turn with the five-inch to No. 4234. It is very small and faint, only 8″ in diameter, and equal in brightness to an eighth-magnitude star. Only close gazing shows that it is not sharply defined like a star, and that it possesses a bluish tint. Its spectrum is gaseous.

The chief attraction of Hercules we have left for the last, the famous star cluster between η and ζ, No. 4230, more commonly known as M 13. On a still evening in the early summer, when the moon is absent and the quiet that the earth enjoys seems an influence descending from the brooding stars, the spectacle of this sun cluster in Hercules, viewed with a telescope of not less than five-inches aperture, captivates the mind of the most uncontemplative observer. With the Lick telescope I have watched it resolve into separate stars to its very center—a scene of marvelous beauty and impressiveness. But smaller instruments reveal only the in-running star streams and the sprinkling of stellar points over the main aggregation, which cause it to sparkle like a cloud of diamond dust transfused with sunbeams. The appearance of flocking together that those uncountable thousands of stars present calls up at once a picture of our lone sun separated from its nearest stellar neighbor by a distance probably a hundred times as great as the entire diameter of the spherical space within which that multitude is congregated. It is true that unless we assume what would seem an unreasonable remoteness for the Hercules cluster, its component stars must be much smaller bodies than the sun; yet even that fact does not diminish the wonder of their swarming. Here the imagination must bear science on its wings, else science can make no progress whatever.

It is an easy step from Hercules to Draco. In the conspicuous diamond-shaped figure that serves as a guideboard to the head of the latter, the southernmost star belongs not to Draco but to Hercules. The brightest star in this figure is γ, of magnitude two and a half, with an eleventh-magnitude companion, distant 125″, p. 116°. Two stars of magnitude five compose ν, their distance apart being 62″, p. 312°. A more interesting double is μ, magnitudes five and five, distance 2·4″, p. 158°. Both stars are white, and they present a pretty appearance when the air is steady. They form a binary system of unknown period. Σ 2078 (also called 17 Draconis) is a triple, magnitudes six, six and a half, and six, distances 3·8″, p. 116°, and 90″, p. 195°. Σ 1984 is an easy double, magnitudes six and a half and eight and a half, distance 6·4″, p. 276°. The star η is a very difficult double for even our largest aperture, on account of the faintness of one of its components. The magnitudes are two and a half and ten, distance 4·7″, p. 140°. Its near neighbor, Σ 2054, may be a binary. Its magnitudes are six and seven, distance 1″, p. 0°. In Σ 2323 we have another triple, magnitudes five, eight and a half, and seven, distances 3·6″, p. 360°, and 90″, p. 22°, colors white, blue, and reddish. A fine double is ϵ, magnitudes five and eight, distance 3″, p. 5°.

The nebula No. 4373 is of a planetary character, and interesting as occupying the pole of the ecliptic. A few years ago Dr. Holden, with the Lick telescope, discovered that it is unique in its form. It consists of a double spiral, drawn out nearly in the line of sight, like the thread of a screw whose axis lies approximately endwise with respect to the observer. There is a central star, and another fainter star is involved in the outer spiral. The form of this object suggests strange ideas as to its origin. But the details mentioned are far beyond the reach of our instruments.

We shall only see it as a hazy speck. No. 4415 is another nebula worth glancing at. It is Tuttle's so-called variable nebula.



Map No. 16.

There are three constellations represented on map No. 16 to which we shall pay brief visits. First Aquila demands attention. Its doubles may be summarized as follows: 11, magnitudes five and nine, distance 17·4″, p. 252°; π, magnitudes six and seven, distance 1·6″, p. 122°; 23, magnitudes six and ten, distance 3·4″, p. 12° —requires the five-inch and good seeing; 57, magnitudes five and six, distance 36″, p. 170°; Σ 2654, magnitudes six and eight, distance 12″, p. 234°; Σ 2644, magnitudes six and seven, distance 3·6″, p. 208°.

The star η is an interesting variable between magnitudes three and a half and 4·7; period, seven days, four hours, fourteen minutes. The small red variable R changes from magnitude six to magnitude seven and a half and back again in a period of three hundred and fifty-one days.

Star cluster No. 4440 is a very striking object, its stars ranging from the ninth down to the twelfth magnitude.

Just north of Aquila is the little constellation Sagitta, containing several interesting doubles and many fine star fields, which may be discovered by sweeping over it with a low-power eyepiece. The star ζ is double, magnitudes five and nine, distance 8·6″, p. 312°. The larger star is itself double, but far too close to be split, except with very large telescopes. In θ we find three components of magnitudes seven, nine, and eight respectively, distances 11·4″, p. 327°, and 70″, p. 227°. A wide double is ϵ, magnitudes six and eight, distance 92″, p. 81°. Nebula No. 4572 is planetary.

Turning to Delphinus, we find a very beautiful double in γ, magnitudes four and five, distance 11″, p. 273°, colors golden and emerald. The leader α, which is not as bright as its neighbor β, and which is believed to be irregularly variable, is of magnitude four, and has a companion of nine and a half magnitude at the distance 35″, p. 278°. At a similar distance, 35″, p. 335°, β has an eleventh-magnitude companion, and the main star is also double, but excessively close, and much beyond our reach. It is believed to be a swiftly moving binary, whose stars are never separated widely enough to be distinguished with common telescopes.

In the studies of Raoul Pictet and Altschul on phosphorescence at very low temperatures, glass tubes containing sulphides of calcium, strontium, and barium, exposed to sunlight for periods that were noted, were plunged into liquid nitrous oxide, the temperature of which, by rapid diminution of pressure, could be brought to − 140° C. After twelve minutes' immersion the tubes were brought into a dark room and their behavior was carefully observed. At first, no indication of phosphorescence could be observed. In a few moments the upper part of the tube, which had not been so strongly cooled as the rest, began to phosphoresce, and gradually the feeble light seemed to spread itself down the tube, the lower part of which, however, glowed more feebly than the upper. After five minutes the tubes acquired their ordinary vivid color, without subsequent exposure to sunlight or even to diffused daylight. All phosphorescent substances appeared to behave in this way.

THE PSYCHOLOGY OF WOMAN.

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EVERY thoughtful observer of both the popular and the scientific movements of the day must have noticed the frequent lack of harmony or co-operation between them. Such lack of co-operation, if not of harmony, is well illustrated in the woman question. Two vigorous movements are now in progress. The first is a popular movement, whose end, apparently being very rapidly realized, is the advancement of woman to a position of complete political, legal, educational, and social parity with man—a position which means much more than mere equality of rights for woman; it means for her a changed sphere of activity, with new duties and new burdens, and may in the end involve radical changes in the state and in the family. The second is a scientific movement in anthropology, conducted by laborious and painstaking research, whose end is to ascertain the constitutional differences, both physical and psychical, between man and woman. It may be that these two movements will be found to support each other; but, if so, it is to be feared that it will be by happy chance rather than by intelligent co-operation.

It is the purpose of this article to bring together some of the results of these anthropological studies relating especially to the psychology of woman, in order that we may see what bearing, if any, they may have upon the above-mentioned popular movement. The most devoted patron of woman's political and educational advancement would hardly deny that the success and permanence of the reform will depend in the end upon the fact that there shall be no inherent contradiction between her new duties and her natural physical and mental constitution. It should be borne in mind, however, that the mere fact of woman's present intellectual or physical weakness, should such be shown, would not be a justifiable ground for denying to her full political and educational privileges. It might be quite the reverse, if it should appear that such weakness were itself the result of the subordinate position which she has been compelled to hold. It would, however, be a justifiable ground for advising woman to assume her new duties gradually, in order that disaster to her cause might not follow the overtaxing of her strength.

In outlining some of the psychological peculiarities of woman as revealed by modern anthropological researches, I shall endeavor to confine myself to those points upon which investigators generally agree, simply omitting those still in dispute, or mentioning them only as questioned.

All facts are best studied in the light of an idea. It may be conducive to clearness, therefore, to mention first the leading theories now in the field concerning woman's peculiarities. It has often been asserted since Aristotle that woman is a stunted or inferior man and represents arrested development. Again, it has been said that woman is a grown-up child, that she belongs to the child type, and must ever to some extent retain the child relation. Again, more recently, it has been maintained that although woman belongs to the child type, yet the child type is in truth the race type and represents greater perfection than is represented by man, whose natural characteristic is senility. Finally, it has been said that throughout the whole animal world, where artificial circumstances have not modified natural relations, the female stands for physical superiority in size and vitality, and more truly represents the essential qualities of the species. Without prejudice for or against any of these theories, let us see what evidence there may be for each.

Psychology is no longer studied apart from physiology. We must therefore first notice some of the secondary sexual characteristics of woman in respect to her physical structure. Although we are chiefly concerned with the nervous system, a few other points may first be mentioned. Woman among all civilized races is both shorter and lighter than man, except at the age of thirteen or fourteen in our climate, when girls are both taller and heavier than boys of like age. Woman's form is more rounded and graceful, less bony and angular, having relatively more fat and less muscle. Her muscular tissue contains a slightly larger percentage of water. As shown by the dynamometer, woman's strength is at the most only about two thirds that of man, while her height is as sixteen to seventeen and her weight as nine to ten. In woman the trunk is, relatively to the length of the arms and legs, longer than in man. Owing to the greater inclination of the pelvis, woman is somewhat less erect than man. The head also is carried less upright, and the gait is comparatively unsteady and indirect. The greater length of the first finger as compared with the third is a feminine peculiarity. This relation, seldom found in man, is not uncommon among women. It gives grace to the hand, and would seem to be an instance of higher evolution, not being found among apes or savages. The vocal cords in woman are shorter and the voice is higher and shriller. The larynx is smaller and higher in the throat. The thyroid gland is considerably larger than in man. It is thought that women in respect to hair and eyes are slightly darker than men, but this has not been verified. Woman's lung capacity is in proportion to her size much less than man's, and the amount of carbonic acid expired is relatively less. Differences in the blood are well marked and are said to be significant. In woman the blood contains a less number of red corpuscles—about four million five hundred thousand in a cubic millimetre to five million in man. It has a larger percentage of water and a lower specific gravity. As compared with man, therefore, woman is naturally somewhat anæmic. The pulse-beat is from eight to twelve per minute faster than in man.

Some interesting differences are now clearly made out between man and woman in respect to birth, death, and disease. Statistics show that about one hundred and five boys are born to every one hundred girls in Europe and America. The proportion in other countries and among uncivilized races is said to be nearly the same. The greater mortality of males, however, begins with birth and continues throughout childhood and adolescence and the greater proportion of adult years. If, therefore, a count be made of boys and girls or men and women at any age after the first year, the females are found to be in a considerable excess, and this notwithstanding the decimation of women by diseases incidental to the child-bearing stage of their lives. These results, formerly attributed to accidental causes, are now known to be due to the greater natural mortality of males, and this is found to be in harmony with another series of sexual differences, namely, the greater power of woman to resist nearly all diseases. Hospital statistics show that women are less liable to many forms of disease, such as rheumatism, hæmorrhages, cancer, and brain diseases; and that while they are more liable to others, such as diphtheria, phthisis, scarlet fever, and whooping-cough, even in these the percentage of fatal cases is so much less that the absolute number of deaths falls considerably below that of men. Sudden deaths from internal causes are much less frequent among women. They endure surgical operations better than men, and recover more easily from the effects of wounds. They also grow old less rapidly and live longer. Among centenarians there are twice as many women as men. Women retain longer the use of their legs and of their hands. Their hair becomes gray later, and they suffer less from senile irritability and from loss of sight, hearing, and memory. In brief, contrary to popular opinion, woman is more hardy than man, and possesses a larger reserve of vitality. In this connection the absence of physical abnormities in woman should be noted. A mass of evidence from anthropological studies in Italy and England shows that degeneration marks, monstrosities, and almost all kinds of variations from the normal type are much less common in woman than in man. Here, too, we may note that statistics of the diseases to which men, women, and children are severally most subject, show a somewhat marked similarity between the diseases of women and of children.

Among the peculiarities of the female skull the following are definitely determined by Rebentisch, Mantegazza, Schaffhausen, and others. The skull of woman is smaller, the base relatively contracted, and the crown larger. The forehead is more nearly perpendicular, making a sharper angle with the flatter crown. The glabella and ridges above the eyes are less prominent. The parietal protuberances are more developed, but the occipital protuberances and the mastoid processes under the ears are less so. The lower jaw is smaller and more rounded. Relatively to the size of the head the face is slightly smaller and lower, and there is a little more prognathism than in man.

The long-disputed questions about woman's brain are now approaching solution in a few leading points. In the first place, woman's brain is of less absolute weight than man's, the proportion among modern civilized races being about nine to ten. This fact in itself has little significance, as man is heavier and taller than woman. If we consider the weight of the brain relatively to the height of the body, it still appears that woman's brain is smaller; but if, as is more just, we consider the weight of the brain relatively to the weight of the body, it appears that there is nearly perfect equality, the difference, if any, being in favor of woman. These results are still of little value, for, as fairly pointed out by Havelock Ellis, other corrections must be made, such as this, that woman has relatively more fat and less muscle than man, the latter, of course, making greater demands upon the brain. On the whole it appears that there is no considerable difference, such as there is being in woman's favor. Of more significance in its bearing upon woman's mental capacity is the relative size of the different parts of the brain. Here it is shown that the lower centers as compared with the hemispheres are larger in the female brain. In the cerebrum itself the frontal region is not, as has been supposed, smaller in woman, but rather larger relatively. The same is true of the occipital lobe. But the parietal lobe is somewhat smaller. It is now believed, however, that a preponderance of the frontal region does not imply intellectual superiority, as was formerly supposed, but that the parietal region is really the more important. As a balance, perhaps, to these female deficiencies, we may note that the circulation of the blood seems to be somewhat greater in woman's brain. In respect to her whole physical structure woman is less modified than man and shows less tendency to variation. Women are more alike than men.

Before proceeding to consider the purely mental peculiarities of woman, we may pause for a moment to ask whether the facts already cited have any bearing upon the various theories regarding woman's nature that were mentioned above. Concerning the superiority of either sex—at any rate a rather meaningless question—little or nothing appears. Woman's greater vitality and immunity from disease might be offered to balance her thinness of blood and preponderance of lower brain centers. Concerning the hypothesis of the infantile character of woman, however, the above summary is more significant. We see at once that a large proportion of her physical peculiarities are also infantile traits. The rounded form, the larger proportion of fat, the percentage of water in the muscles, the greater length of the trunk as compared with the arms and legs, the forward inclination of the head and of the upper part of the body, the deficiency of red corpuscles in the blood, the rapid pulse-beat, the character of the voice and position of the larynx, the large size of the thyroid gland, the contraction of the base as compared with the crown of the skull, the perpendicular forehead, the less prominent glabella and eyebrows, the smaller mastoid processes and the large parietal protuberances, the small, rounded lower jaw, the smaller, lower, and more prognathous face, the preponderance of the lower brain centers and the greater relative weight of the whole brain (if the latter be admitted), all these are distinctively infantile marks.

Let us now trace well-marked psychical differences between man and woman. It should not be necessary to state here that in all these studies average women are compared with average men, but not a little confusion has resulted oftentimes from comparing the best women with average men, or the best men with average women. First, as regards the senses, the popular opinion that woman's sensibility is finer than man's does not seem to be verified by experiment. Lombroso, collecting the results of Italian and English investigators, believes that woman's sensibility is somewhat more obtuse in touch, taste, sight, and hearing, and that her sensitiveness to pain is decidedly less than man's. But each of these conclusions is open to question. Careful experiments made by Drs. Bailey and Nichols in this country showed that the women had a finer sense of taste than the men, but that the men were superior in delicacy of smell. In sight and hearing no conclusive results have been obtained. Attention is called to the fact that piano tuners, and tea and wine tasters, are almost always men. In respect to all the senses more experiments are needed to test the comparative fineness of sensibility. Havelock Ellis, who sums up a large amount of evidence on this head, believes with Galton that women have, on the whole, somewhat less sensibility than men, and that it is their greater affectability or nervous irritability that has given rise to the popular notion of their finer sensibility. In respect to color blindness there is a remarkable difference between the sexes. About three and a half per cent of men are color-blind to a marked extent, while not more than four tenths of one per cent of women are so. None of the popular explanations of this difference are at all adequate. The difference is a constitutional one between the sexes in this era, and is no doubt one of the forms of the greater variational tendency in man.

The general opinion that women are superior to men in manual dexterity seems to be borne out neither by actual experiment nor by accurate observation of woman's work in the mechanical arts. Experiments by Dr. Bryan on rapidity of movements with seven hundred and eighty-nine school children showed that the rate was slightly greater with boys at every age from five to sixteen years, except at the age of thirteen. The same experiments showed that rapidity increased regularly with age. Bryan also made experiments in precision of movements, with the result that there was little difference between the sexes, the figures showing a slightly greater precision for boys. Gilbert's painstaking and accurate experiments upon voluntary motor ability in twelve hundred school children in New Haven, including fifty girls and fifty boys for each year from six to seventeen, gave practically the same results. The tests were based upon the number of taps that could be made in five seconds with the finger. The boys excelled at every age without exception. The average number of taps in five seconds for boys was 29·4, for girls, 26·9; but the rate increased in both sexes from an average of about twenty-one at six years to thirty-four at seventeen years. Gilbert's experiments upon the reaction-time of school children showed that the reaction-time of boys was uniformly shorter at every age from five to seventeen, and that the time in both boys and girls decreased uniformly with age except a slight retardation at fourteen. In respect to dexterity in the manual arts there is much conflicting testimony. Havelock Ellis's inquiries concerning woman's skill in laboratories, in the cigar and cigarette trades, in cotton spinning and woolen weaving, etc., led him to the result that with few exceptions the finer and more dexterous work is done by man in fields where both sexes have equal opportunities and practice. In the cigar and cigarette trades of English manufacturing centers large numbers of women are employed, but are set to the coarser and lower grades of work, men being required to make the finer grades of cigars and to fold the narrow margins of the cigarette papers. Instructors in laboratories in coeducational institutions with few exceptions pronounce the men to be far more skillful in the use of the microscope and all other delicate instruments and to require less direction in the prosecution of their work. The superiority of women in needlework could not be adduced in this connection any more than the superiority of men in many fields where women have not entered into competition with them.

We come now to the well-worn theme of the purely mental differences between the sexes, and here I shall make a brief summary of the more important and well-recognized differences, citing experiments and statistics where they are possible. In perception, woman is in general decidedly quicker than man. She reads a paragraph or book more quickly, and, knowledge of the subject being equal, she grasps more of it. In perception of objects she grasps more quickly a number of wholes or groups, and has a rapid unreasoned perception of relations which has the appearance of intuition. Her perception of details, however, is less accurate than man's, and her rapid reference of things to their proper classes extends only to matters of common human experience. In apperception the subjective factor is larger in woman, and she sees things more from the standpoint of her own experience, wishes, and prejudices. Even more than in man, where feeling is strong, objective perception is blind. Hence women make poorer critics than men, and more rarely are they impartial judges. For the formation of concepts, especially the more abstract ones, woman's mind is less adapted than man's. She thinks more in terms of the concrete and individual. Hence number forms and the associations of colors with sounds are, as is found, more common among women. Differences in habits of thought between the sexes may be well illustrated by a simple experiment in association. If fifty men and fifty women be required to write as rapidly as possible one hundred words without time for thought, in the women's lists more than in the men's will be found words relating to the concrete rather than the abstract, the whole rather than the part, the particular rather than the general, and associations in space rather than in time. As Lotze keenly remarks, women excel in arranging things in the order of space, men in the order of time. Men try to bring things under a general rule, without so much regard to the fitness or symmetry of the result. Women care less for general rules, and are inclined to look only to the immediate end in view, aiming to make each thing complete in itself and harmonious with its surroundings.

In respect to memory, as far as any general statements can be made, woman is superior. In memory tests college girls surpass boys. In Gilbert's tests on New Haven school children, however, the boys were superior in the exact reproduction of an interval of time. In reasoning of the quick associative kind women are more apt than men, but in slow logical reasoning, whether deductive or inductive, they are markedly deficient. They lack logical feeling, and are less disturbed by inconsistency. Analysis is relatively distasteful to them, and they less readily comprehend the relation of the part to the whole. They are thus less adapted to the plodding, analytical work of science, discovery, or invention. Their interest lies rather with the finished product. Of the 483,517 patents issued by the U. S. Patent Office prior to October, 1892, 3,458 were granted to women. In general, woman's thought is less methodical and less deep. The arts, sciences, and philosophy owe their progress more to man than to woman. Whether one studies the history of logic, mathematics, or philosophic thought, of the special sciences or scientific discovery and invention, of poetry or general literature, of musical composition or technique, of painting, sculpture, or architecture, one is engaged more with the names of men than of women. Even in those spheres for which woman by her peculiar physical or mental qualities is particularly adapted, such as vocal music, the stage, and the writing of novels, it is doubtful whether a list of the greatest artists would include more women than men. Even in the arts of cooking and dressmaking, when men undertake them they often excel. Woman, owing to her greater patience, her intuition, and her retentive memory, as well as her constant association with the young, is especially qualified for teaching and has equal or greater success in this work than man. Yet all educational reforms, from the kindergarten to the university, have originated with the latter.

What woman loses in profundity she gains in quickness. She excels in tact, and extricates herself from a difficulty with astonishing adroitness. In language she is more apt than man. Girls learn to speak earlier than boys, and old women are more talkative than old men. Among the uneducated the wife can express herself more intelligently than the husband. Experience in coeducational institutions shows that women are more faithful and punctilious than men, and at least equally apt. In colleges where a record of standing is kept the women gain probably a somewhat higher average. In the years immediately following graduation the men make much greater intellectual progress. Women reach their mental maturity at an earlier age, and develop relatively less after maturity. In many kinds of routine work, especially that requiring patience, women are superior, but they are less able to endure protracted overwork.

We have seen that woman is less modified physically than man and varies less from the average. The same is true mentally. Women are more alike than men and more normal, as it were. The geniuses have been men for the most part, and so have the cranks. Woman's thought pursues old rather than new lines. Her tendency is toward reproduction, while man's is toward production. Woman loves the old, the tried, and the customary. She is conservative, and acts as society's balance-wheel. Man represents variation. He reforms, explores, thinks out a new way.

One of the most marked differences between man and woman is the greater excitability of the nerve centers in the latter. Woman possesses in a higher degree than man the fundamental property of all nervous tissue, irritability, or response to any stimulus. The vasomotor system is particularly excitable, and this fact is in immediate connection with her emotional life. That woman is more emotional than man is only another way of stating the same fact. Various expressions and bodily changes which are really the ground of emotions, such, for instance, as laughing, crying, blushing, quickening of the heart-beat, are more common in woman, and in general her face is more mobile and witnesses more to her mental states. Various forms of abnormal mental conditions, closely connected with the emotions, such as hysteria, are more frequent among women. Women are more easily influenced by suggestion than men, and a larger percentage of them may be hypnotized. Trance mediums are usually women. The word witch has been narrowed almost wholly to the female, and this may be explained by the fact that various forms of mental disturbance connected with superstitious notions are more frequently manifested in women. Sympathy, pity, and charity are stronger in woman, and she is more prominent in works that spring from these sentiments, such as philanthropy and humane and charitable movements. Woman is more generous than man. Her maternal instincts lead her to lend her sympathy to the weak and helpless. She cares for the sick and protects the friendless, and, seeing present rather than remote consequences, she feeds the pauper and pardons the criminal.

In morals a few distinctions between the sexes are well determined. Male criminals outnumber female criminals about six to one. Woman's sympathy and love, her physical weakness and timid nature, her domestic and quiet habits, ill adapt her to the criminal life. Morally bad women too usually find other more attractive fields open to them. Some forms of crime, indeed, such as murder by poisoning, domestic theft, and infanticide, are much more common among women. When women do become criminals their crimes are often marked by greater heinousness, cruelty, and depravity. It is said by Lombroso and his school that in respect to cruelty in general woman surpasses man, particularly in her conduct to her own sex. Woman's appetites are not so strong and her passions are less intense. She is freer from intemperance and related forms of vice. The most marked moral superiority of woman appears in her altruism; her greatest moral defect in her untruthfulness. In her altruistic life of love and self-sacrifice woman shows herself the leader in the supreme virtue of Christian civilization. As far as she leads in this, so far does she fall behind in veracity. She has not the same conception of abstract truth as man, but thinks more of the good to be attained. Deception and ruse in woman, far more than in man, have become a habit of thought and speech. A series of conditions, social, intellectual, and physiological, have forced this habit upon her as a means of self-defense.

Woman's religious nature is stronger than man's. She possesses in a marked degree the qualities of reverence, dependence, devotion, trust, and fidelity. Fear and timidity are feminine qualities, while faith is so natural to woman that she is disposed to credulity rather than to skepticism.

Let us pause a second time to see what theory, if any, our results establish. Here, again, from her mental differences the doctrine of woman's inferiority receives no support—inferior, no doubt, in philosophy, science, and invention, and in her conception of abstract truth and justice, but superior in intuition, in charity, in temperance, in fidelity, in balance. But here again, as in her physical peculiarities, woman approaches the child type. This is seen in the preponderance of the emotional life over the discriminative, and of the impulsive over the voluntary. So also the quick perception and the retentive memory remind us of the child more than do the stern logical processes of the man. Woman's mental associations, selecting the concrete, the individual, the whole rather than the part, relations in space rather than in time, are also those of the child. Woman's receptivity, her faith and trust, her naïve freedom from skepticism, her fear and timidity, her feeling of dependence, her religious instincts, are all child traits. Children, like women, have slower reaction-time and lesser motor ability, are more easily hypnotized, have more number forms and color associations, have less power of inhibition, express their emotions more in their faces, and more readily give way to tears and smiles. Modern child study has shown that children are more cruel than adults and have little power to discriminate between truth and falsehood. They also are sympathetic and changeable, and act with reference to present rather than remote ends. Woman in respect to her altruism, pity, and charity has less resemblance to the child, but these traits are so intimately connected with her duties of motherhood as to have little bearing upon the theory of her naturally infantile constitution.

The hypothesis that woman approximates to the primitive rather than to the child type, that she represents arrested development, may be said to receive a certain amount of confirmation from her mental traits. Indifference to physical and psychical pain, freedom from color blindness, the preponderance of memory and intuition over reason, lack of mechanical inventiveness, conservatism and adherence to custom, precocity, changeableness, cruelty, tact, deceitfulness, emotional expression, religious feeling, are all traits conspicuous among primitive races, and, as we have seen, are more noticeable in women than in men. That women are less modified mentally and are more alike than men also argues for arrested development. It is well known that in insane asylums the female patients are more destructive, noisy, abusive, and vicious than the male patients, although their insanity is less serious and more curable. This fact, together with the other, that when women become bad they become more hopelessly bad, has led some too hastily to conclude that women, like children, are natural savages. The fact that woman has less logical and philosophical ability and has taken so little part in the development of the sciences, arts, and inventions, which are considered to represent human progress, is adduced as further confirmation of this theory. But in many of her mental traits woman departs further than man from the savage type. In her moral qualities she represents higher evolution. This is notably true in respect to her altruism, charity, sympathy, and pity. Woman's greater humanity, philanthropy, conscientiousness, fidelity, self-sacrifice, modesty, and patience, as well as her lesser disposition to crime, are qualities which separate her further than man from the savage. The same may be said of certain other subtle and scarcely definable feminine qualities, such, for instance, as grace and refinement. Woman's development along these lines certainly has not been arrested, and although it may be argued that these qualities are the logical outcome partly of her physical weakness and partly of her maternal duties, still it would be difficult to show that evolution in this direction represents less progress than in the more intellectual direction in which man has developed. It must be admitted, however, that woman's purely intellectual development has been retarded, and this may have a practical significance considering that on these qualities the struggle for existence now so largely turns.

But we must now consider another series of differences between the sexes which, it is alleged, more fully prove the arrested development of woman. These relate to methods of dress and adornment and to habits of life and conduct, in which the history of civilization has shown a constant and definite advance, but in which, it is said, woman is centuries behind. While some of these differences appear of a trifling character, we must admit that they have a certain cumulative force, and even the most trifling may have an anthropological significance.

One of the most interesting chapters in anthropology is that relating to dress. The origin of dress, as is now well known, was the desire to adorn the person, not to protect it. For the sake of adornment, the savage was willing not only to expend a considerable amount of time and wealth, but even to undergo much physical discomfort. To this end were used various paints and pigments, preferably of the brighter colors, feathers of brilliant hues, spotted or glossy skins and furs of animals, beads, shells, shining or colored stones and bits of metal, together with various oils, ointments, and perfumes, all designed to please the sense of sight or of smell. To the same end various mutilations of the body were endured, such as tattooing, or piercing the lips, nose, cheeks, or ears for the insertion of rings or pieces of fancy stone or metal. The neck, also, ankles, wrists, and fingers were used as convenient places for the attachment of ornaments, such as rings of gold or strings of shell or precious stones. The hair, too, was left uncut and tied up in various fantastic ways, and decorated with shells, beads, and gold and silver ornaments. Almost equally early, however, dress was made to serve another purpose than that of pleasing the senses of the beholder. It was used as a means of gaining favor and power by serving as a symbol of the wealth of the wearer. Hence those feathers, skins, and furs which were most rare and difficult to obtain were preferred, and those metals and stones which were not only brilliant but costly, such as gold, silver, diamonds, and rubies. In the manner of wearing this ornamental dress, neither protection nor concealment of the person was so much considered as display. The loose and flowing garments often impeded the movements of the wearer, so that in hours of work or warfare they must often be left behind. In inclement weather, also, they were often laid away, as it was considered more important to protect the dress itself than the person. Starting with these primitive ideas, the evolution of dress has shown a steady progress from display to utility. Clothing tends to be substituted for dress and to have for its end the protection and comfort of the body. Paint, feathers, and pieces of stone and metal tend to disappear as useless. The gaudy colors of the savage, the purple of chiefs and kings, the white of the Romans, give place to the plainer and more useful grays and blacks. Tattooing and other mutilations disappear, skins and furs are replaced by the more comfortable woven cloths, the flowing and dragging robes give way to the close-fitting garment which impedes the movements as little as possible, and the hair is cut shorter for convenience and economy of time. Together with these changes we notice that the symbolic character of dress disappears, so that less and less is it possible to judge of a person's wealth by his attire. It should be observed that none of these ends toward which the evolution of dress is tending have been fully realized even in the most civilized societies, but the civilization of any people is largely judged by the extent to which these ends have been realized.

In the light of these principles the theory of woman's arrested or retarded development receives, it is said, much confirmation.

Among the women of the most civilized communities the idea of dress has only partly given place to that of clothing. The flowing and, upon occasions, even the trailing robe still persists. The hair is uncut and fantastically arranged with bits of shell or metal, and sometimes decorated with ornaments of shell, silver, or gold, or imitations of these. Feathers are still worn upon the headdress, and the headdress itself is purely for adornment, affording little or no protection to the head, and in inclement weather is sometimes left behind for safety or exchanged for a simpler kind. Upon the streets of European towns peasant women in the morning are usually seen with uncovered heads, and in America neighborly women are often so seen passing from house to house, but never upon state occasions. Furs are still worn by both sexes in winter, but much more commonly by women. The use of striking colors, such as red, yellow, blue, green, and purple, is still frequent in the dress of women and children, but much less so in men's dress, where the blacks, grays, and browns prevail. Survivals of the primitive custom of leaving parts of the body entirely exposed and unprotected are still seen in woman's evening dress, showing how little the idea of display has given place to that of utility. The use of rare metals and stones as ornaments for the ankles, wrists, fingers, ears, nose, lips, and neck persisted in the dress of women long after it became extinct with men. Rings in the ears were commonly worn by women within the memory of many of us, and rings and stones upon the wrists and fingers are still very common. For these purposes brilliant stones, such as diamonds, are much prized, but are not worn to the same extent by men as by women. Survivals of the neck ornaments are still seen in the various forms of pins and necklaces. Beads, so highly prized by the lower races, still persist to some extent in the bead trimming of woman's dress. The use of paint to decorate the person is now practically extinct with both sexes, but, as a means of decorating the face, was practiced by women within comparatively recent times. In respect to various powders and perfumes the evolution has not been so rapid, and they are still in use among women to some extent. Mutilations of the body for ornamental purposes are all but extinct, but among women certain mutilations, such as piercing the ears, unnatural constriction of the waist, and pinching of the feet, have persisted almost to the present time. In countries like China, where the last of these is still practiced, the practice is confined to women. In certain other trifling matters there is in woman's dress a suggestive survival of primitive customs. The dress of the primitive man was loosely and irregularly attached to the body, and was fastened with strings or thongs or afterward with pins of metal. Later these pins were attached to the garment and bent into the form of hooks. Buckles, and finally buttons, took the place of the primitive pins and hooks. But women still use the metal pins, and the primitive lack of definite correspondence between the dress and the body is seen, for instance, in the hat or bonnet, which does not fit the head and must be fastened on with strings or pins. This retarded development and absence of differentiation in woman's dress is curiously illustrated in the case of shoes. Only a few decades ago girls' and women's shoes were made straight and worn indiscriminately on either foot, while men's shoes were uniformly made rights and lefts. In many country stores old women's shoes may still be found made straight, while women's overshoes and rubbers are commonly so made at present, and are worn on either foot.

But the most striking case of retarded development in woman's dress is seen in the persistence of the idea that dress is not so much a protection for the body as a symbol of the wealth of the wearer or the wearer's family. In the more civilized societies now it is no longer possible to judge of a man's wealth by his attire; but to the same extent this can not be said of his wife and daughters. In the case of the latter the two primitive purposes of dress—ornamentation and expenditure—are still ascendant. We see the same display of rare and costly furs and feathers, of gold and diamonds, of velvets, laces, and silks, and of harmony of colors, and a somewhat constant relation between the cost of such display and the wealth of the owner. In her emancipation from the tyranny of fashion in dress woman has made less progress than man. In slave-like obedience thereto she submits to frequent and expensive changes in style, to heavy and cumbersome garments involving the sacrifice of comfort, health, and economy.

In justice to the above principles it is only fair to state that it is not urged by those who bring them forward that the dress of man is perfect or free from savage elements, or that the æsthetic motive common to the dress of the primitive man and of civilized woman is not a worthy one, but only that in the evolution of dress there is a definite progressive movement from the primitive conception of display and expenditure to the modern conception of utility and comfort, and that in this movement woman's dress has been retarded or arrested at a primitive stage.

Certain other facts than those of dress point, it is said, to woman's arrested development. The division of labor which marks the progress of civilization has reached no such extent in the work of woman as in that of man. In fact, it may be said that there is in woman's work hardly any division of labor, except in so far as, in recent years, she has entered upon pursuits formerly followed only by men. As we have seen that women are more alike physically and mentally than men, so their work is more alike. In domestic life, which still includes the mass of representative women, each one either does her own housework, or has it done by female servants whose labor is equally unspecialized. No man now in civilized communities makes his own clothes, yet this is not uncommon among women, and in primitive communities they may even spin and weave the material. Not only is their work and manner of work more primitive, but also their tools. In the German cities on market day, for instance, may be seen numbers of men and women bringing their produce from the country, the men using carts or wagons propelled by themselves or their horses, but the women bearing their burdens in baskets upon their backs in quite the primitive fashion.

Before attempting any summary of our results I must call attention to some recent biological researches which may throw new light on the natural relation of the sexes. It has been shown by Geddes and Thomson, Fouillée and others, that in many of the lower and simpler orders of animals the female is larger than the male. This is true, with exceptions, throughout the animal world as high as the amphibians, and is in close logical connection with certain other important differences between the sexes. These, observed also best among the lower orders, are as follows: The male is active, restless, agile. The female is passive and quiescent. She has lower temperature, greater longevity, and a larger fund of vitality; her birth is the accompaniment of conditions of better nourishment. The male is katabolic, representing the expenditure of energy, individualism, variation, and progress. The female is anabolic, representing economy and the building up, conserving, and reproductive functions. She is nearer to and more representative of the race. These, it is said, are natural sexual differences seen at the very threshold of life in the contrast between the male and female cells, and so far as these same differences appear in man and woman they can not and need not be accounted for by any theories of natural or sexual selection nor by artificial social conditions. Those peculiarities of modern woman which are contrary to the natural constitution of the female, such as her smaller size and her alleged retarded development, are rather the qualities in need of explanation. It has been suggested that the greater size and strength of the male among the higher vertebrates may be explained as the indirect result, in part, of his combats with rivals, and, in part, of his greater activity in protecting and supporting himself and his mate when the maternal duties of the latter incapacitate her for these actions, and furthermore that the retarded development of woman is due to artificial and unnatural restrictions arising from a sort of bondage which the above conditions have made possible. Again, if it should be shown that woman conspicuously resembles the infant in body and mind, very unwarranted inferences might be drawn from this. It is true that the infant of the human species has certain curious points of resemblance to the lower animals, notably the ape, but it is equally true that the infant ape has certain marked resemblances to the human species which the adult ape does not have. By analogy we may infer that the human infant has closer resemblance to the more highly developed being of the future than the human adult has, and if woman is more like the child than man is, then she is more representative of the future being. The matter, in fact, reduces itself probably to this: that woman, like the child, represents the race type, while man represents those variable qualities by which mankind adapts itself to its surroundings. Every woman is, as it were, a composite picture of the race, never much worse nor much better than all. Man is, as it were, Nature's experiment, modified to reflect, if possible, the varying conditions of his environment. If superiority consists in adaptation to present environment, then man is superior; if it consists in the possession of those underlying qualities which are essential to the race—past, present, and future—then woman is superior.

The facts examined in this article, then, lend a certain amount of confirmation to all of the four theories mentioned at the beginning, except so far as woman's inferiority may have been implied in them. Woman's more intimate connection with the life history of the race, her childlike, representative, and typical nature, her embodiment of the everlasting essentials of humanity, her at present arrested or retarded development—all these are indicated by modern anthropological studies. These results are indicated, not proved. They must be verified, supplemented, and no doubt, in some instances, corrected by future studies along these lines.

From these studies there would be no want of lessons for political and social reformers, if they would learn them. From woman's rich endowment with all that is essentially human, the most devoted enthusiast for woman's rights and equality might gain new inspiration. From her retarded development the educational and political reformer might learn that woman's cause may suffer irretrievable damage if she is plunged too suddenly into duties demanding the same strain and nervous expenditure that is safely borne by man, and if it is attempted to correct in a century the evil of ages. From woman's childlike nature the thoughtful "spectator of all time and all existence" might learn yet a deeper and more significant lesson. May it not be that woman, representative of the past and future of humanity, whose qualities are concentration, passivity, calmness, and reserve of force, and upon whom, more than upon man, rest the burdens and responsibilities of the generations, is too sacred to be jostled roughly in the struggle for existence, and that she deserves from man a reverent exemption from some of the duties for which his restless and active nature adapts him?

IRRITABILITY AND MOVEMENT IN PLANTS.*

By D. T. MACDOUGAL.

WITH the extension of information concerning the scope, purposes, and adaptations of the movements exhibited by plants, the determination of the nature of the specific forms of irritability under which these movements are induced becomes a question of very great interest. The more apparent movements of plants have long been matters of common observation, yet no apprehension as to their real nature existed before the middle of the present century. Previous to that time natural philosophy was chiefly busied in the definition of the "distinctive qualities" of the great groups—plants, animals, and minerals—and perpetuated without serious inquiry the beautiful vagaries of Aristotle as to the possession of a materialistic soul by plants. Both before and after the dictum of Linnæus, "Lapides crescunt, vegetabilia crescunt et vivunt, animalia crescunt, vivunt et sentient" (1735), the literature of natural history is rich in allusions to the possessions of functions by plants corresponding to the senses of animals. The only actual distinction made by Linnæus between the two groups was the denial of ideal perception to plants. Erasmus Darwin, in his Zoönomia (1794), supposes that plants possess voluntary power. He says: "The sleep of animals consists in the suspension of voluntary motion, and as vegetables are subject to sleep there is reason to conclude that the various actions of opening and closing their petals and foliage may be ascribed to a voluntary power; for without the faculty of volition sleep would not have been necessary for them." Probably a fair representation of prevalent thought on this subject at an early part of the present century is made by the admirable treatise of Tupper,† in which he attributes to plants irritability, a form of instinct (to account for

* Abstract of two lectures given before The Fortnightly Scientific Club of the University of Minnesota, October 20, 1894, and January 19, 1895.

† An Essay on the Probability of Sensation in Vegetables, with Additional Observations on Instinct, Sensation, Irritability, etc. London, 1811. By James Perchard Tupper, Member of the Royal College of Surgeons and Fellow of the Linnæan Society.

spontaneous movements), and a low form of sensation, which he supposes might be accompanied by a degree of consciousness—"and as sensation does exist in animals independently of those eminent attributes with which it is combined in our natures as rational agents, may we not reasonably infer that vegetables have likewise their share of sensitive power, and consequently the means of enjoying their existence?" Hence, as vegetables are necessarily so different from animals in their mode of existence, it is very evident that we can not form any idea how they feel under any circumstances; but we are not on this account to conclude that they are destitute of every kind of sensation. "As they possess *life*, *irritability*, and *motion*, spontaneously directing their organs to what is natural and beneficial to them, and flourishing according to their success in satisfying their wants, may not the exercise of their vital functions be attended with some degree of sensation, however low, and some consequent share of happiness? (*Vide* Smith's Introduction to Botany.)"

Biological literature even in recent years abounds in expressions concerning phenomena of plant life corresponding to the sensorial action of animals. These conceptions were fostered to some degree by Charles Darwin's Power of Movement in Plants and other works, in which the actions of plants are described in terms strictly applicable to the sensorial reactions of animals only. Thus he says of the irritability of the tips of roots, "It is hardly an exaggeration to say that the tips of the roots affected and having the power of directing movement in the adjoining parts act like the brain of the lower animals." This phraseology was, no doubt, intended to be suggestive rather than definitive, but to it may be traced many current erroneous impressions. "Instinct," "intelligence," "nervous action," and a score of similar terms are used indiscriminately to designate actions of plants far removed in character from those denoted by the original meaning of such expressions. A partial justification of this misapplication of terms is found in the lack of systematically arranged information concerning the form of sensibility exhibited by plants. With an extensive nomenclature dealing with the great mass of detail of the neuro-muscular action of animals at command, the apparent similarity between the irritation reactions of plants and the sensorial reactions of animals has been held to be real, in a manner strongly suggestive of the anecdote of the German peasant who, seeing a moving locomotive for the first time, exclaimed, "There's a horse inside of it, or how could it run?"

The conception of the relative character of these two great groups of reactions may be attained by outlining the conditions which have led to the development of each rather than by an accentuation of external similarities.

Protoplasm, the physical basis of animal and plant life, has among other characteristics that of irritability to several classes of stimuli furnished by its environment. It reacts to these stimuli by adjustments, many of which are accomplished by motion or contraction, and to others by metabolic changes. What agencies have been potent in the development of this primal irritability of protoplasm, through reflex action, into sensorial reaction in the animal, and into the various forms of specific irritability in the plant?

It is unquestionable that the paramount necessity for every organism is that of self-preservation. To obtain food, avoid injury, and secure the proper degree of the environmental conditions of light, temperature, and moisture, are then to be considered as the fundamental necessities of every organism.* Animals are organisms in which destructive metabolism prevails, in which more energy derived from complex foods is dissipated than is conserved. Connected with and underlying this condition of the metabolic balance is the fact that animals have steadily developed toward motile forms. In the accomplishment of the conditions of life, motion has become to them an indispensable function. The necessity for the ability to direct the locomotory movements in the avoidance of danger and the attainment of food and comfort has led to the development of irritability into the forms of sensorial action. Plants, on the other hand, are organisms in which constructive metabolism prevails, in which more energy is conserved than is consumed in the performance of the necessary work. Underlying this state of the metabolic balance is the fact that plants have steadily moved along a line toward fixed forms. Consequently irritability has been developed into forms which would be of service to the plant in securing food and protection without moving from place to place. Not only has the protoplasm of the plant developed an irritability to different qualities of the stimuli to which animal protoplasm responds, but it also reacts to certain forces to which the animal is inert, by a mechanism different in every essential from that of the animal. These two lines of development of the primal irritability of protoplasm by reason of the metabolic activity and other conditions attendant on each are so widely divergent that great care must be exercised in the comparison of the higher forms of sensibility exhibited by the plant and the animal. In the animal the higher form is that of sensorial reaction with its vast range of usefulness. In the plant this power has developed with equal facility for the necessities of the organism, but even in its highest form it must needs be

* Arthur, Special Senses of Plants. Proceedings of the Indiana Academy of Sciences, 1893.

termed irritability, although it has attained a degree of specialization in which its delicacy and usefulness are equal to those of sensorial action, and may surpass them in some instances.

Among the more marked forms of irritability shown by the plant may be mentioned those by which it reacts to gravity, radiant energy (heat, light, and electricity), shock, and metabolic action. A clear conception of the character of the reactions of plants to these stimuli may be attained by a consideration of those shown toward gravity, light, and contact of solid bodies.

Since the plant is a fixed organism and can not move in search of food, it is essential that its roots thoroughly penetrate the soil of the locality in which it is found, in such manner as to place its absorbing surfaces (root hairs) in contact with whatever nutrient solutions the substratum may contain. The necessity for such penetration of the soil has led to the development of irritability to gravity in the protoplasm of the roots. Primary roots in response to the stimulus of gravity tend to place themselves in a position with their axes lying parallel to the force of gravity and the tips pointing vertically downward. But if all the roots assumed this position they would depend from the stem in a compact mass in a manner not advantageous to the plant. The secondary or smaller roots, however, react to gravity in such manner that they place their axes at right angles to the line of force, thus securing a penetration of the soil in a second direction. These forms of reaction to gravity are also exhibited by other organs of the plant but do not occur to any extent among animals. The manner in which a primary root curves to place its axis in a vertical position may be seen in Fig. 1, and that of a culm of grass to become erect in Fig. 2.

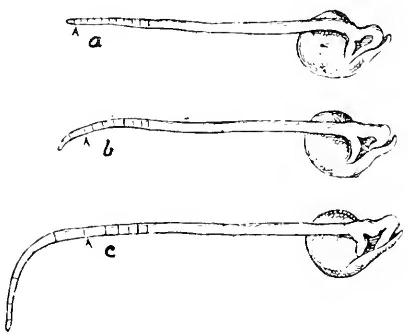

Fig. 1.—Downward Curvature of a Primary Root of Pisum which has been placed in a Horizontal Position.

An important requirement of aërial organs is that they assume a position in which their surfaces will be exposed to the sunlight at an angle most advantageous for the performance of their functions of the formation of food and transpiration. To meet this need, those portions exposed to the light have acquired a specific manner of response to the light by which some place their surfaces parallel and others at right angles to the direction of the rays. Gravity acts continually and invariably in one direction, and with a constant force. Consequently the movements of plants in response to this stimulus are comparatively simple. Light has its source in the sun, which varies its position through one hundred and eighty degrees during the daytime and is wholly

FIG. 2.—UPWARD CURVATURE OF A CULM OF GRASS WHICH HAS BEEN PLACED IN A HORIZONTAL POSITION. The dotted outline denotes the original position of the plant.

absent at night. In consequence the movements of the plant to adjust its surface to this stimulus of ever-varying direction and intensity are of great complexity. This variability of the stimulus has, moreover, induced in the plant a delicacy of irritability toward light far beyond that exhibited toward gravity. The manner in which leaves react to light may be seen in Fig. 3.

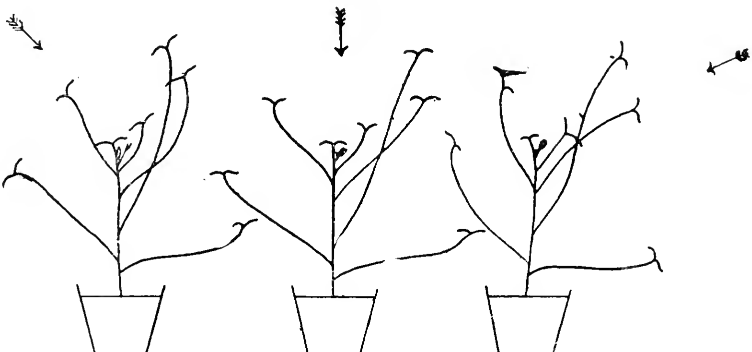

FIG. 3.—DIAGRAM OF LIGHT POSITION OF LEAVES. The arrows indicate the direction of the rays which have fallen on each plant separately.

In a large and varied category of plants it has become of great importance that they execute certain movements when solid bodies come in contact with them or strike their surfaces. This irritability to contact or impact has been developed in a number of carnivorous plants, which entrap and hold insects which serve as food; in the tendrils of climbing plants, which coil around supports and lift the foliage and flowers into sunlight; in a large class of "sensitive plants," which quickly fold their leaves on the reception of such a stimulus, thus avoiding injury from hail or grazing animals. The need of delicacy is much greater here than

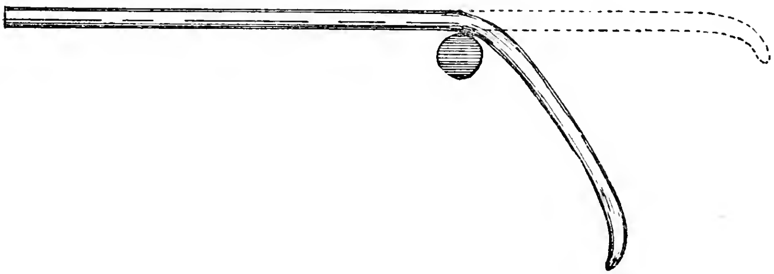

Fig. 4.—Tendril of Passiflora Forty Seconds after Contact of Wooden Rod against Lower Surface. The dotted outline designates the original position of the organ.

in the previous forms described, and the response is much more marked and rapid. As an example of this form of irritability may be cited the contact reaction of tendrils. In Fig. 4 is shown the curvature of a tendril forty seconds after it has been lightly touched with a wooden rod.

With the general features of these reactions at hand, the question as to the mechanism by which they are accomplished becomes one of very great interest. The first point which naturally presents itself is the reception of the stimulus by the plant. Is every cell in the plant or organ affected by the stimulus, and do all bear an equal and similar part in the resulting movement? It is found by experiment that if the terminal region (see Fig. 1) of a root is cut away with a sharp razor, the root will no longer respond to gravity, but will remain in whatever position it may be placed. After a time, when the tip has been rehabilitated, the root regains its power of response to this force as before. The results of this and other experiments tend to show that the only part of the root which can receive the stimulus of gravity is a small mass of cells in the center of the tip. It may be seen, further, on reference to Fig. 1, that the curvature occurs in the fourth and fifth divisions from the tip. Here, then, is an instance in which a distinct mass of cells—"the perceptive zone"—receives the stimulus, and curvature results from the action of another mass of cells—"the motor zone"—several millimetres distant. This would, of course, imply that the impulse from the stimulus received by the perceptive zone was transmitted to the motor zone, and that the reception of the stimulus, the transmission of the impulse, and motion were each accomplished by separate groups of cells. The receiving, transmitting, and motor zones are not always so distinctly separated, however. In stems, leaves, and other aërial organs the perceptive zone may extend over the greater part of the surface, including the region of curvature. In tendrils the perceptive zone comprises the superficial layers of tissue of the concave side of the organ throughout the region of curvature. It is quite probable in all these instances, however, that the cells receiving the stimulus are not identical with those causing the curvature, or, disregarding the cell, separate masses of protoplasm are differentiated for the performance of each of these functions. A clear conception of this mechanism may be attained by a consideration of the structure and action of a tendril. A tendril is generally of bilateral organization, consisting of a middle layer of pith between two layers of elastic and flexible mechanical tissue (wood); outside the wood, on both the upper and lower sides of the organ, layers of mobile thin-walled parenchyma cells, which in the active condition of the tendril are in a state of high internal tension; covering the parenchyma, a layer of epidermal tissue composed of elastic, thick-walled, but easily extensible cells (see Fig. 5). If a solid body is brought into contact with the concave

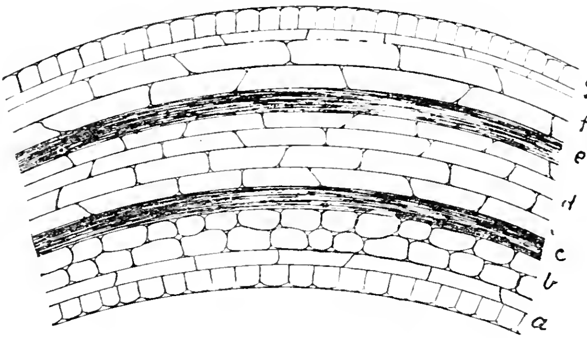

Fig. 5.—Diagram of the Longitudinal Section of a Tendril in the Region of Curvature. *a*, epidermis (perceptive zone); *b*, parenchyma cells which before curvature were similar to *f* in form; *c*, *e*, wood; *d*, pith; *f*, parenchyma slightly more elongated than before curvature; *g*, epidermis of convex side.

side of a tendril, the pressure acts as a stimulus on the ectoplasm—the thin layer of protoplasm lining the walls—of the epidermal cells. The ectoplasm of these cells is connected with that of the thin-walled parenchyma cells at numerous points by means of very fine strands of protoplasm extending through the walls of the intervening cells. An impulse is conducted along the strands to the protoplasm of the thin-walled cells, and their action results in the curvature of the organ. The structure and action of the tendril are generally similar to those of a large number of stems.

The manner of action of the motor cells (Fig. 5, *c*, *e*) has not been clearly made out. By different investigators the curvature has been successively attributed to an accelerated growth of the convex (upper) side of the tendril, a retarded growth of the concave (lower) side, an increased turgor in the region of curvature with an increased extensibility of the walls of the convex side, and an increased turgor of the convex side only, coupled with an increased extensibility of the walls of the cells on this side. But recently the hypothesis that the curvature is due to the increased turgor of the concave side, with an increased extensibility of the walls of this side in one direction only, has been offered. Whether the last offers the true solution of the problem or not remains to be proved. However, it accounts for certain features of the curvature irreconcilable with previous explanations. The conditions of the motor cells after curvature may be seen in Fig. 5.

In plants provided with cushions of tissue—*pulvini*—for the purpose of rapidly displacing leaf stalks and other organs, the movement is effected by a direct contraction of the cells on the side toward which the organ is curved. It will be quite remarkable if it should be found that the rapid movements of the "sensitive plants" are effected by the contraction of the motor cells, and the slower movements of tendrils and other organs by the expansion of these cells.

Of the ultimate molecular changes ensuing in the cells of the motor or perceptive zones, as well as in the transmitting tissues, nothing is known, except that in such cells the metabolic action is necessarily very rapid. In this the physiologist confronts a problem which may not reach its final solution until the ultimate organization of protoplasm is at least approximately ascertained.

The delicacy of the mechanism of irritability in certain instances is such that the amount and intensity of the stimulus necessary to secure a reaction are extremely small. It has been found that tendrils would respond to the contact of a weight not greater than one five-thousandth of a milligramme, and that a plant in a dark chamber would curve toward the light afforded by a single spark from a small condenser coil, or to a light too diffuse to cast a shadow perceptible to the human eye. Some of the lower free-swimming forms have been found susceptible to the presence of an amount of oxygen so small as the one-trillionth part of a gramme, which is very nearly the atomic limit of this substance. This delicacy of perception is doubtless beyond that of the senses of the higher animals.

At all times the amount of a stimulus necessary to produce a response increases with the amount previously acting upon the plant. Thus a plant in total darkness will react to an extremely small amount of light, as has been pointed out; but, if placed in a strong diffuse light coming from all directions, it will be found unresponsive to an increase of the light from one side far in excess of the amount just described. Pfeffer found that, while the spore tubes of ferns were ordinarily affected by an extremely small amount of sodium malate, yet, when placed in a one-hundredth-per-cent solution of this substance, would not respond to an additional amount of the substance until it reached a concentration thirty times as great. The results obtained by other investigators indicate that Weber's law is applicable also to the reactions of plants to light, and perhaps all forms of stimuli.

When a stimulus impinges upon a perceptive zone, the reaction shown by the motor zone does not occur simultaneously with the reception of the stimulus, but after a "latent period" of varying duration.

In Fig. 6 are graphically represented the features of the movement of a tendril which has been stimulated by the contact of a solid body (see Fig. 4). Thirty seconds elapsed after the stimulus was applied before the movement began. The contraction

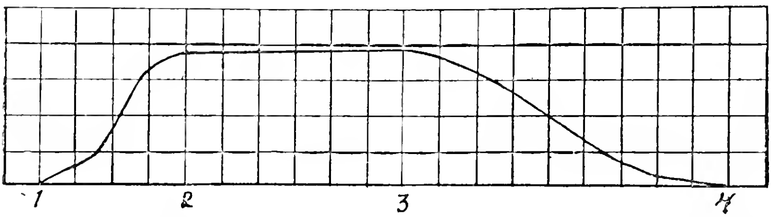

Fig. 6.—Curve of Contraction of Tendril. The distance of the curve from the base represents the amount of displacement of the tip; five centimetres on the base line represents five minutes; 1 to 2, latent period and period of contraction; 2 to 3, period of maintenance of contraction; 3 to 4, period of relaxation.

then went forward with, at first, an accelerating, then a decreasing, rapidity until the maximum of contraction was attained. This position was maintained several minutes, when a relaxation occurred by which the organ was restored to its original position. In comparison with the long familiar reaction of the frog muscle-nerve preparation, it will be seen that in one the latent period is about one hundredth of a second, in the other thirty seconds; the period of contraction in one is five hundredths of a second, and in the other twelve hundred seconds; the period of maintenance of contraction in one is momentary, and in the other it endures eighteen hundred seconds; the period of relaxation is five hundredths of a second in one, and thirty-three hundred seconds in the other.

The essential features of the mechanism of each of the two movements are so widely different that these are not capable of strict mutual interpretation, but in general the rapidity of contraction in plants may be said to be less than in animals. It must be borne in mind that the mechanism of each has developed the rate of movement best adapted to its needs, and that this rapidity of movement is, furthermore, conditioned by the metabolic activity of the organism which supplies the necessary energy.

In recapitulation it may be said that the primal irritability of protoplasm has been developed in the motile, destructively metabolic animals through the phases of reflex into sensorial action, while in the fixed, constructively metabolic plants the main line of advance has been, not toward sensorial action, nor along a line parallel to it, but at a wide angle from it, into a series of highly specialized forms, whose delicacy of mechanism and efficiency is as commensurate with the complex necessities of the plant as those of the sensorial apparatus to the animal.

THE SPIRIT OF MILITARISM.

By A. B. RONNE.

IN the Principles of Sociology (Volume I) Herbert Spencer draws a sharp and clear distinction between two types of society—the militant and the industrial. Leaving out of consideration the analogy between the animal and the social organism in the development of the various systems—the regulating, the sustaining, and the distributing—it will be readily conceded that from the view of sociology the last of these two types—the industrial—stands highest in the scale of development as implying voluntary co-operation among the members of the organization with more of individual liberty; while the first, the militant type, implying compulsory co-operation under a more or less despotic military government with less of individual liberty, is decidedly nearer to the early predatory state. Mr. Spencer also shows how social metamorphoses take place. Especially interesting to note is the transformation or retrogression of the industrial type, partially developed during years of peace, into the militant type when war once more occurs.

Of all the illustrations which might be gathered from history, ancient and modern, as exhibiting this social transformation, Mr. Spencer considers that furnished by England in more recent years the most striking, because the industrial type here was further developed than anywhere else, owing in a great measure to the long era of peace which commenced in 1815. But the usurpation of power by Louis Napoleon in France caused a great change. England soon found herself involved in actual wars, one after the other. The threatening attitudes of neighboring nations alone were sufficient to develop a similar one at home for the sake of defense. A structure for defense, however, is also available for the purpose of offense, and reasons for extending the empire never being scarce, England entered upon an era of aggressive warfare in various parts of the world. This, what Mr. Spencer calls a revival of the predatory spirit, was naturally accompanied by a return toward the militant type in the institutions generally—that is to say, "the extension of centralized administration and of compulsory regulation."

If Mr. Spencer were now to rewrite the Principles of Sociology, there can be no doubt that he would find in the United States an illustration scarcely less striking. Most of what he tells us of the changes in England is a matter of history here. That the immediate result of the late war of rebellion was a tendency of the military officialism to take the place of civil officialism no one will deny; and though it may, perhaps, not be said that we have military heads of all the various departments, still, the disposition to fill all administrative offices with military chieftains, so strong immediately after the war, was in the same line—the result being "a style of administration which asserts authority more and regards individual claims less." At the same time, the revival of the predatory spirit in regard to external affairs has been clearly discernible here too; for although the sin of aggressive warfare on weaker or barbarous nations can not be laid at the door of our Government, the constant cry for coast defenses and for the strengthening and increasing of army and navy are clear indications of the same spirit. But what chiefly must strike us as familiar facts are these: The spirit of sanitary dictation and the usurpation of exclusive privileges by certain professions (prominent among them the medical); poor-law, and we may add tramp-law, administration in various parts of the Union; the demand for municipal distribution of water, gas, and coal, as well as for governmental ownership of railroads and telegraphs; the ever-increasing influence of "a coercive philanthropy" invoking state power to improve people's conduct, etc.; in short, the strong impetus imparted to the socialistic tendency of modern times is nothing but that same military spirit clamoring for the right of the state, or the commonwealth if you please, to regulate the private affairs of the citizen in every department of life.

That this tendency is a real one, with roots deep down in the economic conditions of the masses, it would be useless to deny. Whether it as such is a healthful one, to be hailed with delight and encouraged, is another question—a question that does not come within the scope of this article; but as far as it is animated with the spirit of militarism it may well cause us alarm and misgivings. What shall we say, for example, of the movement, now fairly under way in the State of New York, to establish throughout the country a system of military drill in the public schools and colleges? At a time when so much is heard about Germany groaning under its military system, rigorously maintained by its young war lord, this announcement ought to be well calculated to make every unassuming, liberty-loving American rub his eyes in wonder and ask whether he is dreaming or not. Many there are, no doubt, who will look upon it with a smile as a mere fad, perhaps good-naturedly regard it as a means toward the improvement of the general deportment and physical conditions of the young. But if they for a moment will consider the source from which it springs and carefully weigh the reasons with which it is launched forth, it surely must take a more serious aspect. The fact alone that it originated in G. A. R. circles, is backed and indorsed by certain high military dignitaries, civil functionaries, and legal authorities ought to arouse a suspicion in the ordinary citizen of a supposed free industrial country. It is, however, when we examine the arguments in its favor by some of these high military and legal authorities that its real essence, its military and retrogressive spirit, becomes clear.

In the first place, there is the usual soldier's argument that "if ever an occasion should arise when a call to arms should again be sounded, those to respond (having been trained in the schools to military tactics and to the use of arms) would be tenfold more efficient than were, at first, the brave boys of '61 and '62, who mostly went to the war practically undrilled." To this it only needs to be said that, the business of the professional soldier being to kill, it also becomes part of his business to find or devise new occasions for the exercise of his professional duties. It is significant of the extreme plight in which the military authorities find themselves in this respect that the gentleman, an officer of high rank, who gave utterance to the above warning could find no other possible occasion for the call to arms than "the anarchistic and socialistic forces tending to undermine our democratic republican government." Whatever influence, therefore, he may exert on the timid and the unthinking, to the philosophical, the trained minds, who recognize that these anarchistic and socialistic forces are the natural effects of real causes in our industrial and political conditions, to these his suggestions will have the weight of the professional soldier's pleading for his own existence and no more.

But the burden of argument in favor of this proposed military training of our boys and young men is that it will make them better citizens of this free country—that "a vote in the hands of a man who has been taught to love his country, and to recognize the value of obedience to law, and *to toe out and hold his chin up* by military instruction, is a safe vote for the country." And here Germany is called upon to furnish an illustration of the cherished object. It is seriously asserted that the military system there is worth far more than it costs, for the reason that the young men there, through the several years of military drill and discipline, are made "efficient citizens for all the duties and emergencies of life."

It would seem strange indeed that in a country as young as this, with its Revolutionary antecedents, the sophistry of such arguments should not be apparent to every one at first sight, did we not know that very few appreciate the fact that in all ages it is disobedience rather than obedience to existing laws which has made progress possible; that each age or generation, yes, each new decade, has its own requirements; as the poet says, "must have new men to determine its liberty." If love for country means the obedience to civil and political law which a military discipline inculcates, then let us have less of it. One need not be a student of history to see the results of that kind of loyalty. Already now practical men may be heard every day discussing absurd laws with their far-reaching results; but they will add that a law must be respected at any cost until it is repealed, and as it does not come within their province to repeal it, the law remains, a menace to the liberties and happiness of the people. What must we expect, then, when every one shall have been trained into a military—that is, blind—obedience?

And here it may be well to ask, What is law, that we should cultivate this filial spirit toward it? Let it be understood that the common law, that by mutual consent established respect for life and property, is not here under consideration. The industrial type of society, where *voluntary association* is the rule, owes its growth to the comparative absence of military discipline, and it is just such a state of society where we find the respect for common law best developed. Statute law, then, is what we have to consider. Is this the spontaneous expression of the will of the people or of the best elements among us? Hardly ever. Now, whether it is the will of one or a few, enforced upon the rest through intimidation or strength of arms, etc., or whether it is the will of that always uncertain quantity, the majority, enforced by hook or by crook upon the so-called minority, why should it be held as something inviolable or something holy? Even if we were to take the most optimistic view of law, should regard it as the expression of our own will, "the voice of the whole people," we would by no means be in duty bound to cherish it as something inviolable. That we erred yesterday is no reason why we should continue the error to-day. Or, to leave error out of the question, if we at a former occasion acted according to the light given us then, so, with the increased experience of to-day, let us act according to our present light and disregard what under this must be incomplete or inadequate. Some will here undoubtedly interject the popular notion that in a supposed free country the people have it in their power to repeal useless laws whenever they choose; the facts do not seem to bear out the statement, but, let that be as it may, as already hinted at, the inculcation in the minds of the young of military obedience to law must certainly make the chances for repeal more and more hopeless.

Now, what do they mean, they who seriously argue that if we are to preserve our free institutions we must rear a generation of men "who have a wholesome respect for discipline, a habit of obedience together with an enduring love for flag and country which can not be uprooted by every passing storm of modern *isms*"? What do they mean by saying that a vote in the hands of such is a safe vote for the country? In the mouth of Emperor Wilhelm such words and sentiments are perfectly consistent: his power lies in the obedience of his subjects. But free institutions and a servile spirit can never go hand in hand. Free institutions can only be maintained by the eternal vigilance of the individual men and women, whose power of deciding between right and wrong is strengthened by free play and exercise. Change, ceaseless change, is the essence of life in superorganic as well as in organic bodies. Evolution and dissolution, growth and decay—this is the immutable order everywhere. If freedom and liberty are dependent on institutions, then clearly these must be changeable, for, once they become fixed and stagnant, freedom to act is out of the question. If this be not so, what is the meaning of "a vote in the hand of a freeman"? And what is the meaning of many of our symbols of liberty? At the harbor of New York city was erected the Statue of Liberty as "a pharos light to the weak endeavor." Could this mean simply that the citizens basking in its light should cultivate a submissive obedience to what once was decreed as best for them? Was it not rather intended as a reminder of the fact that liberty can only thrive with a distrust toward the old and a spirit ever ready to adapt itself to the new?

The promoters of this movement can only have this in view: The desirability of securing for our country a population of well-drilled subjects whose business shall be, not so much "to reason why" as it shall be "to do and die"—"to toe out and hold their chins up" when orders are given. When we remember how largely, already now, legislation is dictated by concentrated capital or by various interests intrenched behind governmental protection, how it is influenced by religious or superstitious prejudices; when we remember how conservative these controlling forces from their very nature must be toward everything that modern science, speculative and experimental, teaches, then the reactionary spirit of the movement becomes startlingly clear, and then, perhaps, will we understand the poet, who, speaking for the Goddess of Liberty, said:

> "I am a threat to oppression's sin.
> And a pharos light to the weak endeavor.
> Mine is the love that men may win,
> But lost—it is lost forever!"

JOURNEYING IN MADAGASCAR.*

By FRANK VINCENT.

EARLY on the morning of September 10th I left Antananarivo for Mojanga. My chief reason for not returning to Tamatave was that I preferred to see new country; and the second, that I wished to visit some gold mines worked by a Frenchman, named Suberbie, who had a concession of a large tract about halfway between the capital and the coast. This gentleman has a house in Antananarivo and spends much of his time there. I had the pleasure of meeting him and he favored me with letters of introduction to his manager at one place and a mining engineer at another. The bulk of my baggage had been left in Tamatave, and was to be sent on by the next monthly French mail steamer to Zanzibar, my ultimate destination. I expected to meet a like steamer at Nosy Bé, a French port and island on the northwest coast, with which I learned I might connect by means of a small French steamer which periodically served the principal ports on the west coast of the island. By thus crossing Madagascar I hoped to familiarize myself with its three great races. The Sakalavas on the western portion of the island have always borne a bad name, which they have in part merited, though high-handed aggressions of foreigners ought often to be urged in mitigation thereof. I was warned to keep my revolver in readiness and my escort near at hand, and so determined to take chances of a safe passage to the sea. The direct distance from the capital to Mojanga is two hundred and forty miles in a general northwest direction, though this distance, by many deviations and changes of level, is lengthened by the traveled route into about three hundred and eleven miles. Of this latter distance some two hundred miles are by land in filanzana and the remainder by water in pirogue and dhow, or small sailboat. The total journey may readily be accomplished in ten days. The country through which I would have to pass was

* Extracted from the author's latest book of travel, entitled Actual Africa, recently published by Messrs. D. Appleton & Co.

said to divide itself naturally into three sections: the first was similar to that eastward of the capital, a treeless region of moors and hills. This was the most inhabited. It consisted of four broad terraces which fell rapidly toward the sea. The road, however, leading as it did obliquely across these terraces, presented on the whole easy gradients. Then came a section of nearly uninhabited wilderness, wooded and undulating. The third section contained the cultivated hills and plains of the Sakalavas. I re-engaged for this journey four of the filanzana-bearers and the captain, Mazoto, who had come up from Tamatave with me. This Mazoto was a bright, intelligent fellow, who, besides being the chief of the men, acted as my body servant, and assisted me in cooking and the general duties of vagrant housekeeping. He was born in the country, but of Mozambique parents. His descent showed itself very clearly in his curly hair, his features, and his manner. I then engaged four more filanzana-bearers and six baggage coolies. This made a following of fifteen persons. I took a little larger stock of provisions, but otherwise the outfit was quite the same as when coming to the metropolis from Tamatave. I hired my men only as far as the land journey extended, and was therefore obliged to pay one half more for their return, which seemed no more than just. The bulk of this payment was arranged to be made when they arrived in Antananarivo, and I promised them each also a small present to be earned only by faithful attention to duty and good behavior—so that by these means I had the men pretty well under control. And now it was necessary to call the roll of my assembled bearers and coolies, and this was no easy or quick matter, for scarcely one name was of less length than six syllables. Biographical names in Malagasy are quite as long as geographical. Two of the men were slaves belonging to Mr. Ryder's clerk. In appearance they could not be distinguished from the others, and in amiability and faithful work they proved rather superior to them. All the names, singularly enough, began with the letter R. Here are some of them: Rataimiandra, Ramahamay, Rainivelonandro, Rainizanakolona. The baggage was soon packed in three parcels, and covered with tarred cloth for fear of stray showers. These parcels then being lashed to thick bamboo poles, each borne by two men, were sent on in advance. My filanzana stood waiting, and after a hasty but none the less heartfelt parting from my kind entertainer, I "mounted" and started away north through the deeply gullied streets of the capital, past the edge of the great Zoma, by the tomb of the prime minister's family, and down on to the great plain of Betsimitatatre, covered as far as the eye could see with variously tinted rice fields and everywhere traversed by large and small canals of water obtained mostly from the Betsiboka River. The large canals are utilized by boatmen in

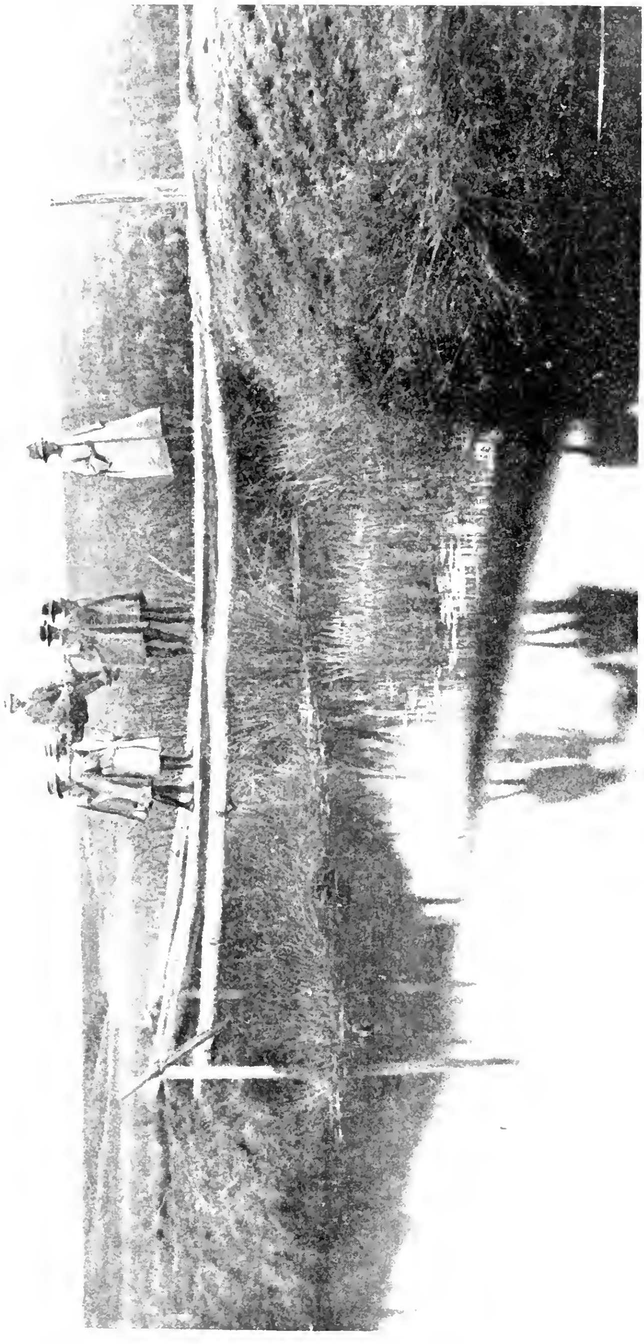

Fig. 1.—On the Road in Filanzana.

bringing their supplies in canoes to market. Squatting by the banks of many of the rice fields were natives armed with guns with which to kill the numerous birds that eat the young growing rice.

The Betsiboka River is here about fifty feet wide in the dry season, but so high and powerful does it become in the wet season that it has to be restrained in its bed by a huge levee of earth some fifty feet in width. On the top of this lay our road for many miles. The other great embankments crossing the plain were nearly covered with mud-walled dwellings. We next reached the banks of the Ikopa, here only a muddy stream about fifty feet wide but one of the largest rivers of Madagascar, whose general course I was now to follow, though at some distance to the eastward, until I reached the sea. I soon left the plain and entered upon a country similar in general character to that found east of the capital, except that the treeless moors were smoother and the road far better. For a long way I enjoyed fine views of Antananarivo, sitting proudly upon her Acropolis, and then, crossing a high ridge, she was gone, to be seen by me no more. Afterward we passed at some distance a great bazaar or weekly market like the Zoma of the metropolis, being held on the top of one of the great smooth downs. The thousands of white shrouded figures collected there were a queer sight. I stopped to eat my lunch in a little roadside hut, and rested upon a comfortable mattress made of palm-leaf ribs and covered with straw matting. On the wall hung a sort of fiddle, with two strings stretched upon a small gourd. The doorway of this hut was only three feet in height, and I had almost to go on "all fours" in order to enter. A very old decrepit woman was the only one about, though I had noticed others in other huts. The sole occupations of these poor old creatures consist in sitting in the sun and gazing at nothing, or, while lying half asleep on a mat, in driving chickens from the rooms with a long pole or with simple hisses. As the doors are always wide open and the fowls always in search of scraps of food, the crones are not idle, at least when inside the huts. No one seems to pay any attention to these reminiscences of humanity, and they themselves appear to wait only for reluctant Nature to dissolve. Going on, there were many outcroppings of granite now to be seen and many curiously shaped erratic bowlders. One hill looked like the round dome of an observatory, another like an ordinary haystack. Everywhere possible rice terraces were placed, and there were many small cultivated fields, but before night the country had become quite deserted, and the road after those to which I had been accustomed was positively lonesome. The strong, pitiless wind which unobstructed sweeps these moors added to this feeling. Traveling at this season is very trying also, for as you sit so long in your filanzana you are chilled and

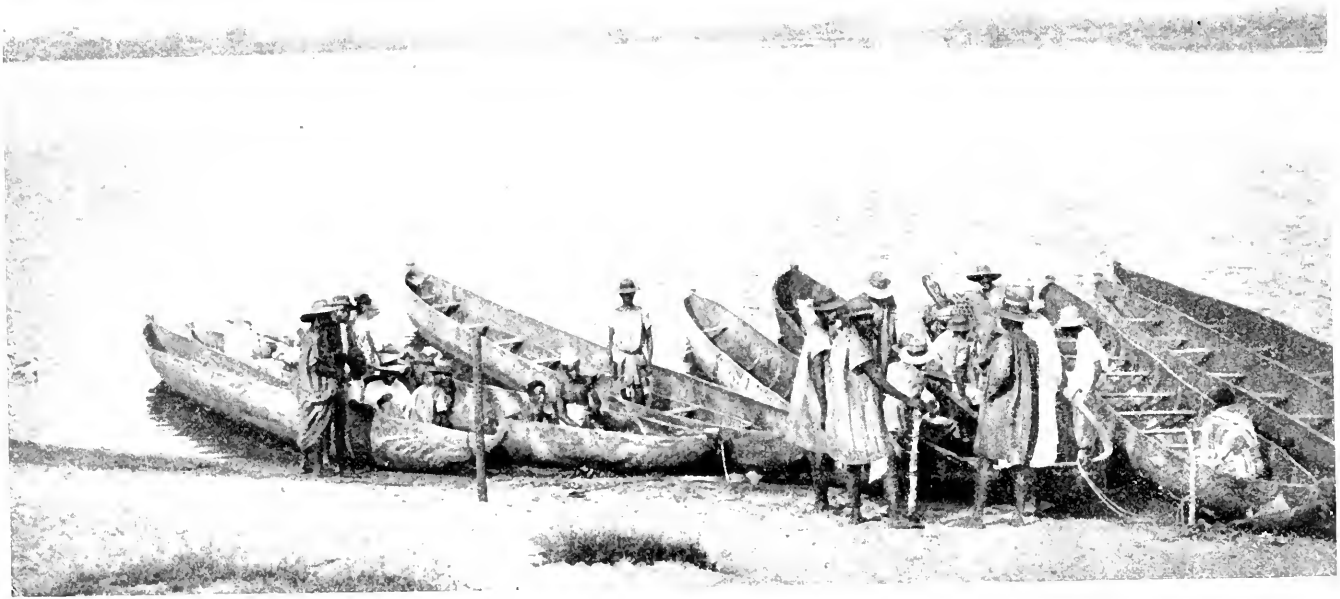

Fig. 2.—Malagasy Canoes.

Fig. 3.—The Traveler's Palm.

cold until midday, then positively roasted until about four in the afternoon, when you again feel cold until your fire warms you at night. You must have a fire, for, although the houses hereabouts are built of mud bricks, they are by no means tight about doors and roofs. While I was in Antananarivo the weather was cool and delightful morning and evening, perhaps a trifle too warm in the middle of the day only. But the air was always clear and bracing, and there was generally a light breeze blowing.

Many of the hamlets were now surrounded by a deep ditch, a huge fence of cactus, and a very wide low wall. They reminded me at once of pictures of scenes in central Africa. The ditch generally has some sort of drain, for fear of its overflowing during the heavy rains of the wet season. The ground within the inclosure is quite smooth and level, and the houses usually stand in two rows right and left of the low and narrow entrance gate, which is partially closed by a great stone slab or by piles of logs. I stopped for the night in one of these villages, and was shown quarters in a wretched hut half full of pigs. That is to say, I was offered a room adjoining the pigsty, into which the door of the house directly opened, while the people scrambled into the dwelling room by a window about two feet square, to which they mounted by a pile of rough stones. Upstairs there was a dirty kitchen, to which you had access from the pigsty by a flight of dark, narrow, steep steps in which there was a turn at right angles, for otherwise the house was so small the steps would have had to be vertical. Adjoining this kitchen was a room just large enough to contain my camp bed, and this I accepted—fleas and all—for, if I had to be in the same house as the pigs, at least I preferred another *étage*. All these villages seemed to allot a large portion of their ground floors to a horrible little black and white spotted pig. The infrequency of pigs on the east coast is more than balanced by their frequency in the central districts.

We continued on during all the next day in a sort of rough valley bordered by ranges of hills. The soil was poor, the grass was coarse, and there was much red clay. The country was very thinly settled and few people were met upon the road. I stopped for my lunch in one of the circular, ditched villages, in a very dilapidated dirty hut in which the only door, as usual, opened directly into the pigsty, while the family scrambled through a little bit of opening several feet from the ground. To facilitate the exit of smoke two large holes had been made at either end of the roof. This let in some daylight, which was much needed, but looked as if much unneeded rain must enter by the same orifices. In the center of the room next the piggery was a fire, and against the walls a few cooking utensils, a rice mortar and pestle, a basket of young squawking ducks, some rolls of matting, and a few clothes.

Fig. 4.—Some Styles of Hair-dressing

In one corner sat two little bright-eyed boys who were studying from some paper-covered books—their readers and spellers. I observed that they had also a catechism and a small Testament. All were of course in the Malagasy language. They had also a slate which was used for writing their exercises. I took a little stroll afterward among the houses, and was surprised and amused to see how frightened the chickens were at my approach. I had expected this of the few curs about, but hardly of the fowls. The hens exhibited the greatest alarm, and strove to marshal and drive away their chickens. Apparently even a glimpse of civilization, as represented in my humble self, was altogether too much for these creatures, so naturally more distrustful than their owners, who cheerfully look at everything foreign but will adopt nothing.

During the afternoon we passed through the large village of Ankozobe, pleasantly situated on a smooth hill, like the whole country hereabouts entirely devoid of trees. The people burn a small reed for their cooking, and charge the same price for this as for firewood. Just outside the capital a great field is covered with huge bundles of this reed, there kept for sale. Nearly all the houses of Ankozobe were built in the shape of wall tents—i. e., they had mud walls two or three feet high, upon which directly rested the high-peaked grass roofs. The governor came from his house to invite me to rest and partake of some refreshment, but I was obliged to decline his hospitality, wishing to reach a certain town before dark. This was called Ambatvarana, with deep, wide moat and a square full of cattle. Pigs swarmed everywhere. Just to the westward was a magnificent great mass of gneiss, with precipitous sides showing vertical striæ which looked like the basaltic columns of the Giant's Causeway of Ireland. The range ends a little to the northward of the village in a vast dome of gneiss, with a big conical top which itself rises all of a thousand feet above the roughly undulating plain. It is called Mount Angavo. The highest point is said to be 4,880 feet above sea level, or about one hundred feet above the site of Antananarivo. I visited several houses in this village that were tendered me, but each seemed worse than the other. Finally, I accepted a room in one, on condition that the pigs should sleep away from home for that night. After putting up my camp bed and mosquito-netting, I found I could not get in all my very limited baggage and myself at the same time unless I suspended the most of the former from the walls, which accordingly I did, having driven wooden pegs into the interstices of the mud bricks. The upper floor into which the family were crowded was reached by a vertical bamboo ladder. Soon after lying down for the night I heard so much noise in the pigsty that I was afraid my hostess had forgotten her promise. On searching I did not, it is true, discover any pigs, but there were a cat, a litter of pups, and a brood of chickens. These, at least at my distance, did not smell, and I supposed would not indulge their respective vernaculars all the night, so I returned, decided to make the best of the situation. But little did I know that by no means had a complete roster of

Fig. 5.—Native Soldiers.

the inmates been taken. I found long before morning that the place swarmed with vermin of all sorts: lice, fleas, mosquitoes, bugs, cockroaches, spiders, and even scorpions. I arose at 2 A. M. and wished to take to the road at once, but had not the heart to waken my tired men before five. Within an hour we were off.

SURVIVALS OF SUN-WORSHIP.

By FANNY D. BERGEN.

WHEN happy boys and girls sing, "Here we go round the mulberry bush," or "Oats, peas, and barley grow," and gracefully step time to the words as they circle round and round, they dream not that in these and other ring games they often keep alive survivals of ancient sacred ceremonies. When some careful housewife tells her daughter or servant to be sure to stir cake or beat eggs in the same direction in which she begins, neither the matron nor her assistant has the faintest notion that this rather general rule in domestic affairs may be the survival of some very old religious rite. In this brief paper no attempt will be made to trace definite relationships between trivial customs of to-day and their ancient prototypes, or to draw any serious conclusions from the few miscellaneous illustrations that I have here and there picked up of the dextral and the sinistral circuits. I simply add them for what they may be worth to the mass of material on the subject that is gradually being accumulated by ethnologists. All sorts of unexpected survivals of old religious observances constantly appear in common everyday life. They are but degraded, tattered remnants of what ages ago were dignified, sacred rites. Considering how English-speaking folk have inherited influences from a great variety of sun-worshiping peoples, it would not be strange if there were found among them many outcrops of a worship that has been, and still is, in some form or other extremely widespread among primitive peoples. The early trading and colonizing Phœnicians, the Druids, the North German and Scandinavian invaders, all have left traces of their religious customs confusedly intermingled with Christianity. In dealing with the origination of actions or customs in which is involved what Dr. Fewkes calls the ceremonial circuit,* it is difficult to determine the value of the factor, whether it be large or small, that is due to the greater convenience of moving in a right-handed direction. Occasionally the dextral circuit is followed in cases in which it is evidently less convenient than the sinistral would be, as in dealing cards in all ordinary games. Also who can tell just how large or small an element may depend upon the tradition that the left hand in itself is uncanny without reference to the sun's apparent motion? There certainly is a general feeling of wide distribution that to be left-handed is unfortunate. Dr. Fewkes's careful and valuable researches among the Moki Indians of Arizona, however, show without doubt that they in

* Journal of American Folklore, vol. v, No. 16, p. 33.

their religious rites make the circuits sinistrally—i. e., contrary to the apparent course of the sun, or, as physicists say, contra-clockwise. The Mokis also are careful to stir medicines according to the sinistral circuit. But countless instances go to show that among Asiatic and European peoples the general belief or feeling is that the dextral circuit—i. e., clockwise, or with the apparent motion of the sun—is the correct and auspicious direction.

The following illustrations of this I quote from William Simpson's Meeting the Sun: * "They [people of past times] held that going sunwise was good and lucky, while going the opposite way was unpropitious. The Lama monk twirls his *mani* or praying cylinder in one direction on this account, and he fears lest a stranger should get his wheel and turn it the other way, thus destroying whatever virtue it had acquired. They also build piles of stones, and uniformly pass them on one side in going and on the other side in returning, thus making a circuit in imitation of the sun. The ancient *dagopas* of India and Ceylon were also thus circumambulated. The Mohammedan performs the '*tawaf*' or circuit of the Caaba after the same fashion; and it is an old Irish and Scotch custom to go 'Deisul,' or sunwise, round houses and graves, and to turn their bodies in this way at the beginning and end of journeys for luck, as well as at weddings and various ceremonies."

To turn the opposite way was called by them "withershins," and supposed to be an act intimately connected with the purposes of the evil one. Witches danced this way, and in imitation of the same read prayers backward. The author of Olrig Grange, in an early poem, describes this most graphically:

"Hech! sirs, but we had grand fun
Wi' the muckle black deil in the chair,
And the muckle Bible upside doon
A' ganging withershins roun' and roun',
And backwards saying the prayer.
About the warlock's grave,
Withershins gangin' roun',
And kimmer and carlins had for licht
The fat of a bairn they buried that nicht,
Unchristened beneath the moon." †

The Imperial Dictionary gives the derivation of the word withershins as from the Anglo-Saxon *wither*, against, and *sunne*, the sun—that is, contrary to the motion of the sun—though I believe there has been some disagreement regarding the origin of the word. It is sometimes spelled *widershins*, which would imply a direct relation to the German *wider* and *schein*. Withershins movements were generally used in working spells or counter-

* Pp. 340, 341. † Confessions of Annaple Gowdie, from The Bishop's Walk.

charms. It was an old popular belief in the Highlands of Perthshire that if on Hallow-eve one were to go alone around one of the fairy hillocks nine times withershins (*sinistrorsum*), a door would open by which he could enter the subterranean abode of the good people.*

In Joseph Jacobs's version of the fairy tale of Childe Rowland it was because in seeking the ball lost by her brothers in their play their sister Burd Ellen ran around a church withershins that the fairies carried her away. Also, when the third brother seeks her in Elfland, it is by following the direction given him by the hen-wife—viz., to go three times withershins around the fairy hill—that he obtains entrance to the Dark Tower, from which he safely carries the long-lost sister and the two elder brothers.†

As contra-sunwise motions were thought to be of ill omen or to be able to work in supernatural ways, so it came to be believed that to reverse other acts—as, for instance, reading the Bible or repeating the Lord's prayer backward—might produce powerful counter-charms. The negroes in the Southern States often resort to both of these latter practices to lay disturbing ghosts. In the ring games of our school children they always move sunwise, though whether because of convenience or from some forgotten reason who can say?

The weight of authority concerning the English May-day festivities and ceremonies goes to prove that their origin was in the old Roman Floralia, but there is some evidence to show that such celebrations are at least in part of Gothic origin. I suppose that there is little or no doubt that the northern European nations did welcome the return of the spring sun with dancing, and Brand quotes Borlase as stating that the May rejoicings in Cornwall are a gratulation to the spring. The old Beltane games and dances—so named from a corrupted spelling of the compound derived from the Phœnician word *Baal*, the sun, and the Gaelic word *tein*, meaning fire—that were practiced in Perthshire and other parts of Scotland until the beginning of this century, contained many survivals of sun-worship.‡

Lady Wilde says that the Beltane dance in a circle about a bush hung with ribbons and garlands, or about a lighted bush or a bonfire, celebrating the returning power of the sun, is still kept up in parts of Ireland on May-day, and that those taking part in the dance always move sunwise.# It seems highly probable that

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* Dr. Grahame's Scenery of the Perthshire Highlands, quoted by Scott in notes to Lady of the Lake, canto iv.

† English Fairy Tales, p. 117 *et seq.*

‡ See Napier's Folklore in the West of Scotland, pp. 161–170.

Ancient Cures, Charms, and Usages of Ireland, p. 106.

the Celtic May-day ceremonials and customs were of quite different origin from those of England, and in many small superstitions concerning May-day we find among the Irish peasantry frequent hints at sun-worship or of the worship of fire, the symbol of the sun. It is still believed to be unsafe or even profane to carry fire from one house to another on May-day; and on that day, when evil-minded persons or witches have special power, the butter in the churn may be protected from bewitchment by placing a live coal under the churn.

Undoubtedly the most remarkable survivals of sun-worshiping festivals in modern Europe are the Christmas rejoicings, which are but a Christianized relic of the old Yule celebration, marking the occurrence of the midwinter solstice, and the merrymaking on St. John's eve, which is merely an adaptation of the midsummer fire-festival of pagan times. In our own country the latter occasion passes unnoticed, but Christmas is sufficiently observed.

It is a general popular belief throughout the United States that in making cake the eggs, or indeed the whole mixture, must be stirred or beaten from beginning to end in the same direction in which the stirring began, or the cake will not be light, and that a custard will curdle if the stirring motion is reversed.

This superstition is still current even in households where a patent egg-beater is used, which is so constructed that its loops of wire revolve in opposite ways at the same time; and, although the result is most satisfactory, the belief in the old rule of stirring "only one way," or in a dextral direction, is unshaken. Often it is said that the stirring must be sunwise, the popular expression for this dextral motion being "with the sun." The same notion is found in Newfoundland; and a woman from Aberdeen, Scotland, tells me that it is a general belief among her countrywomen that, to succeed in any household work where either stirring or rubbing is involved, the movement should always be "with the sun." Some matrons in northern Ohio say that to insure good bread the dough should be stirred "with the sun," and that yeast should be made as near sunrise as possible to secure lightness. It is also a common saying that if, after turning the crank of a churn for a time sunwise (the most natural way for a right-handed person), it be turned backward, all the work done will be undone. The same superstition is found in Newfoundland. In southern Sweden cooks will tell you that, in beating butter to a froth or in making gravy, the stirring must continue as begun, to secure good results; and in eastern Massachusetts I find that the superstition extends even to the processes of making ice-cream and molasses candy. The notion that lye soap will not "come" —i. e., saponify—unless it is stirred "with the sun" is more or less current in localities where this old-fashioned industry is yet carried on; and in parts of the South you will be told that if the soap be stirred backward it will turn to lye. I have been told that wheelwrights, in greasing the wheels of a wagon or carriage, are in the habit of beginning with a certain wheel and going round the whole vehicle in a set way.

In New Harbor, Newfoundland, it is customary, in getting off small boats, especially when gunning or sealing, to take pains to start from east to west, and, when the wind will permit, the same custom is observed in getting large schooners under way. So, too, in the Western Isles, off the coast of Scotland, boats at starting are, or at any rate used to be, rowed in a sunwise course to insure a lucky voyage.

Many persons in our own country are yet careful to have a new house placed exactly with the points of the compass, no matter whether or not by so doing the building is made parallel with the street which it faces. Occasionally one sees a front yard of an awkward three-cornered shape for this reason, though with practical Americans the idea of the necessity of having the house placed with the meridian is now losing ground. However, in older countries the subject of orientation has been much heeded in planning buildings, especially temples and churches. The east has been the auspicious direction, or that to which worshipers faced in many Asiatic countries, in pagan Rome, and in the early though not the earliest centuries of the Christian Church. In the old imperial palace in Kyoto the eastern gate is used for ceremonial purposes; the southern one is a general entrance; on the western sides there are several miscellaneous gates; but the northern gate is never opened save when a funeral passes forth, and under the old *régime* the same custom prevailed to a certain extent among the nobility. In general, the north is considered by the Japanese an unlucky direction, probably because it is thus that the dead are carried out for interment. In a Masonic lodge the master is stationed at the east end of the room, and if his place be not the geographical east it is so called.

It is a very common saying among card-players that if one's luck is poor he may change it by rising, walking around his chair three times, lifting the chair, and then resuming his game. An old love divination that comes from southeastern Ohio was as follows: Go after dark to an unoccupied house and throw a ball of yarn into it through a window; hold the loose end of the yarn in the hand, then pass three times around the empty house, winding the yarn, meantime repeating: "I wind and who holds? I wind and who holds?" Upon coming to the window the third time the questioner of fate will see the apparition of his or her future spouse. Another love divination from Alabama, or "project," as such charms are called in various parts of New England, is on

May morning to look into a spring that runs to the east, when the face of one's destined husband or wife will appear. If, however, the one trying the charm is to die unmarried, a coffin instead of a face will be seen.

The idea of sunwise movement often appears in folk medicine. Before the days of massage, in rubbing for rheumatic or other pains in Concord, Mass., it was thought best to rub from left to right—i. e., dextrally. A central Maine cure for ringworm is to rub in a sunwise direction about the diseased spot with a finger moistened with saliva. A Pennsylvania-German prescription says that a corn, wen, or other excrescence may be removed by rubbing "with the moon" if by night, and "with the sun" if by day. It is thought that the sun or moon, as the case may be, will draw away all pain and enlargement. Alabama negroes believe that a "conjurer" can rub away a "rising" (boil) by coming to your bedside about daybreak, before you have spoken to any one, and rubbing the inflamed surface for nine successive mornings. A reputed cure for biliousness among the negroes of the Eastern Shore of Maryland is to bore three holes in a tree, around which the patient is to walk three times as he repeats: "Go away, bilious. Go away, bilious." *

It will be noticed that in several of these cures, as well as in some of the charms already cited, no rule is given as to the direction to be followed in movement; but it is quite possible that the original description was more explicit, and it is almost certain that in every instance a sunwise course would now be followed.

A remedy for a "curb" in a horse, in northern Ohio, is to rub the curb with a bone at the going down of the sun. This smacks of the doctrine of signatures, as well as of sun lore. In the same region, some years ago there lived a Pennsylvania-German small farmer. He was somewhat known in the neighborhood as a charm doctor, and children who had been burned sometimes went to him to have him "blow the fire out," and strangely enough, as I know by personal experience, the pain would disappear as he with his breath blew upon the smarting spot, meantime softly mumbling to himself. This man's cure for what is popularly known as the sweeny in horses was to rub "with the sun" every third morning until there was relief.

An Alabama superstition is that if the head of one dying be turned to the east his death will be easier. The subject of orientation as applied to the position of the dead, both before and after

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* In the province of Moray, in Scotland, hectic and consumptive diseases were thought to be cured by putting parings of the nails of the fingers and toes of the patient in a rag cut from his clothes, and then waving this parcel thrice round his head, crying, "*Deas soil.*" —Shaw, History of the Province of Moray, quoted in Brand's Popular Antiquities, iii, 286.

burial, is too complicated and extended to be more than barely referred to here, in connection with a few interesting customs still prevalent or lately extant in this country or in Europe. Examination shows that headstones in the old burial grounds of Plymouth, Concord, Old Deerfield, and Rutland, Mass., face the west, so that if the dead could rise to a standing posture they would face the east, long associated "with light and warmth, life and happiness and glory." It is customary among the Irish peasantry in County Cork to lay the dead "to be waked" in a similar position, as well as to dig the grave east and west. These customs are directly derived from the usage that prevailed through mediæval times of digging the grave east and west and placing the head toward the latter point, a practice which doubtless was an outgrowth of the legend that Christ after death was thus laid. Rev. J. Owen Dorsey has found that the Indians of the Kansas and Omaha tribes place the dead with the head toward the east,* consequently no living Omaha will lie in this position. According to Schoolcraft, the Winnebagoes buried their dead in a sitting posture with the face west, or at full length with the feet west, "in order that they may look toward the happy land in the west." † An interesting observation made by Mr. Dorsey is that in singing one of their sacred songs the Kansas Indians were accustomed to raise their left hands, beginning at their left with the east wind, then turning to the south wind, then to the west wind, and last to the north wind, thus completing the dextral circuit. So far as I can gather from the writings of Schoolcraft and others, and from some questioning of experts in Indian customs, there would seem to have been no one rule common to all the North American tribes with regard to the position of the grave with reference to the points of the compass. Some preference for the east-and-west position seems to have existed among certain tribes, but their mode of interment was often modified to suit the contour of the land about their villages.

In a religious observance called "paying rounds," much practiced by the Irish peasantry, one finds an interesting instance of the dextral circuit. "Rounds" are paid for the cure of any disease or ailment, either by the person afflicted or vicariously for him by his mother, if living, or, if not, by some near friend. Servant girls in the United States, when ill, sometimes write home to Ireland and have rounds paid for them. The required rites may be performed at the grave of some holy priest, perhaps one who in his day wrought miracles, or at the grave of a priest who, before dying, gave directions that it would be right and fitting there to

* Mourning and War Customs of the Kansas Indians. American Naturalist, July, 1885.

† Schoolcraft, Indian Tribes, part iv, p. 54.

pay rounds to cure pain or sickness; or sometimes the place selected is a tomb where a saint has appeared, and not infrequently it is one of the "blessed wells"—e. g., the "well of the Blessed Virgin" in the parish of South Kilmaurray in County Cork, where are still shown in a rock near by the print of Mary's fingers and the dint left by the pressure of her knee as she once in her lifetime knelt there in consecrating this well. The mode of procedure in paying rounds at a grave is first to kneel at the foot and repeat a rosary, then to rise and kneel at the right shoulder of the one buried there and repeat another rosary, then to the head and repeat another rosary, then to the left side and repeat a fourth rosary. The person performing the rounds must next go to some neighboring well, whose water is never to be used for any other purpose, and fetch a cup of it to the grave. Into this cup of water he drops a pinch of earth taken from the grave, saying, "In the name of the Father"; then another, saying, "In the name of the Son"; then a third, saying, "In the name of the Holy Ghost." The one who is paying the rounds next goes behind the headstone of the grave, taking the cup of earth and water, and, if the disease to be cured is an external one—e. g., erysipelas—pours a little of the contents of the cup upon the affected part of the body and so bathes it, and also pours a little of it on the ground. If the disease is an internal one, a little of the liquid from the cup is swallowed. What remains of the earth and water is now to be poured back on the portion of the grave from which the earth was taken. Five *paters* and five *aves* are then to be said, after which the ceremony is concluded for the time by placing some "token," which may be a cup, a button, or a small coin, on the grave. Where rounds have been paid for many years, the grave is thickly covered with these tokens. After the first rounds have been completed, the whole ceremony must be repeated twice more, the only suitable day for the observance being Friday or Sunday. In some instances three times three rounds are vowed and paid. If the prescribed rites are gone through with at a holy well, the one seeking relief kneels at four different places around the well, always making the circuit, as at a grave, in a sunwise direction. Instead of leaving a token, the devotee, at each of the four stations, with a pebble scratches a cross on one of the top stones of the well wall.

It is said that it is customary among the Scottish Highlanders, when visiting a consecrated fountain or well, either to bathe or to quench thirst, to make the circuit sunwise.

TIMOTHY ABBOTT CONRAD.

By Dr. CHARLES C. ABBOTT.

IN Philadelphia, early in the present century, there was a strongly developed taste for natural-history pursuits, and eager collectors of the local fauna naturally became so acquainted and thrown together that the formation of a club and then the organization of the Academy of Natural Sciences were the logical outcome. Previous to this, local zoölogy had not been overlooked, as the quartos of the American Philosophical Society show, and Peale's Museum was also an incentive to natural-history studies; but all was more or less chaotic until the academy came into existence. Then fresh enthusiasm was roused and every member became a collector, and every collector a describer of new species. To-day these old naturalists would irreverently be called "species mongers"; but if possibly there was a little less "science" in their labors, all credit is due them for excellent intentions, and every evidence of careful, correct, and valuable work, which has not had to be done over. Looking back to the time when Say, Nuttall, Rafinesque, Lesueur, Vanuxem, Troost, Harlan, Morton, and Conrad filled the pages of the academy's journal, we get a glimpse of a remarkable company, who collected eagerly and studied carefully their "finds" and spicily defended their positions when the great question of "priority of publication" came up. These men were not given to theorizing; evolution was not in their vocabularies, although we see at times some evidence of looking beyond a species to its real significance. De Maillet's strange book had been translated and informally discussed, but, as a general thing, no one troubled himself with Lamarck, or all accepted Cuvier without question. In short, these Philadelphia naturalists gathered specimens all day, and when they had the material sat up all night describing new species. And among them all there was no one more eager in the quest and more popular with his fellows than Solomon White Conrad, the father of the subject of the present sketch. That the elder Conrad was a remarkable man all who remember him assert without reserve. That he was a popular one, the fact that his house was a favorite gathering place for all the scientific notables of the city clearly proves. His was the first natural-history *salon* opened in Philadelphia, and being a matter of six days in the week, instead of at stated intervals, was fully as popular as the celebrated Wistar parties.

A descendant of Thones Kunders (subsequently anglicized to Dennis Conrad), who left Crefeld, Germany, July 24, 1683, and settled at Germantown, then nine miles from Philadelphia, but now in the city limits, like his American ancestry, Solomon W.

Conrad was a strict Quaker and an approved minister of that faith. His father was John Conrad, a blacksmith, and Solomon was born July 31, 1779, and died October 2, 1831. Of his early life nothing is positively known, but it is probable that he was apprenticed to a printer or bookseller. It is known that a strong fancy for scientific study was early developed, and the fears of his friends were realized that he would not be successful in business, because of attention divided between his shop and his cherished specimens at home. His partner ruined him financially. His herbarium is now in the possession of the Philadelphia Academy of Natural Sciences. As evidence that the country was more attractive than the shop on Market Street, I quote the following from the manuscript journal of a nephew: "My father, . . . with Solomon Conrad, would take long walks in search of new specimens. I went with them once on a stroll along the banks of the Schuylkill, when they saw at the same time, in the shallow bed of the river, a fine lot of mussels. Both rushed to the spot, regardless of the rough stones and splashing of the muddy water, the broad tails of their plain coats standing out behind and their arms reaching out in front, eager to secure the prize." In the spring of 1829 Solomon Conrad, who at that time had acquired a wide reputation as a mineralogist and botanist, was elected Professor of Botany in the University of Pennsylvania, and delivered, May 1st, his introductory address. In The Friend of fifth month, 9, 1829, the late Roberts Vaux, of Philadelphia, gives the following estimate of the lecture: "With a succinct review of the history of botany he very happily blended some biographical notices of the distinguished men to whom the science owed its origin and illustration. He traced with great acuteness and perspicuity the analogy of vegetable and animal life, admitting the limit of human knowledge. Every view that he furnished of the subject, upon which he is so well qualified to impart instruction in all its details, was just and forcible, while the simplicity of his manner and chasteness of his style were by no means the least interesting traits of the lecturer." The venerable Frederick Fraley, Esq., of Philadelphia, recently informed me that he was present at the introductory lecture referred to, and that Mr. Vaux had in no wise allowed his enthusiasm to outrun his discretion.

On June 21, 1803, when his father was but twenty-four years old, TIMOTHY ABBOTT CONRAD was born. His mother was then staying at the home of her father, four miles from Trenton, N. J., in Burlington County, New Jersey. To this birthplace young Conrad became so strongly attached that he yearly made pilgrimage thereto, even when no representative of the family lived there. In his purely literary writings he so frequently refers to the place that he was once twitted about it, but without effect.

"Timothy," remarked an old Friend, "was thy grandfather the only man who ever lived in the country?"

"Other men *exist* in the country, but no one else *lived* like my grandfather," he replied.

Brought up, when with his parents, in so scientific an atmosphere, and when at his birthplace so delightfully surrounded not only by congenial kinsfolk, but Nature in her most attractive guise, it is little wonder that Conrad became a naturalist. Mr. Fraley tells me that, when a youth in early teens, Conrad was the "president" of an "Academy of Science" of which he, Mr. Fraley, was "secretary," and that it was conducted with all the decorum and good faith of the institution after which it was modeled.

Conrad was educated at select schools under the superintendence of Friends, but really educated himself, so far as the "higher branches" were concerned, acquiring without a teacher a thorough knowledge of Latin, Greek, and French. His skill in drawing was remarkable and early developed. He not only made all his own illustrations, but did considerable for others, as the shells, seaweed, and other small objects on some of Audubon's plates of birds. Before seriously taking up the special studies that subsequently made him famous, he wrote many sketches of a popular character, and occasionally drifted into verse. His father being a publisher and printer, Conrad entered the establishment as a clerk, reluctantly probably, and there learned the printer's art, and when his father died, in 1831, he continued the business for a short time, but the love of natural history was too strong to be overcome, and he gave up the shop and its belongings. Because of a preference for walking afield to attending religious services, a committee of Friends called upon Conrad, and, not accepting his explanation, they directed his name to be stricken off their roll of membership. Conrad did not like their action, and probably it is due to this that he seldom afterward attended any religious gathering, occasionally dropping into some country Quaker meeting, but always, as he said, for old times' sake and not spiritual profit.

In 1831 he was elected a member of the Academy of Natural Sciences, and, some years after, of the American Philosophical Society. Of many foreign learned societies he was a correspondent, but, keeping no record of such elections, the names and dates of election have been lost.

Conrad's first volume bears date of 1831, and has the following title: American Marine Conchology, or Descriptions and Colored Figures of the Shells of the Atlantic Coast. Of this little volume, printed for the author, Conrad says in his preface, "it is designed to supply a deficiency which has long been felt by the cultivators of American natural history." The work contains seventeen plates, all drawn by the author, and colored by hand by his sister. In 1834 Conrad published New Fresh-water Shells of the United States, with Lithographic Illustrations and a Monograph of the Genus *Anculotus* of Say. Also, A Synopsis of the American Naiades; Philadelphia, Judah Dobson, 108 Chestnut Street, May 3, 1834. The full title of this little volume, with precise date of publication (not much larger than the title is long) is given, because even then questions of priority had arisen, and others laid claim to some of Conrad's species. This unhappy wrangling was kept up for many years. Prof. Dall refers to this, as we shall see further on, as "numerous controversies, which are now ancient history." Conrad's own version should be given. He claimed that the editions of his publications were largely bought up and destroyed by a worker in the same field, and this explains the rarity of some of his writings. In the preface of the little volume above mentioned the author says: "While residing in the mansion of my kind and hospitable friend, Judge Tait, of Claiborne, Alabama, where I was employed in collecting the organic remains of the vicinity, I occasionally made excursions up and down the Alabama for the purpose of procuring fresh-water shells. I have succeeded in obtaining some species which I believe to be new, and hope to fix by accurate delineations and descriptions." The result was the little book, which is dedicated to the late Charles A. Poulson, of Philadelphia, a prominent conchologist in his day, and one of Conrad's financial backers in his several expeditions south in search of both recent and fossil shells. In 1834, in the Journal (old series) of the Philadelphia Academy of Natural Sciences, Volume VII, Conrad published Observations on the Tertiary and More Recent Formations of a Portion of the United States, which appears to have been his first communication to that body. In 1841 the Proceedings of the Academy were commenced, and a new series of the Journal in quarto. In the former, from Volume I to Volume XXXVI, Conrad's contributions appear in every year; the articles varying from two to a dozen in number. In the first four volumes of the new journal he has eleven contributions, all of which are profusely illustrated. In 1836 Conrad published Monography of the Family Unionidæ, or Naiades of Lamarck (fresh-water bivalve shells), of North America. Illustrated by Figures drawn on Stone from Nature. Philadelphia: J. Dobson, 1836. This work, like the Marine Conchology, was never finished. It would seem as if the magnitude of the work had not occurred to him at the time, or that he was soon tired of any subject that he took up, but the real difficulty was a want of financial support. There were never enough subscribers to meet the expense of publication. At this time, too, his health was very bad, and he seemed to lose all interest in every undertaking. "A period of moping would usually end in his writing some verses which nobody would praise, and this seemed sufficiently to nettle him, to rouse him thoroughly, and he would become again enthusiastic in the matter of shells and fossils."

In 1837 Conrad was appointed Geologist of the State of New York, and after resigning the position remained as paleontologist of the survey until 1842. "He prepared official reports on the fossils collected by the United States exploring expedition under Wilkes; by Lieutenant Lynch's expedition to the Dead Sea; by the Mexican Boundary Survey, and some of the surveys for a railroad route to the Pacific undertaken under the supervision of the War Department. Many papers were written by him on the Tertiary and Cretaceous geology and paleontology of the eastern United States and published in the American Journal of Science, the Bulletin of the National Institution, the American Journal of Conchology, Kerr's Geological Report on North America, and other publications. A list of Conrad's papers, which covers most of those bearing on paleontological topics, may be found in Miscellaneous Publications of the United States Geological Survey of the Territories, No. 10; Bibliography of North American Invertebrate Paleontology, by Drs. C. A. White and H. Alleyne Nicholson—Washington, Interior Department, 1878. It contains a hundred and twelve titles" (Dall).

In 1832 Conrad published Fossil Shells of the Tertiary Formations of North America. Illustrated by Figures drawn on Stone from Nature. Vol. I. Philadelphia, 1832. It is dedicated to Samuel George Morton, M. D. In 1838 Conrad published Fossils of the Tertiary Formations of the United States. Illustrated by Figures drawn from Nature. Philadelphia: J. Dobson. These are known generally as the Eocene and Miocene volumes, and both, as original editions, are extremely rare. They have recently been reprinted in facsimile: the former by Mr. G. D. Harris of the Smithsonian Institution, Washington, D. C.; and the latter by the Wagner Free Institute, under the editorial supervision of William H. Dall, of the National Museum. In his introduction Prof. Dall says: "Students of the American Miocene and the later Tertiary deposits of the New World are well aware of the importance to them of Conrad's work, usually referred to by the title of The Medial Tertiary. There can be little doubt that the scarcity of this work and its predecessor, the Eocene volume, is the chief cause of the delay in investigating our rich and interesting Tertiary beds."

Prof. Dall, in considering Conrad as a paleontologist, remarks as follows: "Mr. Conrad had several peculiarities; he wrote his letters and labels frequently on all sorts of scraps of paper, generally without date or location. He was naturally careless or unmethodical, and his citations of other authors' works can not safely be trusted without verification, and are usually incomplete. He had a very poor memory, and on several occasions had redescribed his own species. This defect increased with age, and, while no question of willful misstatement need arise, made it impossible to place implicit confidence in his own recollections of such matters as dates of publication. He himself says in a characteristic letter to F. B. Meek, written in July, 1863: 'I go on Monday to help H—— ferret out my skulking species of Palæozoic shells. May the recording angel help me! God and I knew them once, and the Almighty may know still. A man's memory is no part of his soul.'

"In spite of this constitutional defect, Conrad had an acute and observant eye, and an excellent, if sometimes hasty, judgment on matters of geology and classification. He was in advance of his time in discriminating genera, and in field researches and work on the specimens showed more than ordinary capacity. In those branches of his work which required knowledge of literature and systematic research he took less interest and pains.

"Like many shy people, he was brought rather than ventured into numerous controversies, which are now ancient history, and need not be further alluded to. But the sketch just given will enable readers to understand the origin of much that is irritating to those who are obliged to rely upon Conrad's work and find in it slips and errors so obvious that they seem unpardonable. He had the defects of his qualities, but whether for good or evil he was the principal worker in the field of Tertiary geology in America for many years. He has left a voluminous literature, and neither his faults nor his virtues can by any method be ignored."

When Darwin's Origin of Species was published, Conrad became intensely interested in the discussions that wonderful book provoked. He did not take the theory up as subject-matter for an essay; but contented himself with innumerable notes and memoranda that I found on loose slips of paper after his death. He was bitterly opposed to evolution; considered Agassiz the world's greatest naturalist, and predicted that Darwin's "wild speculations" would soon be forgotten. Every geological age came, Conrad held, to a complete close, and the life of the succeeding one was a wholly new creation. These utterly crude and untenable views he held to, to the last.

It would be unjust to the memory of the subject of this sketch to pass over without notice his characteristics as a man and author. Conrad was something besides a profound paleontologist. This his friends well knew; but for the writer of this sketch to deal with this phase of Conrad's personality is a rather delicate matter. As his nephew, I might say too much; as his biographer, I wish not to say too little.

Conrad was of small stature, thin and homely, yet he had, as an intimate friend recently said, a refined countenance. There was a kindly light in his eyes that words can not describe nor the cunning of the artist depict. I have said "homely"; this on his own authority, for in his poem The Watermelon he declares:

> "The poet may sing of the Orient spices,
> Or Barbary's dates in their palmy array,
> But the huge rosy melon in cold juicy slices,
> Is the Helicon font of a hot summer day,
>
> "Where I bathe the dry wings of the spirit, and sprinkling
> Sweet drops on the pathway of dusty old Care,
> I hold Father Time from his villainous wrinkling
> Of features that never had graces to spare."

As a conversationist, Conrad had few superiors, but a weakness of his voice made it difficult for him to be heard, and it was only when with two or three intimate friends that this quality shone out. He avoided large gatherings and never spoke in public. He had a keen sense of humor and was an inveterate punster. His memory was "very bad" scientifically, says Prof. Dall, but it was remarkably good so far as poetry was concerned, and when walking alone in the country he would repeat aloud long passages from the works of his favorite authors. His fondness for poetry led him to writing verses, some of which were printed in the Philadelphia papers as early as 1828; and his latest effort bears date of 1874. In 1848 Conrad published The New Diogenes, a Cynical Poem. This is well described in the subtitle. It consists of some twenty-five hundred lines of fault-finding. The edition was very small and is not yet exhausted. In 1871 the writer undertook to bring together the scattered short poems, and found thirty-two of these, mostly in the corners of newspapers and two in manuscript. The little volume was "privately printed." It bears the title, A Geological Vision and Other Poems. Trenton, N. J., 1871.

In his non-scientific writings Conrad invites a comparison with Thoreau, but, while loving the outdoor world as devotedly, he always had an eye to physical comfort, and preferred, at the end of a long tramp, a good bed at a tavern to sleeping out of doors. So too, probably, did Thoreau, but then to say so does not sound so prettily in a book.

Timothy Abbott Conrad died in Trenton, N. J., August 9, 1877, the last of the prominent group of early Philadelphia naturalists, who paved the way for the more philosophical biologists of the present day.

CORRESPONDENCE.

EVOLUTION IN 1858.

Department of Biology, Columbia College, New York, *April* 11, 1895.

Reviewer of the Greeks to Darwin:

DEAR SIR: I regret that I do not see the Monthly regularly. A friend has recently called my attention to your review of the Greeks to Darwin, and I write to ask you to consider the following points:

The history ends absolutely with the publication of the theory of Natural Selection by Darwin and Wallace in 1858, therefore has no bearing upon the subsequent development of the evolution theory. The bibliography, also, is exclusively a bibliography of critical and historical articles upon the pre-Darwinian evolution. Where titles are of more recent date, they simply refer to recent historical and critical notices. This being the case, Herbert Spencer's position is simply treated as that which belonged to him previous to 1858; and if you will read his two earlier essays in comparison with Lamarck's Philosophie Zoologie—a large work of two volumes, fully expounding and expanding the evolution theory—I think you will see that I have done Herbert Spencer full justice.

Herbert Spencer, after 1858, as in his remarkable application of the evolution theory to all departments of thought, of course deserves a very high position, second only to Darwin, and this position I accorded him in the same course of lectures for the Columbia students, in treating of the Post-Darwinian Period. The fact that I barely consider any of Darwin's later work renders it evident that the omission of Spencer is not in the nature of a slight, but simply that his work did not come within the limits of the period treated. I fully understand and appreciate the peculiar features of Spencer's contributions to the evolution theory, and have myself contributed extensively to the Neo-Lamarckian literature in this country which is the Spencerian side; at the same time I can see many weak points in Herbert Spencer's biological system, and his rank in the future as a theoretical evolutionist is closely tied up with that of Lamarck in the question of the transmission or nontransmission of acquired characters.

Trusting I have made this matter clear,
I am, Very truly yours,

Henry F. Osborn.

[If the contents of Prof. Osborn's book agreed with its title—From the Greeks to Darwin—we might be able to accept the above excuse as valid. But since the work devotes fifteen pages to tracing the progress of Darwin's thought down to 1881 we fail to see the justice of disposing in as many lines of what has been done by a contemporary, who is the acknowledged master in the broader field which includes Darwinism.

Even if Prof. Osborn were correct in stating that "the history ends absolutely with the publication of the theory of Natural Selection by Darwin and Wallace in 1858," it is easy to show that he has not done justice to Mr. Spencer. Before that time Spencer had published his Social Statics (1851) and Principles of Psychology (1855), showing the working of evolution in social and mental phenomena respectively. He had also published twenty magazine articles, now to be found among his collected essays, or as chapters in his later books, in all of which the development hypothesis is unmistakably the keynote. More important than the single one of these that Prof. Osborn mentions is Progress: its Law and Cause (1857), in which Spencer states the nature of the process of development, with illustrations from all fields of activity. Furthermore, the implication in the above letter that Spencer has merely extended the application of what Darwin announced in 1858 deserves a word. The prospectus of Spencer's Synthetic Philosophy was printed in March, 1860. It has been reprinted since 1880 in the American edition of several of his books, with a note over the initials E. L. Y. from which the following testimony may be taken: "In 1854, he [Mr. Spencer] arrived at the conception of evolution as a universal process of Nature." Referring specifically to the prospectus: "The writer has seen a still earlier manuscript form of this Prospectus, embracing seven volumes instead of ten, but laying out the same subjects in the same order and by the same method, that was written out and became a matter of private correspondence in 1858." Prof. Hudson, in his Introduction to Spencer's Philosophy, corroborates both these dates, and states that the plan for the series of books was formed while Spencer was writing his Nebular Hypothesis, an essay published the day after the date of the journal containing Darwin's and Wallace's historic papers. The real relation between Spencer and Darwin is that the latter worked out independently one division of the great scheme elaborated by the former.—Editor.]

A PREDICTION OF THE PHONOGRAPH.

Editor Popular Science Monthly:

Sir: Your note in the February number of The Popular Science Monthly on Roger Bacon's dream of the steamship tempts me to send you another curious illustration of how extraordinary geniuses in times past sometimes foreshadowed in their writings the marvels of a later era in the world's affairs. Of all the latest wonders of man's ingenuity, the phonograph would seem to be at least one that was not subject to the dictum of Solomon, "Nothing new under the sun"; and yet, a few months ago, while amusing myself with Cyrano de Bergerac's Histoire comique des États et Empires de la Lune et du Soleil (Paris, 1660), I was amazed to come across the matter quoted below, which surely foreshadows the phonograph as closely as do Bacon's words the steamship and railway.

The author (De Bergerac) is on a voyage over the moon. Left alone a little while by his guide, the latter gives him, to help him while away the hour, some books to read. The books, however, are different from any seen on earth. They are, in fact, little boxes, which Cyrano thus describes:

"On opening one of these boxes I found I know not what kind of metal (apparatus) similar to our clockwork, composed of I know not how many little devices and imperceptible machinery. It was a book, certainly, but a most marvelous one, which has neither leaves nor characters; a book to understand which the eyes are useless—one needs only use his ears. When one wishes to read this book he connects it by a sort of little nerve to his ears. Then he turns a needle to the chapter that he wishes to hear, and immediately there emerges from the instrument, as from the *mouth of a man, or from a musical instrument*, all the words and sounds which serve the *Grands Lunaires* for language."

I will say, further, that Cyrano anticipated many of the inventions and conceptions of modern aëronauts. No wonder that he was considered by his contemporaries as "somewhat off," or, as the French say, as a *cerveau brulé*.

FRANK L. JAMES, Ph. D., M. D.

ST. LOUIS, *February* 28, 1895.

EDITOR'S TABLE.

THE GROWTH OF ANTHROPOLOGY.

WHEN in the seventies Prof. J. H. Gilmore introduced the study of anthropology into the curriculum of the University of Rochester he was probably the only instructor in the subject in America. Since then the science has made rapid progress. Agencies for its dissemination and the aid and encouragement of its students have greatly multiplied, so that to-day the science of Man is taught by specialists, and holds a prominent place in many of our leading educational institutions. Among these are the universities at Toronto, Worcester, Chicago, Cambridge, Philadelphia, Lewiston (Bucknell), and Washington (Columbian). Besides these, as Chamberlain has recently shown, teachers, mainly occupied with some other subject, also give instruction in anthropology at Yale, Leland Stanford, Western Reserve, Indiana, Oberlin, Dartmouth, Bowdoin, Wisconsin, Brown, Illinois, City of New York, Johns Hopkins, Massachusetts Institute of Technology, Vassar, Cornell, Lake Forest, Vermont, Kansas, Tufts, Minnesota, Michigan, and Ohio. To this considerable list should certainly be added Wellesley, and probably Union and Mississippi. The list grows, and only a few days since the University of California was announced to introduce anthropology among its subjects for teaching. At most if not all of the institutions where special teachers are engaged in the work there are laboratories for research and practice, and at least beginnings of museums. This is great progress for twenty years, and much more may be expected during the next decade. A subject so important must rapidly force itself into all the prominent institutions of higher learning.

The university instruction reaches

but a small part of the community, but the interest in anthropology extends far outside of the classroom. Courses of public lectures are astonishingly well attended. Prof. Putnam at Cambridge, Dr. Brinton at Philadelphia, Prof. Starr at Chautauqua, at New York, and at Chicago—have with others for some years past spoken to thousands and have helped to kindle a wide public interest in the subject. To-day the great peripatetic Associations for the Advancement of Science—American, Australian, British, French—all have their Section of Anthropology. Many know what a battle had to be fought in at least one of these associations for recognition of the newcomer. To-day it is not only present, it dominates. No other section of the American Association draws to its public meetings as does this one; nor is it surpassed in the number of important papers presented. In the popular magazines of the day a constantly increasing amount of space is given to papers in some one or other division of the science. In the various science series a full share of volumes are anthropological. Thus, it has been noticed that in the Contemporary Science Series nearly all the volumes are devoted to the science of man, and every one has observed the great number of valuable works in this field in the International Scientific Series. And just now, apparently in response to a demand, two other series have been started, the one devoted to anthropology generally, while the other deals with that important subdivision of the science which makes the criminal the special object of study.

Museums of ethnography and archæology increase. In no part of the world are they quite wanting. The Museum of Gizeh in Egypt is superb, for study; that at Tiflis in the Caucasus is rich; at La Plata in the Argentine Confederation is a vigorous young institution, with a good anthropological department; at many of the small capitals of Mexican States are choice series of antiquities. In this matter the United States lags somewhat; but at Boston (Cambridge), Salem, New York, Philadelphia, Washington, Chicago, Davenport, St. Louis, and San Francisco are collections of significance which are open to the public. The last comer in this group is the Field-Columbian Museum at Chicago, with an excellent department in anthropology under the curatorship of Prof. Holmes.

Anthropological societies are not numerous in America. Work in some direction is done in connection with State and local historical societies and State academies of science. Such local societies as the New York, Chicago, and Davenport Academies of Science have Ethnological Sections. Specific Anthropological Societies exist at Washington and New York. The Anthropological Society of Washington publishes an official organ of value. The Woman's Anthropological Society in the same city has been active. Interesting societies, including study and social features, are those at Yonkers, N. Y., and at Brookville, Ind., both of which have had regular meetings at short intervals for several seasons. Of societies which devote themselves to a single phase of work, there are many, among the most interesting of which are the folklore societies. The American Folklore Society meets annually and at various places, but its branches—at Montreal, Boston, Philadelphia, New York, New Orleans, etc.—hold regular meetings at stated times. The Chicago Folklore Society—now the International Folklore Association—holds monthly meetings, and has branch societies in Minnesota and Tennessee.

The governmental work in anthropology can not be well overestimated. The National Museum, the Smithsonian Institution, the Army Medical Museum, and the Bureau of American Ethnology are doing much by displays, lectures, publications, and field work. Of field work by outside organizations more than ever before goes on. The Peabody Museum Exploration in Honduras, the Bandelier Expedition to South America, the Mexican work of the American Museum of Natural History and other organizations, the Armour Expedition to Yucatan, and the Hemenway Exploration in the Southwest testify a widespread interest.

There is no question, then, of interest and activity. These are world-wide, and steadily increasing. The real need now is direction of this interest to the best end. It is necessary to so organize and systematize efforts in each department, and in the whole field, that the man of ordinary intelligence may know the meaning of the movement, and come in touch with it profitably. Helps are not entirely lacking. There are journals—the American Anthropologist, American Antiquarian, Archæologist, American Journal of Folklore—these show the trend. Dr. Brinton's Current Notes in Anthropology in "Science" are helpfully directive. Dr. Fletcher's Quarterly Bibliography in the American Anthropologist, and Prof. Mason's Annual Summary of Progress in Anthropology throughout the World (published by the United States National Museum), keep readers informed of recent literature. With these aids the student has but to select his field. First of all, however, he will do well to read a few good books of a general kind. De Quatrefages's Natural History of Man, and The Human Species, Brinton's Races and Peoples, Tylor's Anthropology, Early History of Mankind, and Primitive Culture, are useful. Some of these are by no means recent works, but they will not soon be replaced.

CONCLUSION OF DR. WHITE'S NEW CHAPTERS.

Our readers who have followed with interest Dr. Andrew D. White's papers on the Warfare of Science—and that they are many is amply proved by the constant stream of inquiries as to the publication of the series in book form which we receive—will be pleased to learn that the last division of the subject is now completed. As already announced, The Warfare of Science is to be published as a volume. While this final division is running through the Monthly, the author will continue his careful revision of the preceding portions, already well advanced, and by the time the last installment appears the printer will probably have begun putting the first part into book form. In his earlier chapters Dr. White has shown how theologians have been forced step by step to yield the domination which they asserted in astronomy, meteorology, medicine, and other fields outside their own province. He is now about to trace the advance from fantastic errors to more rational views which the spread of the scientific mode of thinking has compelled them to make in theology itself. This advance has been brought about not so much by direct action on the part of science as by the disposition which science has aroused in men to use their reasoning powers on all matters that are presented to them. The consequence has been that dogmatism and mysticism in preaching and teaching have found fewer and fewer listeners, while the most intellectual ecclesiastics, feeling the same influence, have shrunk from the dogmatic and mystical extravagances of their predecessors.

LITERARY NOTICES.

Degeneration. By Max Nordau. D. Appleton & Co. 1895. Price, $3.50.

Severe diseases require severe remedies, and the rapidly increasing tolerance of literary, artistic, dramatic, and musical works that have a tendency to apotheosize various vices and defects of the higher mental faculties, demands the trenchant criticism that this volume affords. Years ago, in the comic opera of Patience, Mr. Gilbert satirized the impression created by the æsthetic vagaries of certain contemporaries in the lines—

> "If this young man understands these things that
> are certainly too deep for me,
> Why, what an exceedingly deep young man this
> deep young man must be!"

And too often the self-proclaimed prophet of some new dispensation in art or letters is taken seriously by a number of persons; and worse, in consequence of causes familiar to those experienced in the treatment of nervous diseases, finds a number of imitators.

Dr. Nordau, who is a pupil of Lombroso, has in this volume applied to certain writers and artists the same rigid rules of psychical investigation that were used by the Italian *savant* in his investigations into the factors and features of the degeneration of the criminal classes. Pronounced as the antithesis may be in a comparison of two such groups, there are yet fundamental points of resemblance that are depicted in this volume.

With tremendous diligence the author has perused the works of Rosetti, Swinburne, Verlaine, Maeterlinck, Tolstoi, Wagner, Peladan, Rollinet, Baudelaire, Friedrich Nietzsche, Walt Whitman, Oscar Wilde, Ibsen, Zola, and many other more or less known authors and artists, and he furnishes numerous quotations from their works to support his estimate of their mental condition. The characteristics of degeneration and hysteria manifest themselves "in mysticism, which is an expression of the inaptitude for attention, for clear thought and control of the emotions, and has for its cause the weakness of the higher cerebral centers; in egomania, which is an effect of the faulty transmission by the sensory nerves, of obtuseness in the centers of perception, of aberration of instincts from a craving for sufficiently strong impressions, and of the great predominance of organic sensations over representative consciousness; and in false realism, which proceeds from confused æsthetic theories, and characterizes itself by pessimism and the irresistible tendency to licentious ideas, and the most vulgar and unclean modes of expression."

In the last analysis there is in the degenerate a brain incapable of normal working, and its aberrant functions are manifested in feebleness of will, inattention, a predominance of emotion, a lack of knowledge, an absence of sympathy or interest in the world and humanity, and decay of the notion of duty and morality.

The author is not a pessimist; he does not believe that the degenerates will have more than an ephemeral existence and a limited following; that, like the dancing mania of the middle ages, a number of persons may be participants, but the majority of the people will be unaffected; and that true art and literature will still live and have their being when the whim and caprice of the moment have, like the iridescent soap bubble, broken, leaving nothing but some soapy moisture.

The volume is very interesting, and, while the author often writes with a vehemence that seems too prejudiced to be the expression of sober judgment, his arraignment of the accused and his evidences of their culpability justify his stern indictment.

The book is a strong one, and it is likely to prove suggestive and helpful to many who may think that the so-called art and literature of the future, as expressed by certain mentally defective individuals of to-day, are worthy of their careful study and imitation.

The Making of the Body. By Mrs. S. A. Barnett. London and New York: Longmans, Green & Co. Pp. 288.

The method of this manual is entirely novel. It is the outcome of practical experience in an endeavor to interest untutored minds in physiology. The effort was so successful in an English school among the poor that children and adults became eager to learn about the mechanism of the body.

The circulation of the blood, breathing, digestion, and sensation are described as journeys made by the blood, air, food, sound, and light; all technical names are translated into everyday English: the *peritoneum* is the over-all coat; the *thyroid*, the shield-ring. The terms employed are very ingenious and readily remembered; the stories apt and generally well founded. One, however, betrays a hasty generalization—an American girl burns her hands on a grate in England because in America *they only use closed stoves!*

Nevertheless, the book is an excellent one, and may be heartily recommended for home reading, as well as to teachers of elementary classes.

Mr. Herbert Spencer on the Land Question. A Correction of Current Misrepresentations of his Views. New York: D. Appleton & Co. Pp. 30. Price, 25 cents.

A profound misconception respecting the difference between Mr. Spencer's original view concerning landownership and that he now holds having been widely diffused, he has thought it desirable to dissipate this misconception by a simple statement of what the original view was and what the present view is. For this purpose, besides a brief general statement in a preface of what his original doctrine was and what his views are now, and of the extent to which they have been modified, he reprints in parallel columns, Chapter IX of Social Statics, published in 1851, embodying the first published expression of his views, and pertinent extracts from Justice, published in 1891, embodying his latest published expression of them. He originally contended, he says, that the land could not become individual property, but was the property of the community, and that this is in fact the current legal doctrine, as illustrated in the theory of eminent domain. This doctrine he continues to hold, and has emphasized it in Justice, and strengthened it by numerous illustrative facts. With this assertion of the claim of the community to the land is coupled that of the private owner for compensation for the additional value he has given it when the state asserts its right. He contemplated, however, that the exercise of its claim by the community, under the condition stated, would leave a balance of benefit to it. If this were not the case, although he held the doctrine still good in absolute equity, he would in practice forbear the exercise of the right. Of late years he has become satisfied that the burden of compensation would outweigh the benefit of possession, if the compensation were anything like equitable in amount; and has therefore come to the conclusion that the change from private tenure to public would be impolitic. Furthermore, it has become clear to him that the prevailing assumption that the existing landowners hold from those who first seized the land and misappropriated it is untrue, and he has pointed out that among the people who are supposed to be robbed exist in large measure those who are descendants of the robbers. Hence the anger fostered against landholders is largely misdirected. These original views, as well as the modifications of them, are not at variance with the opinions held by the landed classes in England, but are views which they have themselves publicly enunciated through certain representative members of their class. The selections in parallel columns of the present pamphlet—which were first published for the use of the English Land Restoration League—are followed by a postscript, in which Mr. Spencer shows from authentic statistics that land in England is not all held by "dukes, earls, and baronets," but that an immensely larger proportion of owners possess but moderate quantities, and that those who possess small quantities are a hundred times in number those who possess great quantities. If equity requires that the large holders shall be expropriated, the same rule must apply to the small ones—in the majority of cases wage-earners—who have acquired their estates by hard work and self-denial in poverty. Does any one in his senses advocate this? Having made this demonstration, Mr. Spencer adds that the beliefs expressed in the essay—1, that a reversion to public landownership could not justly be effected without compensation to private owners; 2, that the making of compensation would bring more loss than gain to the community; 3, that the equitable adjustment of compensation would be extremely difficult; and, 4, that the administration of the land as public property by state officials would entail all the vices of officialism—by no means involve the belief that private landownership should continue without change. Immense estates should not be allowed to be held in permanency; but a fundamental change in land tenure is not required for remedying this evil. In England, abolition of primogeniture will do it. Recognizing the right of the state to restrain the use of land in ways at variance with public welfare, we may at the same time hold that there are cases in which it is both politic and practicable to exercise that right. The publication frees Mr. Spencer beyond all doubt from any possible charge of inconsistency between the views formerly published by him and those which he has more recently expressed.

Memoir of Sir Andrew Crombie Ramsay. By Sir Archibald Geikie, with Portraits. New York: Macmillan & Co. Pp. 397. Price, $4.

Sir Andrew Ramsay was one of the leaders in the geology of his time, and, by virtue of his pleasant and strong qualities, exercised a wide influence over his contemporaries. He joined the Geological Survey of the United Kingdom when it was still in its infancy, and remained on its staff during the whole of his active scientific career—a period of forty years. "So entirely," says Sir Archibald Geikie, "did he identify himself with the aims and work of the survey and so largely was he instrumental in their development, that the chronicle of his life is in a great measure the record also of the progress of that branch of the service. Recognizing this intimate relation, I have woven into my narrative such additional details as might perhaps serve to make the volume not only a personal biography, but an outline of the history of the Geological Survey of the United Kingdom." From the summary of Ramsay's work given by the author, it appears that his earliest and his latest labors—beginning with a pamphlet on the geology of Arran, and ending with the second edition of a monograph on North Wales—were in structural geology. "Between these two limits he accomplished a large amount of investigation directed toward the elucidation of the geological structure of Britain." His two presidential addresses to the Geological Society mark a distinct epoch in stratigraphical work, in that in them he indicated the historical meaning of the imperfection of the geological record which had been pointed out by Darwin. His physiographical work was abundant, remarkably original, and important, and bore on denudation in general, the history of river valleys, and the results of the operations of ice. Connecting his stratigraphical with his physiographical researches was a series of papers discussing the former existence of continents or of terrestrial conditions, during the deposition of the geological record. His principal contributions to the literature of the history of geology were two inaugural lectures at University College, and his address as President of Section C of the British Association of 1881, which embodied historical reviews. He was a thorough uniformitarian in his theories to the end. His literary work included criticisms and lively articles in the Saturday Review. A still wider view of the extent of his influence is afforded when it is recollected that for nearly thirty years he was a teacher of geology, that he was an able debater in the Geological Society and a brilliant lecturer, and that he had the practical training of men on his staff in the Geological Survey who have since become conspicuous in educational life.

The Evolution of the Massachusetts Public-School System. By George H. Martin. International Education Series. New York: D. Appleton & Co. Pp. 284. Price, $1.50.

Two very significant statements are made by the editor in his preface to this book. The inhabitant of Massachusetts receives, on an average, nearly seven years of schooling, while the citizen of the nation at large enjoys only four years and three tenths of such training. In the same State the average earnings apportioned to each man, woman, and child would be seventy-three cents per day; elsewhere in the United States this amount is represented by forty cents.

"There would seem to be some connection between these facts," warily observes Dr. Harris. Although the wealth-producing power may not represent the intellectual status of the individual, that it is proportional to the intelligence of a large community admits of scarcely a doubt, and for this the amount of schooling may stand as an exponent. Mr. Martin depicts the schools as passing through three stages of evolution. The earliest era, when the only object was to make a storehouse of the mind; the three Rs were deemed sufficient to fill it at an elementary dame-school; later the classics were added, and more recently grammar, geography, and the sciences. During this period the "child was to be held down and operated upon, or headed off when he obeyed an impulse of Nature." Secondly came the graded system, when the aim was to supply a measurable quantity of knowledge, to get per cents, and pass examinations. Thirdly emerged the modern school, which inquires into the child's nature and seeks to develop it. "Instead of viewing the new pupil as one more to be registered, put through geographies, arithmetics, and marked done, it recognizes an incipient man, and asks what the future may demand of him."

The new school is described as differing from the older in purpose and in spirit, studies, and methods of instruction. The work is so changed as to seem a revolution.

American Spiders and their Spinning Work. By Henry C. McCook, D. D. Vol. III. The Author, Academy of Natural Sciences, Philadelphia. The set, $50.

Dr. McCook and all araneologists are to be congratulated on the completion of this able and conscientious work. And when we consider that this task has been accomplished in such odd hours and vacation times as a busy professional life affords, the fact that it has been completed seems little short of a marvel. The present volume contains six chapters similar to the contents of the two preceding volumes—i. e., dealing with various habits and activities of spiders. Among the topics treated in these chapters are the toilet making of the orb-weavers, the manner in which some of them burrow, their social habits, evidences of memory, feats of mimicry, the parasites that infest them or their cocoons, and a number of minor topics grouped under the head Biological Miscellany. Much of this material is supplementary to chapters in the two preceding volumes. Molting habits and the renewal of lost organs are considered at some length. Dr. McCook denies that the actions of spiders can be taken as indications of approaching weather changes, showing from his notes that the little weavers construct webs even that are destined to be destroyed within a few hours. He also puts on record some interesting superstitions regarding spiders, which need no refutation. Certain attempts to utilize spiders' silk commercially are recorded, but none of these have been economically successful. A second division of the volume consists of technical descriptions of genera and species of the orb-weavers, one hundred and twenty-three species being described. Following the index to the volume are twenty-eight colored plates, filled with figures of orb-weavers and of some of their organs, besides two plates of figures representing species of other aranead groups. There are also ninety-eight cuts in the text of the first portion of the volume. The present ascendency of that biology which occupies itself with examining microscopic portions of the dead bodies of animals seems to be decreasing the number of field naturalists who observe the phenomena and habits of living creatures. Let us hope that the latter side of zoölogy will not be too far neglected, and this handsome record of research seems to promise that it will not.

The Life and Writings of Rafinesque. By Richard E. Call. Louisville: John P. Morton & Co. Pp. 227. Price, $2.50.

In this sumptuous publication a much ridiculed and little understood naturalist is presented in the light afforded by a careful research. Besides an account of his life the volume contains a chapter on his personal appearance, with some discussion on the genuineness of the two portraits which are given in it. The part dealing with his scientific work tells of what he did in Sicily, in Lexington, Ky., and also takes up his investigations by subjects—conchology, ichthyology, botany, archæology, etc. A list of the medals, diplomas, and other honors conferred upon him, and of the genera and species of plants and animals named after him, is given. There are also a bibliography of writings by or about Rafinesque, numbering over four hundred titles, and a copy of his eccentric will. Pages from two of his works are given in facsimile.

Scientific French Reader. Edited by Alexander W. Herdler, of Princeton University. Boston: Ginn & Co. 1894.

For twenty years past the necessity of a good reading knowledge of French and German by students of technical branches, as well as of pure science, has been recognized in our colleges. Very little progress has been made, however, in the matter of providing proper introductory language lessons for such studies. The present book must now be added to the still too short a list of books available for this purpose.

There are many difficulties in the preparation of such a book; for not only is linguistic knowledge necessary, but also technical knowledge covering all subjects treated, otherwise a correct vocabulary can not be appended to the book. Mr. Herdler has had the assistance of several well-known teachers of science in the proper rendering of these technical French terms into English, which insures their correctness in the connection in which they are used in the text.

The matter in the book consists of well-selected short articles, increasing in difficulty with progress through the volume. It will be found of greatest use to engineering students, chemists, and electricians, as the application to practical life of scientifically constructed devices is mainly treated. It will probably be a long time before special students in the departments of astronomy, meteorology, geology, zoölogy, etc., will have prepared for them books of this class which will enable them to acquire in a few months a technical vocabulary which now requires years of reading in special science literature.

Common Sense applied to Woman Suffrage. By Mary Putnam-Jacobi, M. D. New York: G. P. Putnam's Sons. Pp. 236. Price, $1.

In this strong argument on the natural rights of women, Mrs. Dr. Jacobi has embodied the substance of what has been urged by past advocates of the "emancipation of woman," and by the leaders of the present movement, and has supplemented it with some forcible considerations of her own suggesting, which are commended to those who are interested in the subject. Of the author's ability to make the strongest presentation of the "woman" question, and of the worthiness of whatever she may have to say to be carefully and respectfully considered by candid men, there can be no question. A lady of high scientific attainments and of wide general culture, she has thought long and well on this subject and the others kindred to and connected with it. The address she made in favor of woman suffrage before the recent New York Constitutional Convention fell before an unsympathetic, timid audience largely governed by political exigencies; now she appeals to a different audience, which, though it may be unwilling, will not be afraid, if it sees fit, to move in the direction she wishes.

Missouri Geological Survey. Vols. IV and V. Palæontology of Missouri. By Charles Rollin Keyes, State Geologist. Jefferson City: Tribune Printing Company. Pp. 271 and 266, with 56 Plates.

This report includes the notes prepared by the former State Geologist for publication, embracing the results of the observations of himself and his assistants and correspondence, and the additional information that has been acquired under the present administration of the survey—the whole being carefully rewritten or revised. The material on which it is based has been gathered by members of the survey or found in local cabinets, private collections, and the cabinets of colleges and public museums. The author aims to present, briefly, an index to the fossils of the State by means of which the forms can be recognized easily, with a bibliography of Missouri palæontology, a summary of what has so far been done in it, and an introduction to more comprehensive faunal studies, tending toward a solution of stratigraphical problems more or less obscure. As a rule, all the species described have passed under personal observation. The disposition to fabricate or imagine "new species" has been resolutely checked, and attention has been turned in preference to the discussion of the morphological relations and stratigraphical significance of the fossils. Brief nominal histories have been appended to the descriptions of many of the most important species, together with some of the most salient points brought out in the present investigation concerning the structural features of the various types. In illustration, the leading Missouri species of each genus have been figured, and also some of those forms heretofore described from the State, but never illustrated. Besides the consideration of the fossils, the stratigraphy of the State is described in an introductory chapter, and a geological map is furnished. In the present volumes animal remains are represented. The fossil plants are to be described hereafter. The work is thoroughly well done.

A History of the United States. By Allen C. Thomas, A. M., Professor of History in Haverford College, Pennsylvania. Boston: D. C. Heath & Co. Pp. 410 + 72. Price, $1.25.

This is a convenient and useful handbook of American history. The volume is profusely illustrated, including some excellent portraits of our distinguished men. Prof. Thomas has condensed within very narrow limits nearly all the essentials of our nation's story. His aim has been to muster the main facts, and impartially deal with events, the causes of which are briefly but clearly brought before the reader's mind. Though the details of great battles are omitted, the causes that led from time to time to hostilities are disclosed, and the best authorities are often cited.

A recent publication of the United States Department of Agriculture is a *Monographic Revision of the Pocket Gophers*, exclusive of the species of *Thomomys*, by Dr. *C. Hart Merriam*. It is a pamphlet of 258 octavo pages, illustrated with nineteen plates, four maps, and seventy-one figures in the text. Excepting part of the first chapter, less than twenty pages, it is composed of the most technical sort of biological material, absolutely unintelligible to ninety-nine per cent of the farmers for whose information it is ostensibly published. The author, who is Chief of the Division of Ornithology and Mammalogy in the department, explains its appearance in these words: "In preparing a bulletin on the economic relations of the pocket gophers it became necessary to determine the status and geographic distribution of the various forms. This study developed the fact that the group was sorely in need of technical revision. The present paper is the outgrowth of an attempt at such a revision. It has grown so far beyond the limits originally intended that a large genus (*Thomomys*) has been of necessity omitted and will form the subject of a subsequent paper." So it seems that another volume like this is threatened, and meanwhile the farmers must wait for what may be of some use to them—the economic account, which, the author tells us, "will appear as a separate bulletin prepared by my assistant." The biological information in the bulletin before us has its value for science, but it is an imposition to pay for its collection and publication with money that the people have devoted to the advancement of agriculture.

The first issue in the political series of the Bulletin of the University of Wisconsin is an examination of *The Geographical Distribution of the Vote of the Thirteen States on the Federal Constitution*, by *Orin G. Libby*. While State lines are used for convenience in pointing out the distribution of Federal and anti-Federal sentiment, attention is directed especially to those social and economic areas which have been the true units in political history. The monograph is accompanied by General Walker's map showing the distribution of the population of the United States in 1790, and a map showing the distribution of the vote on the Federal Constitution.

Parts II and III of Vol. XXVI, *Proceedings of the Boston Society of Natural History*, contain papers on Faceted Pebbles on Cape Cod, by Prof. W. M. Davis; Small Mammals from the New Hampshire Mountains, by Gerrit S. Miller, Jr.; Some Typical Eskers of Southern New England, by J. B. Woodworth; Spharagemon, a Study of the New England Species, by Albert P. Morse; Theories of Evolution, by Prof. Edward B. Poulton, of Oxford; and briefer communications from Profs. Harrison Allen, N. S. Shaler, F. W. Putnam, W. G. Farlow, and others. In the year 1893-'94 the society received by gift a large number of stuffed animals from the Boston Museum collection. Some of these had been formerly in the famous Peale Museum in Philadelphia. The work of a guide in explaining the society's collections to visitors was continued through the year by the liberality of a Boston lady. An arrangement was made with the Boston Normal School whereby the resources of the society were employed to aid in the training of teachers of science. Other evidences of activity are reported.

The numbers of the *Journal of the College of Science, Imperial University, Japan*, as they come to us, bear continuous evidence of the original work that is done in scientific investigation by Japanese students. The latest three are Vol. VII, Part II, On the After Shocks of Earthquakes, by F. Ōmori, a careful study, with elaborate tables and sixteen plates and charts; Vol. VII, Part III, Mesozoic Plants from Kōzuke, Kii, Awa, and Tosa, by Matajiro Yokoyama, Professor of Paleontology, with ten plates; and Vol. VIII, Part I, Studies on the Ectoparasitic Trematodes of Japan, by Seitaro Gotō, of the Science College, with twenty-nine plates. The last two papers include full and definite descriptions of species.

A curious insight is given into the mythologies and modes of thought of some of our Indian tribes by the study of Mr. *J. Walter Fewkes* of *The Walpi Flute Observance.* This primitive drama, as we gather from Mr. Fewkes's concluding paragraphs, is performed on alternate years with the "snake" ceremonials, to celebrate the coming, in the early times, of the Horn or Flute people to Walpi, where the Bear people and the Snake people were living, and their reception by them. The ceremony illustrates the permanence and the significance of the mythologies and the rituals of primitive peoples, which are incomprehensible to our ordinary knowledge. The ritual is not to these peoples, Mr. Fewkes says, a series of meaningless acts, performed haphazard and without unity, varying in successive performances, but is fixed by immutably prescribed laws which allow only limited variations. Throughout the Flute ceremony there is the same rigid adherence to prescribed usages which exists in other rites, and there is the same precision year after year in the sequence of the various episodes. The observance is celebrated by a special fraternity, of which, as well as of the ceremonies, carefully detailed descriptions are given.

In *The World's Great Farm* (Macmillan & Co., New York) an attempt is made by *Selina Gay* to set forth and illustrate the economy of Nature. The world and all that is upon it are regarded as a vast farm, its tillers and its crops; and the purpose of the book is to tell what these crops are and how they are grown. First is the tilling, which is done by the pioneer laborers, the gases of air and water breaking up the rocks; the soil-makers —cryptogamic vegetation of lichens and mosses pulverizing the rock fragments and preparing them for the more dainty vegetation; soil-carriers—the winds and the waters; the field laborers—burrowing animals, from the earthworm up; the office of water as a factor in vegetable growth, the roots and the food drawing from the soil; leaves absorbing nourishment from the air; the blossom and seed and the various agencies employed in the fertilization of flowers, and to secure the scattering of the seed; the chances of life of the plant and the way they are guarded; the friends and foes of the Nature farmer and the militia by which the foes are kept down; and "Man's Work on the Farm"—the purpose being kept in view throughout, as Prof. G. S. Boulger says in the preface, to give an account which, while simple enough to be understood by unscientific readers, and so accurate as to teach nothing that will afterward have to be unlearned, shall also be extremely attractive in the selection and marshaling of facts.

A very favorable impression is made upon us by the *Popular Scientific Lectures* of Prof. *Ernst Mach*, of the University of Prague, of which a translation authorized, revised, and commended by the author, by Thomas J. McCormack, is published by the Open Court Publishing Company, Chicago. The lectures were delivered between 1864 and 1894, at Prague and Gratz, and were intended to give the public an intelligent comprehension of the nature of scientific work in the lines covered by them, and enlist their sympathy with it. The most of them are very lucid explanations of facts and phenomena concerning which the people are inquiring, while the last four are of a more philosophical character, and deal principally with the nature and methods of scientific inquiry. The subjects are The Forms of Liquids, The Fibers of Corti, The Causes of Harmony, The Velocity of Light, Why has Man Two Eyes? Symmetry, The Fundamental Concepts of Electrostatics, The Principle of the Conservation of Energy, The Economical Nature of Physical Inquiry, Transformation and Adaptation in Scientific Thought, The Principle of Comparison in Physics, and Instruction in the Classics and the Mathematical Physical Sciences.

A discussion of much literary interest—and scientific, too, so far as it relates to the evolution, growth, and variations of popular tales—is given by Prof. *Richard Jones*, of Swarthmore College, in his book on *The Growth of the Idyls of the King* (J. B. Lippincott Company, Philadelphia). The effect of the study—especially of the Arthurian legends in their different versions—"is a disregard of the criticism that Lord Tennyson's ideal knight and blameless king is not the Arthur whom we know through Malory." Sir John Malory's Morte d'Arthur is a compilation from numerous legends in various languages. It does not form a consistent whole, and does not always present the most significant stories or the best versions. That Tennyson does not always agree with him means simply that he selected some other version than the one given by him, or exercised the poet's license of modifying the version to make it conform to his purpose. These views are brought out in the preliminary chapters of the book; and after this follows a minute criticism of the structure of Tennyson's group of poems, and a comparison of the editions from the earliest, showing by the successive changes in the text the gradual unfolding of his ideal.

The List of the Publications of the Bureau of Ethnology, compiled by *Frederick Webb Hodge*, with its index to authors and subjects, will be a valuable aid to students in this department. The Bureau has done most excellent work in a field where it was much needed, and at a time when it could be done more efficiently than ever afterward.

The *Index to St. Nicholas*, Vols. I to XXI, was composed by Mr. *W. M. Griswold*, an indexer well known by his other similar works, for the use of his children, aged eight and nine years. Any one who glances at it, the compiler says, "will see that few branches of knowledge suitable for children are unmentioned," while in some cases works are given which are models of what such should be.

In placing the book *Central Station Bookkeeping and Suggested Forms* before the electrical public, the author, *Horatio A. Foster*, has endeavored to show a classification of accounts and a system of reports for central light and power stations, such that the management may by their use know the full details of the business of distributing the electric current. It appears that the means of securing these data are very deficient, or neglected, at many of the smaller stations. The book contains diagrams for the organization of the staff of electrical central stations, the classification of accounts and reports, and includes sample forms for every department. It is devoted mainly to accounting departments of central stations, and outlines a scheme for their organization and routine which will enable the management to determine at any moment the condition of business and the unit cost of the generation and distribution of current. The forms were devised after an examination of several hundreds in practical use in many stations, and are intended to embody the best points of all. In an appendix is furnished a classification of accounts of electrical street railways, together with instructions, forms of books, etc., necessary to carry it out. (Published by the W. J. Johnston Company, limited, New York.)

The *Ninth Annual Report of the Commissioner of Labor*, *Carroll D. Wright*, relates entirely to Building and Loan Associations in the United States, including under that title all associations having the purpose indicated by it. Such associations have existed in this country since about 1840. Their growth has been very rapid since then, and their accumulated assets have increased to an enormous amount. As private corporations, doing a semi-banking business, conducted by men not trained as bankers, they offer a study in finance not afforded by any other institutions. England, France, and some other countries have kindred institutions, but nowhere have they grown to such vast proportions as in the United States.

Five thousand eight hundred and thirty-eight associations are represented, in the reports of which five thousand five hundred and ninety-eight were local and two hundred and forty national. The total dues paid in on installment shares in force, plus the profits on the same, amount to $450,667,594. "A business represented by this great sum, conducted quietly, with little or no advertising, and, as stated, without the experienced banker in charge, shows that the American people, in their own ways, are quite competent to take care of their savings." Only thirty-five of the associations now in existence showed a net loss at the end of their last fiscal year, and this loss amounted to only $23,332. When an association disbands, no loss can occur, because its whole business consists of loans, mostly to their own shareholders. A disbanded association, therefore, simply returns to its members their own property. Full particulars are given of the associations by States and by individual associations.

A History of Higher Education in Iowa has been prepared by Prof. *Leonard F. Parker*, of Iowa College, as Circular of Information No. 17 of the United States Bureau of Education. There is much in the educational history of Iowa, as Commissioner Harris well says, which is instructive to all students and observers of educational progress, since within the limits of that State a noteworthy zeal has prevailed from the time of the earliest settlements in founding institutions of learning and in providing instruction for all classes of people. The narrative tells the story of the first schools in Iowa previous to 1838, Education during the Territorial Period, Early Education in the State, the Free-School System, Provisions for the Education of Teachers, the State Agricultural College, the State University, Private Secondary Schools, Denominational Colleges, Institutions no longer existing, the Higher Education of Women in Iowa, and Educational Auxiliaries.

In the *Report on the Crustacea of the Order Stomatopoda* (No. XXXII of the Scientific Results of Explorations by the United States Fish Commission Steamer Albatross) Dr. *Robert P. Bigelow* makes a classification of the *Squilla* family from a study of the specimens in the National Museum, the Fish Commission, and a private collection made by him in the Bimini Islands (Bahamas). These, he finds, represent thirty-four species distributed through five genera, of which fourteen are new. The collection of larvæ was large, but unfortunately contained nothing like a complete series of stages of any one species. The changes of form between two stages are so great that almost no larva in the collection could be referred with certainty to its adult form.

In his paper on *The Systematic Position of the Siphonaptera* Prof. *Alpheus S. Packard* bases his opinions upon the work of Landois, Kraepelin, and Wagner, besides some work of his own. He believes that the fleas should be referred to an independent order, and not classed with the flies. He calls attention to the presence of a temporary larval structure in the dog flea (*Pulex canis*) that is, so far, unique among insects. This is an egg-shell burster. It is a thin vertical plate like the edge of a knife, situated on the median line, and so placed that the larva, by rubbing its head back and forth, would produce a slight split in the shell and cause it to burst asunder. In the larva just before hatching the plate is no more hard than the rest of the head; later it entirely disappears. While he places them nearer to the *Diptera* than to any other order, he calls attention to our very imperfect knowledge of their embryology, and states that the present assignment may be temporary.

From Volume XIII of the *Transactions of the New York Academy of Sciences* it appears that in the year ending in February, 1894, eighty-one papers had been presented before the academy. The departments of science most largely represented in these papers were zoölogy, astronomy, geology, and paleontology, in the order named. This volume contains the report of the committee on the Audubon monument, with the speech of Prof. Thomas Eggleston presenting the monument to the corporation of Trinity Church, that of Dr. Morgan Dix accepting it, and the address of Daniel G. Elliot on the life and services of Audubon. Among the more extended papers of the volume are Observations on the Geology and Botany of Martha's Vineyard, by Arthur Hollick; The Ore Deposits at Franklin Furnace and Ogdensburg, N. J., by J. F. Kemp; The Intrusive Rocks near St. John, N. B., by W. D. Matthew; The Geology of Essex and Willsboro Townships, Essex County, N. Y.; and Microscopic Organisms in the Clays of New York State, by Heinrich Ries. Several are illustrated with plates or cuts. Appended to the volume is a catalogue of the articles shown at the first annual reception and exhibit of recent progress in science held by the academy, March 12, 1894.

The *Report of the Smithsonian Institution* for 1892–'93 is a record of work of the usual character done in the institution and its several allied bureaus—the United States National Museum, Bureau of Ethnology, National Zoological Park, and Astro-Physical Observatory. In accordance with the custom of several years past, the progress of science during the year of the report is represented by a considerable number of papers, mostly reprinted or translated from scientific journals, but some appearing first here. The subjects thus represented include photography in colors and photography of moving objects, aërial navigation, the ice age, polar exploration, American bows and arrows, descriptions of biological and meteorological stations, and a biographical sketch of Henry Milne-Edwards.

The operations carried on under the direction of the *United States Commissioner of Fish and Fisheries* in 1891–'92, as set forth in his *Report*, comprise inquiries into the causes of the decrease of food fishes in the waters of the United States, the collecting of statistics and accounts of methods of the fisheries, culture of fish at twenty-two stations and their distribution to the number of 228,000,000 fry, 75,000,000 eggs, and 2,000,000 adults and yearlings. Preparations for the extensive exhibit at the World's Columbian Exposition of the following year were carried on. Appended to the Report are several papers, the most considerable of which is on the Parasites of Fishes, by R. R. Gurley. Some Notes on the Oyster Industry of New Jersey are furnished by Ansley Hall, and there is a bibliography on oysters, by C. H. Stevenson.

The large and handsomely printed volume numbered two, which has been issued by the Iowa Geological Survey, is a full account of the *Coal Deposits of Iowa*, by *Charles R. Keyes*. After a general description of the carboniferous basin of the Mississippi Valley, the geology of the Iowa coal region is described in more detail, and the lithology and stratigraphy of the coal measures in this area are successively set forth. The coal beds now operated throughout the State are then taken up by counties, after which the composition and properties of Iowa coals are stated, and some information on waste in coal mining and the extent of the coal industry in the State is given. The volume is illustrated with many maps, views, and diagrams.

From the *Sixty-second Annual Report of the Perkins Institution*, of Boston, it appears that the total number of blind persons in the school, kindergarten, and workshop for adults, including sixteen employees, was 237 in September, 1893, an increase of twenty-seven during the preceding year. Music is so often a source of remunerative employment for the blind that this department receives special attention. There were three blind and deaf children—Edith Thomas, Willie Robin, and Tommy Stringer—in the school, and making more than satisfactory progress. Their portraits and special accounts of their school work are given. Ten or a dozen books were issued from the printing office in the course of the year. A second building for the kindergarten had been completed, and the number of pupils in that department had increased to sixty-four.

PUBLICATIONS RECEIVED.

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POPULAR MISCELLANY.

Death of Professor Dana.—Prof. James Dwight Dana, the veteran American geologist, died at his home in New Haven, Conn., of disease of the heart, April 14. He had been apparently in good health, manifesting no signs of weakness other than by taking his walks less frequently, but on the morning before his death was attacked with a nervous fluttering of the heart, which, being not uncommon with him, was not regarded as serious. After sleeping for a while at night, he awoke feeling worse, and died before the doctor was able to reach him. A brief sketch of Prof. Dana's life and work up to that time was given in the third number of The Popular Science Monthly, July, 1872. Besides the books and published papers mentioned in that article he has since revised the text-books and manuals of geology and mineralogy, bringing them up to very recent dates; added to his works The Geological Story Briefly Told and a small volume on the New Haven region entitled The Four Rocks; contributed numerous papers on scientific subjects to the journals in which they appropriately found a place; and edited the American Journal of Science to the end of his life. He continued to serve in his professorship in Yale College till 1892, when he asked the corporation to appoint his successor, and Prof. H. S. Williams was elected; but he continued, at the request of the corporation, to deliver his lectures till January, 1894. After this he finished the revision of his Manual of Geology, which has been published recently; continued his contributions to the American Journal of Science; kept up his investigation of the phenomena of the Hawaiian volcanoes, for which he made a recent visit to the Sandwich Islands in 1887; and completed a short work on Cephalization, or a system of classification based upon progressive nerve centering in the brain. He was a man of lovable disposition and high personal character; and he held honors, memberships, or medals from most of the important scientific societies of the world. The complete list of his books and published papers given in the American Journal of Science contains two hundred and fourteen titles. It begins with a paper on the Condition of Vesuvius in 1834, published in 1835, and ends with the fourth and revised edition of the Manual of Geology, which Prof. Dana finished in February, 1895. A month later he had completed the manuscript of a new edition of The Geological Story, and then began work on a new edition of the Text-Book.

Treatment of the Morally Defective.—The question of the treatment proper to be applied to the morally defective was treated with considerable effectiveness by Prof. A. J. McClatchie, in a lecture delivered at Pasadena, Cal. The speaker first named the influences under which persons became criminals. Many are born of convicts or of criminals who have escaped punishment, and hence have a natural tendency to be morally deranged. Other persons are surrounded by unfavorable circumstances, and, being weak, are drawn into a life of crime against their will. Others are quick-tempered, irritable, supersensitive, and liable at any time to be provoked to do that which they would not do in soberer moments. Others are born of good parents and have good surroundings, but under certain circumstances—such as the influence of bad associates—and in their weakness yield gradually to temptation, and thus slowly develop into criminals. Shutting these persons in prisons with more hardened criminals, where all the influences are demoralizing and not one healthful—the ordinary course—is obviously not the best one or a good one in any way. Prof. McClatchie, on the other hand, looking upon the cases as involving moral disease, outlines a reformatory treatment based on principles similar to those which rule at the Elmira institution. The first precept to be observed in it is that first offenses should never be overlooked; vigorous treatment in the beginning is really a kindness to the subjects. Next, a system of graded institutions is needed, so that prisoners may be classified and segregated. "Those guilty of different degrees of criminality should be placed in different institutions and given entirely different treatment. The sentence should in all cases be what is called indeterminate—that is, no one should be sentenced for any given time. He should be placed in the institution and should remain there until competent men pronounce him cured. The treatment should all be disciplinary. It should not consist of simply kind treatment, but should be firm and vigorous. All three of their natures—their physical, mental, and moral—must be treated simultaneously." The discipline must be continued until it is easy for the subjects to control their will and to use their hands and their minds in the right manner. "They must form the habit of doing right until it has become a part of their nature, or the work will not be thoroughly done. . . . If it is found that it is impossible to reform the criminal, he should be kept confined indefinitely."

St. Augustine and the Days of Creation.—St. Augustine of Hippo is said to have been a diligent student of the Mosaic record of the creation, and tried earnestly to find a method of interpreting it consonant with what he knew of the facts of Nature. In writing of this feature of his career the Rev. John A. Zahm, of the University of Notre Dame, says that during the twenty-five best years of his life the first two chapters of Genesis were continually before his mind. What did Moses mean by the word "days"? he asked again and again. "How could there be days in the ordinary acceptation of the word before the sun was created on the fourth day? Were not the first three days mentioned by Moses periods of time rather than ordinary days of twenty-four hours each? And what about the seventh day—a day that had no evening—a day, therefore, that still endures? How explain, according to the laws of Nature, which are the laws of God, the production and development of the various forms of plant and animal life in the short period of six ordinary days? The idea that God, during the days of Genesis, operated in a manner different from that which subsequently characterized his providence, that the laws which governed the material universe were not the same then that they were afterward; that the Hexaëmeron was distinguished by a series of miracles and a succession of specific creations rather than by the reign of law that the Creator himself had imposed on matter, and by which it was endowed with the power of gradual evolution and differentiation, seemed so repugnant to the keen and logical intellect of Augustine that he could never bring himself to adopt it, much less give it his support. . . . The word 'days,' according to the illustrious doctor, was not to be taken in a literal but in a figurative sense. They meant not ordinary days, but the works of creation which were unfolded in time by a series of progressive transformations. For a similar reason the words 'evening' and 'morning' are to be interpreted metaphorically as meaning not dusk and dawn, but the beginning and end of the divine works. God, according to St. Augustine, as well as according to St. Gregory of Nyssa, first created matter in an elementary or nebulous state. From this primordial matter — created *ex nihilo* (from nothing) — was evolved, by the action of physical laws impressed on it by the Creator, all the various forms of terrestrial life that subsequently appeared. In this process of evolution there was a succession, but no division of time. The Almighty completed the work he had begun, not intermittently and by a series of special creations, but through the agency of special causes, by the operation of natural laws—*causas rationes*—of which he was the author."

Wabbling of the Earth.—Displacements of the rotational axis of the earth, says Prof. Forster in a paper read in the British Association, have been observed from the very earliest times, and are so great that they can be detected with very simple apparatus. These effects are due to exterior causes, and consist in a displacement of the axis of the earth in space, and a consequent wandering of the pole among the stars. The action of internal forces in the earth would be to produce a displacement in the rotating body itself. A deviation of the rotational axis from the principal axis of inertia would cause a rotation of the pole round the principal axis of inertia. Such a rotation would have a period of nearly ten months, and could be best detected by continuous and active observations of latitude at various observatories. Measurements were made as early as the middle of this century, but gave no definite results, the ten-monthly period being marked by other disturbances due to currents and circulations in the atmosphere, oceans, and rivers. Four years ago the International Geodetic Union secured co-operation of observations, and this, together with an expedition to Honolulu, has led to definite results. These show that the north pole wanders through about fifty feet between its extreme positions.

Bactericidal Solar Rays.—Although investigation has not been idle, experimenters have not been wholly agreed as to the exact property or field of the sun's rays which is most efficient in action on bacteria and fungi. The inquiry has been continued by Prof. H. Marshall Ward, to whom the thought occurred in the course of his work that the most direct answer to the question, Which rays are the most effective ones? might be best obtained by shining the solar spectrum directly upon the film of spores, and making it record the effects by their subsequent behavior, according as the different groups of rays fell upon them—in other words, by obtaining a photograph of the spectrum in living and dead bacteria. The results showed conclusively that the rays that kill the bacteria are the blue and violet ones. An observation was made during the investigation which may go far to account for the unsatisfactory character of the determinations of former experiments. The chief difficulty to be overcome was the great weakening of the intensity of the dispersed rays of the beam of light decomposed to form the spectrum—a weakening caused by the distribution of the incidence of the rays over a larger area and by their absorption and reflection in passing through the lenses and prisms. It was found also, in working with the electric light, that the power of the blue and violet rays was further impaired—in other words, that they were stopped — by the material (glass) through which they had to pass. The effect of the glass was practically the same as that of mist or haze in the atmosphere, which so filters out the blue-violet rays that the light of a dull day was of little effect in the author's experiments. These difficulties were overcome by using quartz instead of glass, with which it was possible to obtain a very pure spectrum sufficiently rich in blue and violet rays to kill the spores in a few hours. The author found it easy to obtain satisfactory results in the summer with the solar rays, even with glass lenses, mirrors, etc., and exposures of five or six hours, but in winter the exposures required to be so long as to be almost impracticable.

Work of the Peabody Museum. — The Curator of the Peabody Museum of American Archæology and Ethnology calls attention, in his report for 1893–'94, to the lack of room in the museum. Several collections made under the curator's direction have been secured. Besides a generous gift of money, Mr. Clarence B. Moore has contributed a good representative collection of the singular pottery which he obtained from a mound in Florida, and other objects of interest from the burial and shell mounds of that State. The publication of Mr. Nuttall's memoir has been provided for, and the work has been held in press for the incorporation of newly discovered facts. Space has been provided for the collections of archæological, historical, and educational objects and relics made by the late Mrs. Hemenway, of which Mr. J. Walter Fewkes is in charge. The collection of Mr. Frederick H. Rindge, deposited in the museum, contains the finest and most extensive lot of obsidian implements ever brought together from the Klamath country. Some of the chipped implements are remarkable for their size, and others for their beautiful finish. The collection also includes gems of workmanship in stone, bone, and ivory from the tribes of the northwest, and many carvings obtained from the Eskimos. Dr. C. C. Abbott has presented a quantity of material obtained from the site of an old Dutch trading house on the Delaware, which tells the story of the early contact of the white race with the Indians. Mr. Valk explored during the year an ancient village site and burial place in the Delaware Valley, where interesting discoveries were made relating to the early inhabitants. In his examination of the singular and ancient burial places on the coast of Maine, Mr. Willoughby has ascertained several important facts, and has obtained many interesting objects, some of which show Eskimo affinities. Mr. George Byron Gordon has undertaken the exploration of Copan under a concession from the Government of Honduras. More money is needed for this work, and other institutions are invited to cooperate in it. The collection already in the museum is pronounced to be of remarkable interest and not equaled elsewhere, but is so crowded and unprotected that it is not open except under special arrangement. The course of general anthropology was attended by nine pupils.

The Passing of Torture.—Asiatic peoples tolerate torture, practice it, almost seem to like it (the infliction of it, that is); European nations do not now permit it. The difference presents a problem in the development of human character. Europeans did not always abhor torture; they have changed since the Romans delighted in gladiatorial shows and in seeing captives and Christians thrown into the arena to be devoured by wild beasts. Aversion to torture can hardly be called a characteristic of Christians, although it is inculcated in the Christian code, and may have been developed under Christian teachings. King Menelek of Abyssinia, who is said to have recently condemned a treacherous page to terrible sufferings by mutilations and exposure in the wilderness, calls himself a Christian. The Inquisition was in full blast under the ægis of the Church only two or three centuries ago, and *autos da fé* were festivals in Madrid down to 1750. Prisoners convicted of certain crimes were broken on the wheel only a bare hundred years ago in France. Torture was legal in Denmark within living men's memories, and is still practiced, though not authorized, in Russian prisons. And what are we to say to the punishments still sometimes inflicted upon offending negroes in the southwest? But these things have passed away, and only a few vestiges of them, like the last mentioned, remain among any men of European lineage, while the world at large abhors the recital of them. Having shown a number of other special causes the validity of which, he considers, can not be depended upon to account wholly for the change, a writer in the London Spectator assumes that "there must be some separate moral impulse which has arisen apart, or in a certain degree apart, from any teaching of the creeds; and we find it difficult not to believe that it is a new impulse, that man's moral nature has on this side made in Europe a distinct stride forward. It is an advance the extent and depth of which have not yet been tested, for the masses of Europe have not of late years been provoked to furious anger, as they once were, by heresies and treasons, or as they may be, by and by, by anarchist explosions; but it is an advance which it is impossible not to recognize, and one that has gone far down, reaching classes whom the spirit of practical Christianity has hardly touched. If that is true, it is the most hopeful thought suggested by any of the social phenomena around us; and after much observation, continued for many years, the present writer can hardly doubt that it is true."

Oysters and Disease.—In view of what has been said of the possibility of the communication of disease by eating raw oysters, inquiries have been instituted by the English Local Government Board into the circumstances under which the cultivation and storage of shellfish along the coast are carried on. As a result of his bacteriological investigation of water from an oyster bed and of oysters from the same source, Prof. Cruikshank, of King's College, London, reports that he found a considerable number of bacteria in the sea water, but very few in the liquid of the oyster, in which the increase of bacteria was also very slow, but that in both cases the bacteria were familiar and harmless species, and there was no septic odor. Hence he finds no evidence that would lead him to condemn the oysters as dangerous or unfit for food. Nevertheless, he adds, the possibility of a constant or intermittent contamination of the oyster beds ought to be carefully inquired into.

American Women in Science.—The annual meeting of the National Science Club for Women was held in Washington, January 2d, 3d, and 4th, in the new reading room of the club in the Lenman Building. The election of officers resulted in the choice of Mrs. Rosa Smith Eigenmann, of Bloomington, Ind., as president; Mrs. Almena B. Williams as vice-president; Miss Isabel Lenman as treasurer; Mrs. Laura Osborn Talbot as general secretary; Mrs. Edward Goodfellow as recording secretary, and Mrs. Horatio King, Mrs. Mark Harrington, Mrs. Herschell Main, Mrs. Anna Lowell Woodberry, all of Washington, and Mrs. Jean Brooks Greenleaf, of Rochester, N. Y., as members of the Executive Committee. The address of the retiring president, Mrs. A. D. Davidson, who had served for three successive terms, was mainly upon geological forces in Europe. General meetings were held on Thursday, January 3d, at the Hall of the National Museum, where a lecture was delivered by Mrs. Olive Thorne Miller on The Birds our Brothers, and papers were read constituting a rich programme of scientific essays by members from all parts of the country. On Friday, the 4th, the Council met at the Lenman Science Rooms, and adjourned till January, 1896. These rooms will henceforth be open to women who come to Washington for scientific study and investigation, who will be admitted on cards from members. The library needs gifts of books and pamphlets in science.

The Koreans.—While the Koreans generally display Mongolian characteristics, features are often met with in them almost European in refinement and Caucasian in cast, indicating a mixture of race among them. As described by Mr. H. S. Saunderson, they are tall, finely built, with features approaching more nearly to the European cast of countenance than those of the Chinese or Japanese. Their hair is black, sometimes shading to brown; is worn by the men tied up into upright columns on the tops of their heads, and by the women parted in the middle and made into chignons. Both sexes have small hands, which they are careful to keep clean and soft, and small feet. Their complexions are not so dark as those of the Chinese, nor so yellow. Their foreheads are high, and their voices are low and well modulated. They are genial when treated according to their notion, ready to laugh at a good joke, and to throw themselves into the fun of the moment. They are very proud, but treat foreigners politely while they despise them. Their policy of isolation is the result of long and hard wars with the Chinese and Japanese, and was adopted in the first place to make the country difficult of access to hostile forces. According to Mr. Saunderson, its effects have been detrimental to the national character. Their dress is strictly regulated. They pay great attention to the cleanliness of their outer robes. "No one who respects himself will ever appear in a dirty coat. Consequently, the women's chief occupation consists of washing the raiment of their lords and masters, and far into the night can be heard the tapping of the sticks with which the wet clothes are beaten—a most destructive process. As the clothes are but roughly tacked together and are glued at the seams with rice paste, they come to pieces every time they are washed, and have to be reglued when dry. The starch used consists of a mixture of rice paste and honey, and it gives the surface a peculiarly beautiful gloss." This regard for cleanliness does not extend to the underclothing or the body, which, according to Mr. Saunderson, are shamefully neglected. In summer basket-work frames are worn on the arms, back, and chest, under the robes, in order to keep the latter clean and dry, and also for the sake of coolness.

The Pamirs.—The term Pamirs, as applied to a particular region in central Asia, was defined by the Hon. George Curzon in a recent address before the Royal Geographical Society. It does not mean a vast tableland, as some suppose, or a "series of bare and storm-swept downs," as others have conceived, or a steppe; but, as is illustrated in the region itself, a mountainous valley of glacial formation, differing from the adjacent or other mountain valleys only in its superior altitude and in the greater degree to which its trough has been filled up by glacial detritus and alluvium. It thereby approximates in appearance to a plain. This appearance is due to the inability of the central stream to scour for itself a central channel—a fact attributable to the width of the valleys and the consequent absence of glaciers on any scale, and to the short summers, which do not last long enough, or receive sufficient solar heat, to admit of a very powerful erosive impetus being communicated to the melting snows. Mr. Curzon estimates the extreme length and breadth of the Pamirs to be nearly equal, and each about one hundred and fifty miles.

A Model Public Library.—The report of the Board of Directors of the Los Angeles Public Library, Cal., furnishes many facts of much interest. One of the most noteworthy of them is the declaration that the library has been a paying investment for the city, as a means of education and recreation to the citizens, and as an attraction to the tourist population. Among the novel features is that of the circulation of current literature, which has met with hearty appreciation from the beginning, and is believed to have been a potent feature in encouraging the reading of the best class of the books and periodicals of the time. Another popular feature is the musical department, which has been much utilized by students of music, and has proved a means of education. Early in the administration of the library, civil-service rules were adopted for the appointment and regulation of the staff of attendants. The first appointments were made after a rigorous examination into the qualifications of applicants, ignoring all objects except the greatest good of the library. A training class was established in November, 1891, from the graduates of which, and of succeeding classes, all appointments to the staff have since been made. Appointments and promotions are all regulated according to efficiency and length of service; and it being understood that the employed of the library are entitled to retain their positions during good behavior, the formality of reappointment from year to year has not been recognized as necessary or advisable. It shows how little the American people are removed from barbarism in the management of public affairs that these matters—embodying the plainest and most obvious common-sense principles—have to be explained in the report and shown to be right. The library has 42,313 volumes; gave out for reading at home or in the library or the reference room, 489,086 volumes in 1894; has 18,057 registered members; and employs nineteen attendants.

The Office of Natural Selection.—Natural selection, Prof. A. S. Packard holds, in his paper on the Inheritance of Acquired Characters, as he has from the first insisted, is not an initial or impelling cause in the origination of new species and genera. It does not start the ball in motion; it only, as we might say, guides its motions down this or that incline. It is the expression, like that of "survival of the fittest" of Herbert Spencer, of the results of the combined operation of the more fundamental factors. In certain cases we can not see any room for its action; in some others we can not at present explain the origin of species in any other way. Its action increased in proportion as the world became more and more crowded with diverse forms, and when the struggle for existence had become more interesting and intense. It certainly can not account for the origination of the different branches, classes, or orders of organized beings. It in the main simply corresponds to artificial selection; in the latter case man selects forms already produced by domestication, the latter affording species and varieties due to change in the surroundings—that is, of soil, climate, food, and other physical features, as well as education.

An Ancient Flint-Implement Factory.—Large numbers of flaked stone implements of beautiful form and material, and in some cases of unusual size, are abundant in the Mississippi Valley within a radius of one hundred and fifty miles of St. Louis. An important site, from which a material and instruments were supplied closely corresponding with those used in the St. Louis region, has been found nearly three hundred miles southwest of that city, and is described by Mr. W. H. Holmes. The stone is a whitish or light-gray chert, of conchoidal fracture, flaking easily, and resonant. The excavations are in three groups, occupying four or five acres, and are roundish pits and trenches. "The story of the working of the quarry and the management and the manipulation of the stone is to be read with almost as much ease as if the work had closed but yesterday. The fragments and masses of fresh chert were selected and removed from the pits, and the work of reduction and manufacture began. Shops were established on the margins of the pits, on the dump heaps, and at convenient points in the vicinity. . . . The shops are very numerous over the level space included between the three main groups of quarries, but, as a rule, they are not found more than one hundred or one hundred and fifty feet from the pits. Small trimming shops are found, however, much farther away, scattered through the forest and along the water courses." The circular clusters of white chert refuse are clearly defined on the dark ground, and especially so after forest fires have destroyed the growth of weeds and small underbrush. In the center is a shallow depression, which was the fireplace of the lodge. Around this the workmen sat, and here are the fragments and flakes, the rejects and hammer stones left by them, covering about the space inclosed by the lodge, and hardly disturbed since the site was deserted. Where the work has gone on for a long time, near the quarry margins the accumulations of refuse are so great that separate shops are obliterated, a number coalescing in the general mass, which in some cases reaches many feet in depth. One can sit on these accumulations and, without changing position, select bushels of the abortive implements and partially worked pieces broken under the hammer. Little or no specialization of form was attempted on the quarry sites; but blanks were chiefly made to be subsequently elaborated. It is evident that all the work was professional.

The Eight-hour System in Practice.—A most successful result of the operation of the eight-hour system is recorded in the works of Brunner, Mond & Co., English manufacturers. It has been in force there for five years, and the result has not been an increase in the cost of production. At first the wage cost per ton went up, but it then dropped, and is now as low as it was in 1889, the last year of the twelve-hour day. The managers are satisfied that the result is not owing wholly to improvements in machinery or methods of manufacture, but largely to the change in the length of the working day. They affirm that though the men work fewer hours, the efficiency of their work is not diminished, and their opinion is borne out by the fact of such improvements as greater regularity in attendance, increased application, and better health among the employed. The men used often to be irregular and drunken; now they come to their shifts regularly and sober. They are no longer found asleep at their posts. "The improvement in the men's looks," Mr. Brunner says, "and especially in their gait when leaving the works at the end of the shift, is very marked."

Astronomical Work of Harvard Observatory.—The forty-ninth annual report of the Director of the Astronomical Observatory of Harvard College is for the eleven months ending September 30, 1894. The most important events of the year were the practical trial of the Bruce telescope and the successful operation for several months of the Boyden Meteorological station on the summit of the Misti (Peru), at a height of 19,200 feet. Some criticisms that have been made of the photometric work of the observatory are answered, so far as they are of a scientific character. Sixteen hundred and fifty-seven photographs were taken with the eight-inch Draper telescope, and seventeen hundred and eight in Peru with the eight-inch Bache telescope. Seven variable stars were shown to have the hydrogen lines bright in their photographic spectra. Eleven new variables were discovered from the presence of bright hydrogen lines in their spectra, besides three whose variability was discovered from changes in their photographic images. Five gaseous nebulæ were discovered from their spectra. Several photographs were obtained of the new star in the constellation Norma, the spectrum of which, as in the case of the new star in Auriga, has become that of a gaseous nebula. This object is gradually becoming fainter. Nine hundred and twelve photographs were taken with the eleven-inch Draper telescope. An investigation has been in progress for the detection of stars having large parallaxes or proper motions.

The meteorological station on the Misti was successfully conducted for several months, one of the assistants visiting it every ten days and readjusting the self-recording instruments, till the station was broken into by Indians and some of the instruments were carried off. Long-exposure photographs were taken at Arequipa of three nebulæ and clusters under an improved method by which certain errors due to flexure and refraction are corrected. The great advantages of the atmospheric conditions at Arequipa are insisted upon. With the Bruce photographic telescope the spectra of the faint stars prove very satisfactory; and stars too faint to be photographed with other instruments can thus be studied. Experiments have been made to determine the photographic magnitudes of the brighter stars on a uniform scale.

The New Element in the Atmosphere, Argon.—The real existence of the new element which Lord Rayleigh and Prof. Ramsay claim to have discovered in the atmosphere appears to be proved by further investigations, of which, and of the substance itself—named *argon*—the discoverers recently gave a full account at the University of London before the members of the Royal Society. The discovery seems to have been first made by Lord Rayleigh in the course of his experiments for the determination of the densities of some of the more permanent gases. He found that nitrogen obtained from chemical compounds was about a half per cent lighter than when obtained from the atmosphere. Prof. Ramsay took up the investigation with Lord Rayleigh's permission. Both achieved the separation of argon from nitrogen; Prof. Ramsay by a chemical method, and Lord Rayleigh by the process of "sparking." It has now been separated from the air by atmolysis—a kind of filtering process applied to gases—by red-hot magnesium, and by sparking. Its density has been determined to be about 19·7. It is very soluble in water, and it has been proved that the nitrogen extracted from rain-water is twice as rich in argon as that which exists in the air. Argon is best obtained by freeing the air, from which carbonic acid and water have been removed, from oxygen by means of red-hot copper and then absorbing the nitrogen by means of metallic magnesium, which, when heated to redness, combines with the nitrogen, forming an orange-colored mass of magnesium nitride. The residual gas after this series of operations—the passage of the gases being repeated again and again—is argon. In this process chemically derived nitrogen yields no such residue. The density of pure argon is 20 (19·7); hence its molecular weight, in accordance with Avogadro's law, must be 40. There are reasons for believing that, like mercury, its molecule contains but one atom; its atomic weight, 40, is therefore identical with its molecular weight. Argon is soluble to the extent of four volumes per one hundred volumes of water, so that it is about two and a half times as soluble as nitrogen, and possesess approximately the same degree of solubility as oxygen, and is accordingly found to occur in increased proportion to nitrogen in rain-water. According to Dr. Olszewski, argon easily condenses to a colorless liquid at a temperature of $-128·6°$ C. and under a pressure of thirty-eight atmospheres. At a lower temperature argon freezes to a crystalline mass like ice; at a still lower temperature it becomes white and opaque. Its freezing point is $-189·6°$, its boiling point $-187°$, and its density as a liquid is 1·5. Mr. Crookes has found that it has two spectra, marked by red and blue lines respectively. This indicates that it may be a mixture of two elements. Other properties indicate that it is a single element, and the weight of the evidence seems so far to be in favor of this supposition. There are difficulties in the way of the unqualified acceptance of either view. It presents other problems of constitution and behavior, in view of which much study will yet be required before a satisfactory conception can be gained of its exact nature and of its place in the chemical series. It is chemically the most inert element yet found.

Distinction of Animals and Plants.—Finding that the definitions of the distinctions between animals and plants fail when the attempt is made to apply them to the lower organisms, Prof. Charles S. Minot suggests, in Science: "Animals are organisms which take part of their food in the form of concrete particles, which are lodged in the cell protoplasm by the activity of the protoplasm itself. Plants are organisms which obtain all their food in either the liquid or gaseous form by osmosis (diffusion)." Immediately he finds that there are certain facts which appear to invalidate these conclusions. The myxomycetes at one stage of their lives take solid particles of food very much like the amœbæ, but no other plants are known to do so, and may not there be a connecting link? The tapeworm in the intestine does not apparently take up any solid food, but is nourished by absorption; but this is an exception induced by a parasitical life, as near relatives of the tapeworm take up solid food. The definitions are not, however, proposed as a fixed theory, but as a speculation suggesting lines of research that appear promising.

NOTES.

The economic value of fossils, says State Geologist Charles R. Keyes in his report on the Palæontology of Missouri, is commonly entirely overlooked. To the laity usually these remains of life are merely curious; to the specialist the interest in the ancient organisms is largely scientific. But with him who wills it even a slight acquaintance with the true character of fossils enables the rocks to be read as a printed page. It is one of the best established facts in modern geological science that an intimate relation exists between mineral deposits and the surrounding rocks; hence the geological age of the particular beds becomes an important factor in the early attempts to develop new mineral districts. This suggestion, again, rests on one of the cardinal principles of geology: that the geological succession of strata is determinable readily by the remains of life contained. Thus, in reality, fossils are labels on the rocks, telling man at a glance the age of the bed he is working, and providing him with the most reliable guides he could possibly secure to direct him to the layers most likely to contain the mineral sought.

Colgate University, with three departments leading to degrees in arts, philosophy, and science, and offering a total of one hundred and twenty-five courses of instruction, has adopted the policy of requiring the master's degree to be earned by graduate work. The old plan will cease after 1896.

The summer course in botany of the Torrey Botanical Club and the College of Pharmacy of New York was opened in the College of Pharmacy, March 27th. It is to include fourteen lectures by Dr. Smith Eli Jelliffe, given on Wednesdays, with excursions for study in the field and the collection of specimens. The lectures during May and June will be on the stem, leaves, infloresscence, and parts of the flower, general conclusions, history, and herborization. Besides the lectures, Dr. Jelliffe is giving a course of lessons on Thursday evenings in Vegetable Histology, or the microscopic anatomy of plants.

A curious instance of the formation of snow was witnessed at Agen, France, on the night of the 30th of January. A fire broke out in a sawmill when the temperature was ten degrees centigrade below the freezing point. The water thrown upon it was instantly vaporized, and, rising into the cold, dry air, was immediately condensed and fell as snow. What with bright starlight and a strong northwest wind blowing, the whirling snow above and the raging fire below, a brilliant spectacle was presented.

A severe storm in England in December last was marked by the deposition of notable quantities of salt on the trees, the ground, and various objects at considerable distances from the coast. Similar phenomena have been observed rarely before. Mr. G. Symons has shown in the Monthly Meteorological Magazine that the spray of the ocean was carried to distances of between seventy-five and one hundred miles from the sea.

At the Los Angeles Public Library, California, the copies of magazines not needed for binding are filed away, some to replace worn-out circulating copies, while others are taken apart, the illustrations are cut out, sorted, and mounted on gray Bristol board, forming collections of pictures for teaching geography, history, literature, and mythology, besides being samples of the modern school of illustrators and artists. The articles are sorted into classified groups, which are sewed together, some for school, some for library use, some for the hospitals, etc. The comic pictures and advertising pages are sent to the social settlements and to kindergartens for scrapbooks. "For all-around usefulness, attractiveness, and satisfaction," the librarian says in her report, "the magazines which are duplicated for home use are unsurpassed. There is no trouble in securing volunteers for the cutting of pictures, for collectors of material will gladly exchange work for pictures. The report of the teachers on the use of this material in the schoolroom is a general cry for more."

An experience of the observers at the meteorological station on the summit of Ben Nevis, Scotland, is cited as bearing upon the question of the value of high-level residence in the treatment of tuberculous conditions. These observers are changed every three months. While on duty at the observatory, with all the exposure to extremes of weather to which they are subjected, they are remarkably free from all kinds of ailments. This has been the case during eleven years. The subsequent residence at a lower level renders them liable to a kind of influenzal catarrh.

The great exposition to be held in Paris in 1900 is to be much like the two which have preceded it; but a new and special feature will be added. It is intended to make it a sort of a mirror of the century of which it will mark the close.

The industrial exhibitions now so common are wittily characterized by the Count Alphonse de Calonna, in the Revue des Deux Mondes, as festivals of which industry is only a pretext and amusement has become the real object. "The great capitals and even the secondary cities take turns in dancing a grand six months' saraband around a shrine in which the product of the mental and material efforts of a decade has been piled up."

The Austro-German Alpine Club includes two hundred and fourteen local sections and more than thirty-one thousand registered members. Its purpose is to improve the roads of the Alps and increase knowledge of the mountains. An exhibition of remarkable maps was given at the general meeting in August, 1894, among them a relief map of the Jungfrau group, on a scale of 1 to 100,000.

Concerning the possibilities of the molecular constitution of argon and its chemical position, Prof. Mendeléef finds that if it be monatomic, with an atomic weight of 40, as found by Lord Rayleigh and Prof. Ramsay, it has no place in the periodic system. If it be diatomic, with a molecular formula A_2, its atomic weight would be about 20, and its place would be in the eighth group of the second series, or after fluorine. If the molecule contains three atoms, the atomic weight of argon would be about 14, and it might be regarded as condensed nitrogen; and much may be said in favor of the hypothesis. If its molecule contains four or five atoms, its atomic weight would be 10 or 8, and there would be no room for it in the periodic system. If its molecule be found to contain six atoms, and its atomic weight to be 6·5, it would be placed in the first series, and probably in the fifth group. This, or the supposition that argon is condensed nitrogen, seems to Prof. Mendeléef most probable.

While the employment of anæsthetics has made only slow progress in veterinary practice, a considerable number of the English veterinary surgeons resort to them on all possible occasions, and find them of great advantage. Some operations on horses could not be attempted with any successful result without their aid. Of all animals, the horse is the one to which chloroform can be most safely administered; it is even very hard to injure him with it. Some surgeons, however, use it diluted with air. Attention is now increasingly directed to this matter. An improved apparatus to be used in connection with the administration of it has been devised by Mr. Wallis Hoare, of Cork, by the aid of which the treatment is made more convenient and even safer than before.

M. Berthelot has found that argon, under the influence of the silent electric discharge, combines with several organic compounds, and notably with benzene.

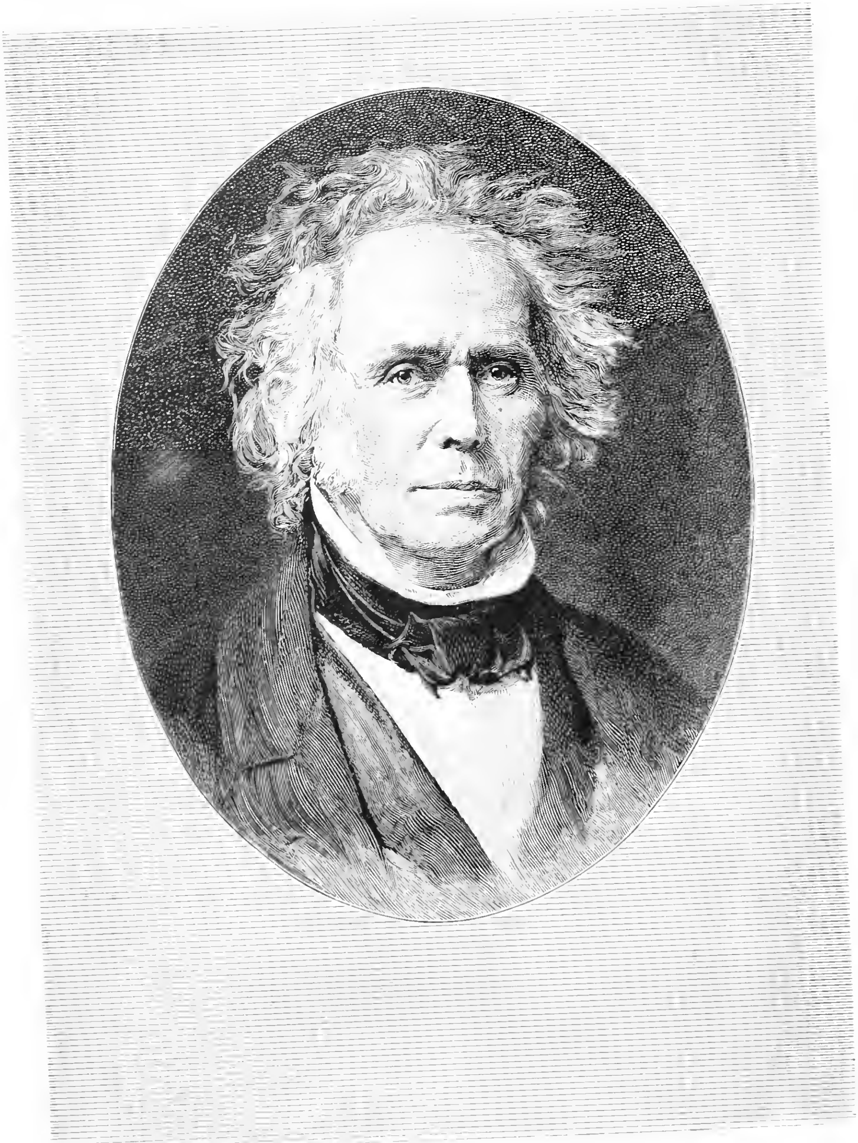
A curious report has been made to the Medico-chirurgical Society of Bristol, England, of operations performed in the Zoölogical Garden. Among them were the removal of an ingrowing nail on a lion, a Cæsarean operation on a gazelle, and gastrotomy on an ostrich which had feasted too heartily on indigestible food, having swallowed a handkerchief, pebbles, a pencil, a portfolio, and a prayer book. The unfortunate fowl died.

A society has been formed in Berlin for the purpose of preventing the extermination of the elephant in the German African possessions and of promoting the increase and usefulness of the animals.

OBITUARY NOTES.

General John Newton, a distinguished officer, Chief of Engineers of the United States Army, and an eminent engineer, best known, perhaps, from his services in clearing the channel of Hell Gate from its dangerous rocks, died at his home in this city, May 1st, after an illness of a few weeks, from chronic rheumatism. A portrait of him and a sketch of his life up to his appointment as Commissioner of Public Works of the City of New York were given in The Popular Science Monthly for October, 1886. A detailed account, with maps and illustrations, of the improvement of the East River and Hell Gate, furnished by him, was published in the Monthly for February, 1886. His appointment as Superintendent of Public Works of this city was an ideal one, of the fittest man for that highly responsible position to be found. In it he executed some of the most important works the city has undertaken, and his administration is described as having been notably able and having resulted in great public good. Since April, 1888, he had been President of the Panama Railway Company, the Panama Steamship Company, and the Columbian Steamship Line.

Dr. George A. Rex, of Philadelphia, whose sudden death was recently announced, was an earnest student of the lower orders of fungi, an authority of the highest repute on myxomycetes, an ardent microscopist, and a discoverer of many new species in his special province.



WILLIAM CRANCH BOND.

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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XX.—FROM THE DIVINE ORACLES TO THE HIGHER CRITICISM.

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II. BEGINNINGS OF SCIENTIFIC INTERPRETATION.

AT the base of the vast structure of the older scriptural interpretation were certain ideas regarding the first five books of the Old Testament. It was taken for granted that they had been dictated by the Almighty to Moses about fifteen hundred years before our era; that some parts of them, indeed, had been written by the corporeal finger of Jehovah; and that all parts gave not merely his thoughts but his exact phraseology. It was also held, virtually by the universal Church, that while every narrative or statement in these books is a precise statement of historical or scientific fact, yet that the entire text contains vast hidden meanings. Such was the rule: the exceptions made by a few interpreters here and there only confirmed it. Even the indifference of St. Jerome to the doctrine of Mosaic authorship did not prevent its ripening into a dogma.

The book of Genesis was universally held to be an account, not only divinely comprehensive but miraculously exact, of the creation and of the beginnings of life on the earth; an account to which all discoveries in every branch of science must, under pains and penalties, be made to conform. In English-speaking lands this has lasted until our own time. The most eminent living English biologist has recently told us how in every path of natural science he has, at some stage in his career, come across a barrier labeled "No thoroughfare. Moses."

A favorite subject of theological eloquence was the perfection of the Pentateuch, and especially of Genesis, not only as a record of the past, but as a revelation of the future.

The culmination of this view in the Protestant Church was the Pansophia Mosaica of Pfeiffer, a Lutheran general superintendent or bishop in northern Germany, near the beginning of the seventeenth century. He declared that the text of Genesis "must be received strictly"; that "it contains all knowledge, human and divine"; that "twenty-eight articles of the Augsburg Confession are to be found in it"; that "it is an arsenal of arguments against all sects and sorts of atheists, pagans, Jews, Turks, Tartars, Papists, Calvinists, Socinians, and Baptists"; "the source of all sciences and arts, including law, medicine, philosophy, and rhetoric"; "the source and essence of all histories and of all professions, trades, and works"; "an exhibition of all virtues and vices"; "the origin of all consolation."

This utterance resounded through Germany from pulpit to pulpit, growing in strength and volume, until a century later it was echoed back by Huet, the eminent bishop and commentator of France. He cited a hundred authors, sacred and profane, to prove that Moses wrote the Pentateuch; and not only this, but that from the Jewish lawgiver came the heathen theology—that Moses was, in fact, nearly the whole pagan pantheon rolled into one, and really the being worshiped under such names as Bacchus, Adonis, and Apollo.*

About the middle of the twelfth century came, so far as the world now knows, the first gainsayer of this general theory. Then it was that Aben Ezra, the greatest biblical scholar of the middle ages, ventured very discreetly to call attention to certain points in the Pentateuch incompatible with the belief that the whole of it had been written by Moses and handed down in its original form. His opinion was based upon the well-known texts which have turned all really eminent biblical scholars in the nineteenth century from the old view by showing the Mosaic authorship of the five books in their present form to be clearly disproved by the books themselves.

But Aben Ezra had evidently no aspirations for martyrdom; he fathered the idea upon a rabbi of a previous generation, and, having veiled his statement in an enigma, added the caution, "Let him who understands hold his tongue." †

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* For the passage from Huxley regarding Mosaic barriers to modern thought, see his Essays recently published. For Pfeiffer, see Zoeckler, Theologie und Naturwissenschaft, vol. i, pp. 688, 689. For St. Jerome's indifference as to the Mosaic authorship, see the first of the excellent Sketches of Pentateuch Criticism, by the Rev. S. J. Curtiss, in the Bibliotheca Sacra for January, 1884. For Huet, see also Curtiss, ibid.

† For the texts referred to by Aben Ezra as incompatible with the Mosaic authorship of the Pentateuch, see Meyer, Geschichte der Exegese, vol. i, pp. 85–88; and for a pithy short

For about four centuries the learned world followed the prudent rabbi's advice, and then two noted scholars, one of them a Protestant, the other a Catholic, revived his idea. The first of these, Carlstadt, insisted that the authorship of the Pentateuch was unknown and unknowable; the other, Andreas Maes, expressed his opinion in terms which would not now offend the most orthodox, that the Pentateuch had been edited by Ezra, and had received in the process sundry divinely inspired words and phrases to clear the meaning. Both these innovators were dealt with promptly. Carlstadt was, for this and other troublesome ideas, suppressed with the applause of the Protestant Church, and the book of Maes was placed by the older Church on the Index.

The new truth appeared but dimly here and there until the middle of the next century, when Hobbes, in his Leviathan, and La Peyrère, in his Preadamites, took it up and developed it still further. The result came speedily. Hobbes, for this and other sins, was put under the ban, even by the political party which sorely needed him, and was regarded generally as an outcast; while La Peyrère, for this and other heresies, was thrown into prison by the Grand Vicar of Mechlin, and kept there until he fully retracted; his book was refuted by seven theologians within a year after its appearance, and within a generation thirty-six elaborate answers to it had appeared. The Parliament of Paris ordered it to be burned by the hangman.

In 1670 came an utterance vastly more important, by a man far greater than any of these—the Tractatus Theologico-Politicus of Spinoza. Reverently but firmly he went much more deeply into the subject. Suggesting new arguments and recasting the old, he summed up all with judicial fairness, and showed that Moses could not have been the author of the Pentateuch in the form then existing; that there had been glosses and revisions; that the biblical books had grown up as a literature; that, though great truths are to be found in them, and they are to be regarded as a divine revelation, the old claims of inerrancy for them can not be maintained; that in studying them men had been misled by mistaking human conceptions for divine meanings; that, while prophets have been inspired, the prophetic faculty has not been the dowry of the Jewish people alone; that to look for exact knowledge of natural and spiritual phenomena in the sacred books is an utter mistake; and that the narratives of the Old and New Testaments,

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account, Moore's introduction to the Genesis of Genesis, by B. W. Bacon, Hartford, 1893, p. 23; also Curtiss, as above. For a full exhibition of the absolute incompatibility of these texts with the Mosaic authorship, etc., see The Higher Criticism of the Pentateuch, by C. A. Briggs, D. D., New York, 1893, especially chapter iv.

while they surpass those of profane history, differ among themselves not only in literary merit, but in the value of the doctrines they inculcate. As to the authorship of the Pentateuch, he arrived at the conclusion that it was written long after Moses, but that Moses may have written some books from which it was compiled—as, for example, those which are mentioned in the Scriptures, the Book of the Wars of God, the Book of the Covenant, and the like—and that the many repetitions and contradictions in the various books show a lack of careful editing as well as a variety of original sources. Spinoza then went on to throw light into some other books of the Old and New Testaments, and added two general statements which have proved exceedingly serviceable; for they contain the germs of all modern broad churchmanship, and the first of them gave the formula which was destined in our own time to save to the Anglican Church a large number of her noblest sons. This was that "sacred Scripture *contains* the Word of God, and in so far as it contains it is incorruptible"; the second was that "error in speculative doctrine is not impious."

Though published in various editions, the book seemed to produce little effect upon the world at that time, but its result to Spinoza himself was none the less serious. Though one of the most religious of men—his theory of the universe led Novalis to speak of him as "a God-intoxicated man," and Schleiermacher to call him a "saint"—he was, for this work, and for the earlier expression of some of the opinions it contained, abhorred as a heretic both by Jews and Christians: from the synagogue he was cut off by a public curse, and in the Church he was regarded as in some sort a forerunner of Antichrist. For all this, he showed no resentment, but devoted himself quietly to his studies, and to the simple manual labor by which he supported himself, declined all proffered honors—among them a professorship at Heidelberg—found pleasure only in the society of a few friends as gentle and affectionate as himself, and died contentedly without seeing any widespread effect of his doctrine, other than the prevailing abhorrence of himself. Down to a very recent period hatred for him has continued. When, about 1880, it was proposed to erect a monument to him at Amsterdam, discourses were given in churches and synagogues prophesying the wrath of Heaven upon the city for such a profanation; and, when the monument was finished, the police were obliged to exert themselves to prevent injury to the statue and to the eminent scholars who unveiled it.

But the ideas of Spinoza at last secured recognition. They had sunk deeply into the hearts and minds of various leaders of thought, and, most important of all, into the heart and mind of Lessing; he brought them to bear in his treatise on the Education of the World, as well as in his drama, Nathan the Wise, and both these works have spoken with power to every generation since.

In France, also, came the same healthful evolution of thought. For generations scholars here and there had known that multitudes of errors had crept into the sacred text. Robert Stephens had found over two thousand variations in the oldest manuscripts of the Old Testament, and in 1633 Jean Morin, a priest of the Oratory, pointed out clearly many of the most glaring of these. Seventeen years later, in spite of the most earnest Protestant efforts to suppress his work, Cappellus gave forth his Critica Sacra, demonstrating not only that the vowel pointing of Scripture was not divinely inspired, but that the Hebrew text itself, from which the modern translations were made, is full of errors due to the carelessness, ignorance, and doctrinal zeal of early scribes, and that there had clearly been no miraculous preservation of the "original autographs" of the sacred books.

While orthodox France was under the uneasiness and alarm thus caused, appeared a Critical History of the Old Testament by Richard Simon, a priest of the Oratory. He was a thoroughly religious man, and an acute scholar, whose whole purpose was to develop truths which he believed healthful to the Church and to mankind. But he denied that Moses was the author of the Pentateuch, and exhibited the internal evidence, now so well known, that the books were composed much later by various persons, and edited later still. He also showed that other parts of the Old Testament had been compiled from older sources, and attacked the time-honored theory that Hebrew was the primitive language of mankind. The whole character of his book was such that in these days it would pass, on the whole, as conservative and orthodox; it had been approved by the censor in 1678, and printed, when the table of contents and a page of the preface were shown to Bossuet. The great bishop and theologian was instantly aroused; he pronounced the work "a mass of impieties and a bulwark of irreligion"; his biographer tells us that, although it was Holy Thursday, the bishop, in spite of the solemnity of the day, hastened at once to the Chancellor Le Tellier, secured an order to stop the publication of the book, and to burn the whole edition of it. Fortunately, a few copies were rescued, and a few years later the work found a new publisher in Holland; yet not until there had been attached to it, evidently by some Protestant divine of authority, an essay warning the reader against its dangerous doctrines. Two years later a translation was published in England.

This first work of Simon was followed by others, in which he sought, in the interest of scriptural truth, to throw a new and purer light upon our sacred literature; but Bossuet proved implacable. Although unable to suppress all of Simon's works, he was able to drive him from the Oratory, and to bring him into disrepute among the very men who ought to have been proud of him as Frenchmen and thankful to him as Christians.

But other scholars of eminence were now working in this field, and, chief among them, Le Clerc. Virtually driven out of Geneva, he took refuge at Amsterdam, and there published a series of works upon the Hebrew language, the interpretation of Scripture, and the like. In these he combated the prevalent idea that Hebrew was the primitive tongue, expressed the opinion that in the plural form of the word used in Genesis for God, "Elohim," there is a trace of Chaldean polytheism, and, in his discussion on the serpent who tempted Eve, curiously anticipated modern geological and zoölogical ideas by quietly confessing his inability to see how depriving the serpent of feet and compelling him to go on his belly could be punishment—since all this was natural to the animal. He also ventured semi-scientific explanations of the confusion of tongues at Babel, the destruction of Sodom, the conversion of Lot's wife into a pillar of salt, and the dividing of the Red Sea. As to the Pentateuch in general, he completely rejected the idea that it was written by Moses. But his most permanent gift to the thinking world was his answer to those who insisted upon the reference by Christ and his apostles to Moses as the author of the Pentateuch. This answer became a formula which has proved effective from his day to ours: "Our Lord and his apostles did not come into this world to teach criticism to the Jews, and hence spoke according to the common opinion."

Against all these scholars came a theological storm, but it raged most pitilessly against Le Clerc. Such renowned theologians as Carpzov in Germany, Witsius in Holland, and Huet in France berated him unmercifully and overwhelmed him with assertions which still fill us with wonder. That of Huet, attributing the origin of pagan as well as Christian theology to Moses, we have already seen; but Carpzov showed that Protestantism could not be outdone by Catholicism when he declared in the face of all modern knowledge that not only the matter, but the exact form and words of the Bible, had been divinely transmitted to the modern world free from all error.

At this Le Clerc stood aghast, and finally stammered out a sort of half recantation.*

For Carlstadt, and Luther's dealings with him on various accounts, see Meyer, Geschichte der Exegese, vol. ii, pp. 373 and 397. As to the value of Maes's work in general, see Meyer, ii, 125; and, as to the sort of work in question, ibid., iii, 245, note. For Carlstadt, see also Farrar, History of Interpretation, and Moore's introduction as above. For Hobbes's view that the Pentateuch was written long after Moses' day, see the Leviathan, iii, 33.

During the eighteenth century constant additions were made to the enormous structure of orthodox scriptural interpretation, some of them gaining the applause of the Christian world then, though nearly all are utterly discredited now. But in 1753 appeared two contributions of permanent influence, though differing vastly in value. In the comparative estimate of these two works the world has seen a remarkable reversal of public opinion.

The first of these was Bishop Lowth's Prelections upon the Sacred Poetry of the Hebrews. In this was well brought out that characteristic of Hebrew poetry to which it owes so much of its peculiar charm—its parallelism.

The second of these books was Astruc's Conjectures on the Original Memoirs which Moses used in composing the Book of Genesis. In this was for the first time clearly revealed the fact that, amid various fragments of old writings, at least two main narratives enter into the composition of Genesis; that in the first of these is used as an appellation of the Almighty the word "Elohim," and in the second the word "Yahveh" (Jehovah); that each narrative has grammatical and literary characteristics of its own which distinguish it from the other; that, by separating these, two clear and distinct narratives may be obtained, each consistent with itself, and that thus, and thus alone, can be explained the repetitions, discrepancies, and contradictions in Genesis which so long baffled the ingenuity of commentators, especially the two accounts of the creation, so utterly inconsistent with each other.

Interesting as was Lowth's book, this work by Astruc was, as

For La Peyrère's view, see especially his Præ-Adamitæ, lib. iv, chap. ii, also lib. ii, *passim*; also, Lecky, Rationalism in Europe, vol. i, p. 294; also interesting points in Bayle's Dictionary. For Spinoza's view, see the Tractatus Theologico-Politicus, ch. ii and iii, and for the persecution see the various biographies. Details regarding the demonstration against the unveiling of his statue were given to the present writer at the time by Berthold Auerbach, who took part in the ceremony. For Morinus and Cappellus, see Farrar as above, p. 387 and note. For Richard Simon, see his Histoire Critique de l'Ancien Testament, liv. i, chap. ii, iii, iv, v, and xiii. For his denial of the prevailing theory regarding Hebrew, see liv. i, chap. xiv. For Morinus (Morin) and his work, see the Biog. Univ. and Nouvelle Biog. Générale; also Curtiss. For Bossuet's opposition to Simon, see the Histoire de Bossuet in the Œuvres de Bossuet, Paris, 1846, tome xii, pp. 330, 331; also x, 738; also sundry attacks in various volumes. It is interesting to note that among the chief instigators of the persecution were the Port-Royalists, upon whose persecution afterward by the Jesuits so much sympathy has been lavished by the Protestant world. For Le Clerc, see especially his Pentateuchus, Prolegom., dissertat. i; also, Com. in Genes., vi–viii. For a translation of selected passages on the points noted, see Twelve Dissertations out of Monsieur Le Clerc's Genesis, done out of Latin by Mr. Brown, London, 1696; also, Le Clerc's Sentiments de Quelques Theologiens de Hollande, *passim*; also, his work on Inspiration, English translation, Boston, 1820, pp. 47–50, also 57–67. For Witsius and Carpzov, see Curtiss, as above. For some subordinate points in the earlier growth of the opinion at present dominant, see Briggs, The Higher Criticism of the Hexateuch, New York, 1893, chap. iv.

the thinking world now acknowledges, infinitely more important; it was, indeed, the most valuable single contribution ever made to biblical study. But such was not the judgment of the world *then*. While Lowth's book was covered with honor and its author promoted from the bishopric of St. David's to that of London, and even offered the primacy, Astruc and his book were covered with reproach. Though, as an orthodox Catholic, he had mainly desired to reassert the authorship of Moses against the argument of Spinoza, he received no thanks on that account. Theologians of all creeds sneered at him as a doctor of medicine who had blundered beyond his province; his fellow-Catholics in France bitterly denounced him as a heretic, and in Germany the great Protestant theologian, Michaelis, who had edited and exalted Lowth's work, poured contempt over Astruc as an ignoramus.

The case of Astruc is one of the many which show the wonderful power of the older theological reasoning to close the strongest minds against the clearest truths. The fact which he discovered is now as definitely established as any in the whole range of literature or science. It has become as clear as the day, and yet for two thousand years the minds of professional commentators, Jewish and Christian, were powerless to detect it. Not until this eminent physician applied to the subject a mind trained in making scientific distinctions was it given to the world.

It was, of course, not possible even for so eminent a scholar as Michaelis to pooh-pooh down a discovery so pregnant; and, curiously enough, it was one of Michaelis's own scholars, Eichhorn, who did the main work in bringing the new truth to bear upon the world. He, with others, developed out of it the theory that Genesis, and indeed the Pentateuch, is made up entirely of fragments of old writings, mainly disjointed. But they did far more than this. They impressed upon the thinking part of Christendom the fact that the Bible is not a book, but a literature; that the style is not supernatural and unique, but simply the Oriental style of the lands and times in which the books were written; and that they must be studied in the light of the modes of thought and statement and the literary habits generally of Oriental peoples. From Eichhorn's time the process which, by historical, philological, and textual research, brings out the truth regarding this literature has been known as "the higher criticism."

He was a deeply religious man, and the mainspring of his efforts was the desire to bring back to the Church the educated classes who had been repelled by the stiff Lutheran orthodoxy; but this only increased hostility to him. Opposition met him in Germany at every turn, and in England Lloyd, Regius Professor of Hebrew at Cambridge, who sought patronage for a translation of Eichhorn's work, was met generally with contempt and frequently with insult.

Throughout Catholic Germany it was even worse. In 1774 Isenbiehl, a priest at Mayence who had distinguished himself as a Greek and Hebrew scholar, happened to question the usual interpretation of the passage in Isaiah which refers to the virgin-born Immanuel, and showed then what every competent critic knows now—that it had reference to events looked for in older Jewish history. The censorship and faculty of theology attacked him at once and brought him before the elector. Luckily, this potentate was one of the old, easy-going prince-bishops, and contented himself with telling the priest that, though his contention was perhaps true, he "must avoid everything likely to make trouble, and remain in the old paths."

But at the elector's death, soon afterward, the theologians renewed the attack, threw Isenbiehl out of his professorship and degraded him. One insult deserves mention for its ingenuity. It was declared that he, the successful and brilliant professor, showed by the obnoxious interpretation that he had not yet rightly learned the Scriptures; he was, therefore, sent back to the benches of the theological school, and made to take his seat among the ingenuous youth who were receiving the rudiments of theology.

At this he made a new statement so carefully guarded that it disarmed many of his enemies, and his high scholarship soon won for him a new professorship of Greek; the condition being attached to it that he should cease writing upon Scripture. But a crafty bookseller having republished his former book, and having protected himself by keeping the place and date of publication secret, a new storm fell upon the author; he was again removed from his professorship and thrown into prison; his book was forbidden, and all copies of it in that part of Germany were confiscated.

In 1778, having escaped from prison, he sought refuge with another of the minor rulers, who, in blissful unconsciousness, were doing their worst, while awaiting the French Revolution, but was at once delivered up to the Mayence authorities and again thrown into prison.

The Pope, Pius VI, now intervened with a brief on Isenbiehl's book, declaring it "horrible, false, perverse, destructive, tainted with heresy," and excommunicating all who should read it. At this, Isenbiehl, declaring that he had written it in the hope of doing a service to the Church, recanted, and vegetated in obscurity until his death in 1818.

But despite theological faculties, prince-bishops, and even popes, the new current of thought increased in strength and volume, and into it at the end of the eighteenth century came important contributions from two sources widely separated and most dissimilar.

The first of these, which gave a stimulus not yet exhausted, was the work of Herder. By a remarkable intuition he had anticipated some of those ideas of an evolutionary process in Nature and in literature which first gained full recognition nearly three quarters of a century after him; but his greatest service in the field of biblical study was his work, at once profound and brilliant, The Spirit of Hebrew Poetry. In this field he eclipsed Bishop Lowth. Among other things of importance he showed that the Psalms were by different authors, and of different periods—the bloom of a great poetic literature. Until his time no one had so clearly done justice to their sublimity and beauty; but most striking of all was his discussion of "Solomon's Song." For over twenty centuries it had been customary to attribute to it mystical meanings. If here and there some man saw the truth, he was careful, like Aben Ezra, to speak with bated breath; or if, like Castellio, under the sway of Calvin at Geneva, he dared speak openly, he must submit to obloquy and persecution. Here, too, we have an example of the efficiency of the older biblical theology in fettering the stronger minds and in stupefying the weaker. Just as the book of Genesis had to wait over two thousand years for a physician to reveal the simplest fact regarding its structure, so the Song of Songs had to wait even longer for a poet to reveal not only its beauty but its character. Commentators had interpreted it at great length; St. Bernard had preached over eighty sermons on its first two chapters; Palestrina had set the most erotic parts of it to sacred music; Jews and Gentiles, Catholics and Protestants, from Origen to Aben Ezra, and from Luther to Bossuet, had uncovered its deep meanings, and had demonstrated it to be anything and everything save that which it really is. Among scores of these strange imaginations it was declared to represent the love of Jehovah for Israel; the love of Christ for the Church; the praises of the Blessed Virgin; the union of the soul with the body; sacred history from the Exodus to the Messiah; Church history from the Crucifixion to the Reformation; and some of the more acute Protestant divines found in it references even to the religious wars in Germany and to the Peace of Passau. In these days it seems hard to imagine how really competent reasoners could thus argue without betraying doubts, after the manner of Cicero's augurs. Herder showed "Solomon's Song" to be what the whole thinking world now knows it to be—simply an Oriental love-poem.

But his frankness brought him into trouble; he was bitterly assailed. Neither his noble character nor his genius availed him. Obliged to flee from one pastorate to another, he at last found a happy refuge at Weimar in the society of Goethe, Wieland, and Jean Paul, and thence he exercised a powerful influence in liberating human thought.

It would hardly be possible to imagine a man more different from Herder than was the other of the two who most influenced biblical interpretation at the end of the eighteenth century. This was Alexander Geddes, a Roman Catholic priest and a Scotchman. Having at an early period attracted much attention by his scholarship, and having received the very rare distinction, for a Catholic, of a doctorate from the University of Aberdeen, he began publishing in 1792 a new translation of the Old Testament, and followed this in 1800 with a volume of critical remarks. In these he supported mainly three views: first, that the Pentateuch in its present form could not have been written by Moses; secondly, that it was the work of various hands; and, thirdly, that it could not have been written before the time of David. Although there was a fringe of doubtful theories about them, these main conclusions, supported as they were by deep research and cogent reasoning, are now recognized as of great value. But such was not the orthodox opinion then. Though a man of sincere piety, who throughout his entire life remained firm in the faith of his fathers, he and his work were at once condemned; he was suspended by the Catholic authorities as a misbeliever, denounced by Protestants as an infidel, and taunted by both as "a would-be corrector of the Holy Ghost." Of course, by this taunt was meant nothing more than that he dissented from sundry ideas inherited from less enlightened times by the men who just then happened to wield ecclesiastical power. But not all the opposition to him could check the evolution of his thought.

A line of great men followed in these paths opened by Astruc and Eichhorn, and broadened by Herder and Geddes. Of these was De Wette, who, early in the nineteenth century, showed to the world how largely poetical myths and legends had entered into the formation of the Hebrew sacred books, and whose Introduction to the Old Testament gave a new impulse to fruitful thought throughout Christendom. He had, indeed, to pay a penalty for thus aiding the world in its march toward more truth; he was driven out of Germany, obliged to take refuge in a Swiss professorship; and Theodore Parker, who published an English translation of his work, was, for this and similar sins, virtually rejected by what claimed to be the most liberal of all Christian bodies in the United States.

But contributions to the new thought continued from quarters whence least was to be expected. Gesenius, by his Hebrew Grammar, and Ewald, by his historical studies, greatly advanced it.

To them and to all like them during the middle years of the nineteenth century was sturdily opposed the colossus of orthodoxy, Hengstenberg. In him were combined the haughtiness of a Prussian drill-sergeant, the zeal of a Spanish inquisitor, and the flippant brutality of an ultra-orthodox journalist. Behind him stood the gifted but erratic Frederick William IV, a man admirably fitted for the professorship of æsthetics, but whom an inscrutable fate had made King of Prussia. Both these rulers in the German Israel arrayed all possible opposition against the great scholars laboring in the new paths. But this opposition was vain; the succession of acute and honest scholars continued: Vatke, Bleek, Reuss, Graf, Hupfeld, Delitzsch, Kuenen, and others wrought on in Germany and Holland, steadily developing the new truth.

Especially to be mentioned among these is Hupfeld, who published in 1853 his treatise on The Sources of Genesis. Accepting the "Conjectures" which Astruc had published just a hundred years before, he established what has ever since been recognized by the leading biblical commentators as the main basis of work upon the Pentateuch—the fact that *three* main documents are combined in Genesis, each with its own characteristics. He, too, had to pay a price for letting more light upon the world. A determined attempt was made to punish him. Though deeply religious in his nature and aspirations, he was denounced in 1865 to the Prussian Government as guilty of irreverence; but, to the credit of his noble and true colleagues who trod in the more orthodox paths, men like Tholuck and Julius Müller, the theological faculty of the University of Halle protested against this persecuting effort, and it was brought to naught.

The demonstrations of Hupfeld gave new life to biblical scholarship in all lands, but most important among the newer contributions was that made by Reuss and Graf. The former had developed it by a sort of intuition, but in his timidity had withheld it from publication for nearly fifty years, and he only made it known when Graf's courage strengthened his own.

These men penetrated the reason for a fact which had long puzzled commentators and given rise to masses of futile debate; namely, the fact that such great men as Samuel, David, Elijah, and Isaiah, and indeed the whole Jewish people from Joshua to the exile, showed in all their utterances and actions that they were unacquainted with the Levitical system. These scholars solved the problem by demonstrating that the Law and Ceremonial Code, which the theological world up to that time had so generally believed to have been established at a vastly earlier period, were really the product of a later epoch in Jewish history. Thus was the historical evolution of Jewish institutions brought into harmony with the natural development of human thought;

ceremonial institutions carefully devised being shown to have come after the ruder beginnings of religious development instead of before them. Thus fell another main support of the older biblical theology.

To work out this new discovery and to close for a time this great line of Continental scholars came Kuenen. Starting with strong prepossessions in favor of the older thought, and even with violent utterances against some of his opponents, he was borne on by his love of truth until, in his great work, The Religion of Israel, published in 1869, he took his place as, in many respects, the leader in the upward movement. He, too, opened new paths. Recognizing the fact that the religion of Israel was, like other great world religions, a development of higher ideas out of lower, he led men to bring deeper thinking and wider research to the great problem. With ample learning and irresistible logic he also proved that the Old Testament prophecy was never supernaturally predictive, and least of all predictive of events recorded in the New Testament. Justly has one of the most eminent divines of the contemporary Anglican Church indorsed the statement of another eminent scholar that "Kuenen stood upon his watchtower, as it were the conscience of Old-Testament science"; that his work is characterized "not merely by fine scholarship, critical insight, historical sense, and a religious nature, but also by an incorruptible conscientiousness and a majestic devotion to the quest of truth."

Thus was established the science of biblical criticism. Its further development and results, especially in Great Britain and America, will be next considered.*

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* For Lowth, see the Rev. T. K. Cheyne, D. D., Professor of the Interpretation of the Holy Scripture in the University of Oxford, Founders of Old Testament Criticism, London, 1893, pp. 3, 4. For Astruc's very high character as a medical authority, see the Dictionnaire des Sciences Médicales, Paris, 1820. It is significant that at first he concealed his authorship of the Conjectures. For a brief statement see Cheyne; also, Moore's introduction to Bacon's Genesis of Genesis; but for a statement remarkably full and interesting, and based on knowledge at first hand of Astruc's very rare book, see Curtiss, as above. For Michaelis and Eichhorn, see Meyer, Geschichte der Exegese; also, Cheyne and Moore. For Isenbiehl, see Reusch in Allg. Deutsche Biographie. The texts cited against him were Isaiah, vii, 14, and Matt. i, 22, 23. For Herder, see various historians of literature and writers on exegesis. For his influence, as well as that of Lessing, see Beard's Hibbert Lectures, chap. x. For a brief comparison of Lowth's work with that of Herder, see Farrar, History of Interpretation, p. 377. For examples of interpretations of The Song of Songs, see Farrar, as above, p. 33. For Castellio (Chatillon), his anticipation of Herder's view of Solomon's Song, and his persecution by Calvin and Beza, which drove him to starvation and death, see Lecky, Rationalism, etc., vol. ii, pp. 46–48; also, Bayle's Dictionary, article Castalio; also, Montaigne's Essais, liv. i, chapit. xxxiv; and especially the new life of him by Buisson. For a remarkably frank acceptance of the consequences flowing from Herder's view of it, see Sanday, Inspiration, pp. 211–405. For Geddes, see Cheyne, as

THE BOWELS OF THE EARTH.

By ALFRED C. LANE.

WHITHER man can not go his imagination the more fondly travels. Thus a most striking difference between man and the apes lies in the vast and boundless range of man's curiosity. Curiosity indeed becomes the mother of Science, while the collection of curiosities grows into the scientific museum. It is natural, therefore, that for generations the mysterious and inaccessible north pole and the bowels of the earth have been favorite dwellings for men's fancies. Since the abodes of the dead are equally mysterious and inaccessible to the living, we are not surprised to find these regions combined, and the dead consigned either to infernal—that is, inferior—regions, or, as did the Scandinavian saga, to the frozen north. But it was reserved for the fertile genius of an American naval officer to combine with one fell swoop the solution of all these mysteries into one, by supposing that the world was hollow, and that there was no north pole, but, instead, a vast annular cavity leading into interior and Arcadian regions, auroral glimpses and flashes of whose electric lights sometimes stream beyond the portals. Unfortunately, his solution is erroneous, and it is our aim in this paper to see what light science really has from the dark regions of Proserpine, and to consider why the world can neither be hollow nor stuffed with sawdust. Our light is, of course, indirect, as the depth below the surface of the earth to which man has burrowed is very small. The deepest mines are little over four thousand feet deep; and although, when one sees the rapid strides that the science of mining is making and the unexampled speed with which in the past four or five years shafts have been sunk over four thousand feet deep to tap the rich deposits of native copper on the south shore of Lake Superior, one may soon hope to see mines over a mile deep, yet, if we say that mines will never go down over two miles below the

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above. For De Wette and contemporaries, see Meyer, Cheyne, and others, as above. For Theodore Parker, see his various biographies, *passim*. For Reuss, Graf, and Kuenen, see Cheyne, as above; and for the citations referred to, see the Rev. Dr. Driver, Regius Professor of Hebrew at Oxford, in The Academy, October 27, 1894; also, a note to Wellhausen's article Pentateuch, in the Encyclopædia Britannica. For the view of leading Christian critics on the book of Chronicles, see especially Driver, Introduction to the Literature of the Old Testament, pp. 495 *et seq.;* also Wellhausen, as above; also, Hooykaas, Oort, and Kuenen, Bible for Learners. For many of the foregoing see also the writings of Prof. W. Robertson Smith; also, Beard's Hibbert Lectures, chap. x. For Hupfeld and his discovery, see Cheyne, Founders, etc., as above, chap. vii; also, Moore's Introduction. For a justly indignant judgment of Hengstenberg and his school, see Canon Farrar's History of Interpretation, p. 417, note.

surface, we shall probably not live long enough to see our prediction proved false. The deepest mines, therefore, far from reaching the bowels of the earth, can not pierce so far in proportion as does the mosquito into the human epidermis. And yet we are not wholly without information concerning the deeper regions of the earth.

In the first place, man has succeeded in the weighing of the earth as a whole. In accordance with the law of gravity, if two balls of lead attached to elastic steel rods are placed close to each other, they must attract each other with a force increasing with their masses, but decreasing with the distance which separates them. The steel rods will be very slightly bent toward each other in consequence. But the same steel rods extended horizontally will be far more strongly bent downward, owing to the attraction of this great ball which we call the earth. If, then, we compare the size, the distance apart, and the density of the two balls, and the effect they produce, with the size of the earth, the distance of its center, and the effect it produces, we may find the average density and weight of the earth. We find that the earth weighs much more than would a ball of granite of like size, but less than a ball of iron. Its density is about halfway between the two, and it is about twice as heavy as, on the average, are the rocks at the surface.

Not only do we know the average weight and density of the earth, but we can form some idea as to how that density varies. It must, of course, increase toward the center, as the surface rocks are lighter than the average; but we can be even more precise than that. If we compare two tops of like mass which have similar conditions of support and are spinning away so as to make an equal number of turns a minute, that one will wabble least whose mass is farthest from the axis about which it turns. Therefore a top is often made in the shape of a light upright axis upon which it may turn, and this axis is connected by light spokes to a wheel in the rim of which, as far as possible from the axis, the mass is mainly collected, for we thus have the extra stability. If we have two such tops of exactly the same shape and size and weight, but the one having a wooden wheel spinning on an iron axis, the other having the iron in the rim of the wheel and the axis all wood, the latter will wabble least. Now, the earth is spinning like a top, and the axis about which she spins connects the north and south poles, and points at present nearly to the north star. But this axis wabbles also, and has not always pointed to the place to which it now points in the starry firmament. The time has been (since Egyptian monuments were built) when the pole star was other than the present one to which the lip of the Dipper points, and quite possibly our remote descendants may look to yet another star as the pole. The wabbling of the earth's axis in the heavens thus indicated is due to the attraction of the sun and the moon on the mass of the earth, and we can obtain, from its observed amount and from the forces known to be producing it, some idea as to how the mass of the earth must be distributed. Still, we can not, even with this help, be absolutely sure as to the law of the density, but we may rule out the idea of a hollow earth, and accept, as agreeing well with all the facts, the suggestion of Laplace that the condensing effect of pressure decreases as the density produced becomes greater. This increase of density with pressure is, of course, in part to be accounted for by the pressure of the outer layers of the earth on those beneath, which increases until it is something enormous, and, of course, tends to squeeze together the interior and thus render it more dense.

There are, nevertheless, limits to this squeezing effect; and there is another thing that we know about the earth's interior—namely, that it is hot. Hence, as the effect of heat is to expand, the increase of heat would tend to counteract the condensing effect of the increase of pressure. That the earth is really hotter within, and that thus the literally infernal regions are actually hot whatever may be said of the metaphorical inferno, is shown by various lines of reasoning.

In the first place, the astronomers tell us (although they are not quite so sure now that the earth may not be a lump of coagulated meteorites) that this world has cooled from a fluid mass. If so, of course it must be hotter inside. Further, although we have pierced but so little a way into the earth, yet everywhere we meet an increasing temperature. The rate of increase varies very much, however. In the deep copper mines of Lake Superior, for example, at a depth of three thousand feet the temperature has risen from a surface temperature of 40° F. only up to about 70° F., which is still quite a comfortable working temperature. This gives an increase of only one degree Fahrenheit per hundred feet. Beneath the peninsula of Lower Michigan there are brines and sheets of mineral water lying in basin form, and very rich in salt, bromides, etc., and of great medical and commercial value. They have been reached by numerous wells which run down to about three thousand feet near the center of the basin, as at Alma and Bay City. The water comes up from the bottom of these wells hot (over 90°), showing a decidedly more rapid increase in temperature than in the copper mines. But the famous Comstock lode, where fabulous wealth lured the miners on, showed perhaps the most rapid increase in temperature that man has ever dared to face. It was, however, doubtless due to the action of hot waters rising from still greater depths—probably the same waters that deposited the silver ores, still at work. In the mines of this region the miners, naked as savages, reeking with perspiration, drinking pailful after pailful of ice water (twenty tons of ice, or, in another case, ninety-five pounds per man, were used each day), could labor but ten minutes at the drift (in imminent danger of being scalded by striking a stream of hot water) before being overcome by the heat and reeling to a cooler place. Fainting, delirium, even death have been the effect of the reaction on coming to the surface. Verily the Cuban proverb, that a Yankee would be found to go after a sack of coffee though it were at the gates of hell, was not far from the literal truth.

However the rate of increase of temperature may vary, all indications thus agree that less than ten miles below us a red heat is attained and within twenty a white heat. Think of it! Ten miles below us it is red hot. Ten miles above we have the pitiless cold, far below zero, of interplanetary space. To what a narrow zone of delicately balanced temperature is life confined!

From the deeper zones of higher temperatures we have samples furnished us by the volcanoes, opened along great cracks in the earth, whence red or white hot foaming lava rises. They confirm our idea of the downward increasing heat of the earth. These outpourings of molten matter from volcanoes give us some idea also of the composition of the earth. To the path of investigation thus opened we shall return in a moment. They have also given rise to the very prevalent notion that the earth's surface is but a solid crust over a fluid interior of the consistence of lava. Observers on the Hawaiian Islands have even thought they could hear the dashing of the lava waves beneath. But it is not hard to see that the phenomena of volcanoes are far more complex than the mere welling up of a fluid interior. The lava is often more heavy than the crust, and it often stands at different heights in neighboring vents. Moreover, contemporaneous, not far distant vents sometimes furnish quite different material. This could hardly be possible if all volcanoes had a common source. The really essential and important part of a volcanic eruption is the escape of gases, which are or soon become largely steam. This forms the clouds which overhang a volcano, and descends in time of violent eruptions in torrential rains, such as buried Pompeii in mud. Hence, some have supposed that a volcanic eruption was due to the explosive action of sea water reaching the heated interior. But it is perhaps more probable that the gases which escape are originally contained in the lava and burst forth from the interior of the earth on their own account wherever a crack gives them a chance. According to this notion, the working of volcanoes is not unlike that of a bottle of ginger ale. All that is needed is the formation of some sort of a crack, to answer to drawing the cork, and fizz, away she goes!

Possibly the thought that we live on top of such effervescent stuff may not be comfortable, for it suggests that the whole earth will some time explode if the volcanoes allowing the gas to escape cease to act as safety valves. There are, indeed, astronomical traces of such catastrophes. Stars have suddenly burst into unwonted radiance, only to fade again almost as quickly; and the belt of asteroids around the sun, occupying as they do a place which naturally would be filled by one large planet, have been supposed to represent some disaster in the process of planet-making. Whether the course of life on this world is ended by the world suddenly exploding, or by a slow refrigeration, or whether the world finally drops into the sun, or is knocked staggering through space by some collision, makes little difference to us, however, so long as the inevitable end that none can foresee must some time come.

Something like this giving off of gas from within the earth is a curious "spitting," as it is called, of molten silver, which when melted absorbs much oxygen gas and gives it off again in cooling. Now, the spectroscope has shown us the kinship in composition of matter throughout the universe, so that stars millions of miles away are composed of the very same elements which make up our own earth and our own bodies. Thus, if we grant the possibility of the earth's exploding, we may expect to find fragments of similar explosions, in composition like that of the earth, scattered through space. And, in fact, every once in a while as we gaze into the starry heavens we see a flash and exclaim, "A shooting star!" It is in reality a bit of matter that has come into collision with our atmosphere at such a tremendous velocity that when so struck even the air resists almost like granite. Indeed, sometimes the shock of collisions dissolves these shooting stars into vapor or dust, but at other times they explode, and the fragments reach the earth, and are picked up. Such fragments are commonly known as meteorites, and we examine them with extreme interest to see if they can throw any light on the average composition of the earth. I think we find that they do, for they are closely allied in composition to some of the series of rocks in the earth's crust that have arisen from beneath and are associated with volcanic activity—the igneous rocks as they are called. In general the meteorites are much heavier than the average surface rocks, and their average weight is much nearer that of the whole earth. The heaviest meteorites are composed mainly of iron—native iron—not quite pure, but associated with some nickel and sulphur and also diamond. This last-named interesting component of meteorites was for years overlooked, but Foote's discovery of some sizable lumps of black diamond in the Cañon Diablo meteorite led Mr. Huntington to investigate further in the very extensive collection belonging to Harvard University, and he found, on dissolving sample chips as thoroughly as possible, that a powder remained whose resistance to corrosives and invincible hardness are signs manual of the sovereign of stones. We find, too, in these iron meteorites gases absorbed, such as those at whose door we have laid the responsibility for the production of volcanic eruptions.

Since the weight of our earth and the evidence of sample fragments of planetary matter point to its being mainly iron—if we may not only say that this is an iron age but also an iron world—is it any wonder that iron is so widely distributed, or that it is the universal pigment, even dyeing the blood of our veins? But there is further evidence on these lines at which we have as yet but hinted. We said that meteorites were connected in composition with terrestrial rocks. It is in fact true that native iron similar in structure to that of meteorites is found in some basaltic dikes in Greenland as large masses, and in microscopic quantities elsewhere, and it seems almost certain that it has been torn from the depths of the earth. The rock in which the diamonds occur in the Kimberly mine (and everywhere else where they occur originally, and not in sand and gravel, they are in similar connection) is very rich in iron, is composed of minerals common in meteorites, but is devoid of quartz and feldspar, the commonest minerals of the upper crust. Practically, all the minerals of the meteorites occur native in the earth's crust, but only sparingly, except in connection with rocks that have risen through fissures from beneath. They do not occur in connection with all these rocks, but only in connection with rocks like the Kimberly rock, which are darker and heavier and less siliceous. There are a number of reasons for supposing that these darker and heavier igneous rocks, containing more iron and less silica, have a deeper source than those composed mainly of quartz and feldspar, but we will mention only one. Our earth is wrapped with an atmosphere of oxygen, an element exceedingly ready to enter into combination —so much so that in all our ordinary surface rocks all the other elements are combined with oxygen as much as can be. Now iron, as is well known, has the power of combining with oxygen either in the proportion of three of oxygen to two of iron or in even proportions. The former compounds which have more oxygen are those found in ordinary rust, and are much more readily formed, being the so-called ferric compounds. They are often yellow or red in color. The other compounds containing less oxygen—the so-called ferrous compounds—very readily absorb more oxygen. In fact, their readiness to do so under the influence of light is at the basis of many photographic processes, notably those of making blue prints and tintypes. Now, of course, in the meteorites containing native iron, not all of the iron is oxidized, and the iron is contained in its less oxidized condition in the other associated minerals, such as the yellowish-green mineral known as chrysolite, sometimes used for a gem. In

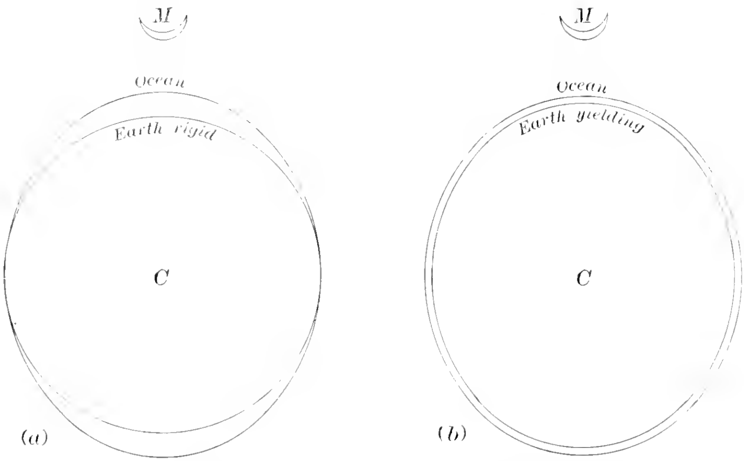

Fig. 1.—Much-exaggerated Sections of the Earth through the Equator—illustrating (a) the tidal effect on a rigid earth with a fluid envelope, (b) on a yielding earth.

general, also (there are exceptions), the rocks which contain less silica and more iron have their iron less oxidized. By analogy, as we go from the oxidizing effect of the atmosphere toward the center of the earth, we may expect finally to encounter rocks not oxidized even in the less degree. To sum the argument up in a nutshell, we find among the rocks furnished us by volcanic and igneous agencies from various depths in the earth a series from quartzose and feldspathic rocks to those with less quartz and feldspar, more iron, less oxygen, and greater weight, in which the presence of a trace of nickel and the occasional occurrence of diamonds and native iron betoken a kinship to the meteorites. The latter in every way continue this series toward a goal which is nearly pure iron, and the weight of the earth as a whole is consistent with this idea that it is largely iron, almost purely so at the center, but gradually, perhaps not perfectly uniformly, growing more quartzose toward the crust.

One question still remains to us: In what condition is the interior of the earth? Is it a molten fluid or what? If we look at the downward increase in temperature alone it would seem as if within thirty miles a heat would be reached where even pure iron, which is much less fusible than cast iron containing carbon, would be quite fluid. If the earth were freely fluid, however, it would yield to the attraction of the sun and moon as the oceans now do. Some effects of this pull may indeed be seen in the distribution of earthquakes, which are more frequent at full moon than at other times, as though the strain produced by the attraction of the moon helped to produce these shocks by the cracking and giving way of the earth. But if the earth as a whole were anything like as fluid as water, it would yield as a whole and assume the same shape, bulging about as much toward the moon as the watery envelope, so that the water would not be perceptibly deeper toward the moon than elsewhere; whereas, if it were perfectly rigid, it would retain its shape unaltered, and the water about it alone would be drawn by the moon. It would be pulled up into tidal waves. These two different cases and effects are illustrated in Fig. 1. As a matter of fact, we find that the heights of the tides are nearly as great as though the earth were absolutely rigid. The earth, therefore, must be exceedingly rigid; we may say solid, so far as these tidal strains are concerned. These are, however,

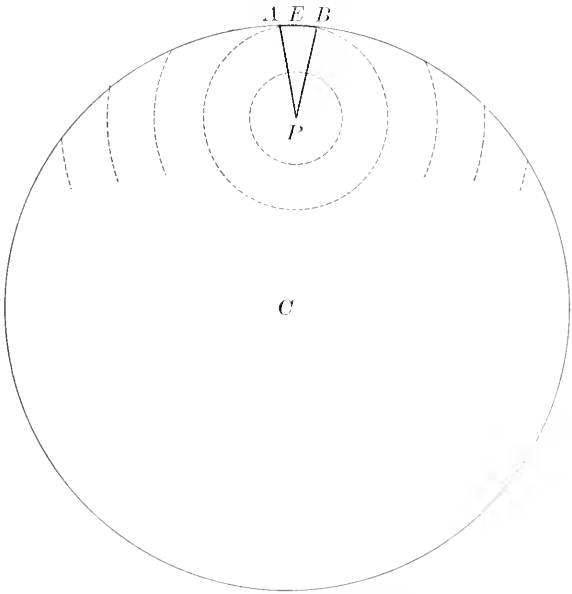

Fig. 2.—P, point of origin of earthquake shock; E (epicentrum), point on the surface directly over it; A, B, limits of the area of vertical, simultaneous, and earliest shock.

so varying in their application, shifting their direction through all the points of the compass every twenty-four hours, that if the interior of the earth is very viscous—and we know that hot iron is in just this viscous condition when at welding heat—the yielding to forces so rapidly changing direction might be no greater than that which is observed.

Another argument for the solidity of the earth is based on the fact that the mountain ranges and continents are lifted so high above the normal level. To be sure, their weight is not so very great in comparison with that of the earth, nor the distance they project above the general level. But then the breadth of the base in comparison with the height is very great, and if we compute the thrust which so broad an arch as that of the Rocky Mountain plateau, for example, must exert on its abutments, we find that the earth, if not entirely solid, must have a solid crust some hundreds of miles thick; or else possibly that the density of the mountains and the part of the crust beneath them is much lighter than the average, so that they can rise by floating on a liquid interior to their present height. There are, in fact, some indications that these plateaus, and the continents generally, really have lighter matter beneath them than the sea basins do, so that the above argument against the fluidity of the earth has not much weight. Another more important argument for the solidity of the earth may be derived from earthquakes. Sometimes these convulsions of Nature are caused merely by the jar due to a giving way or cracking in the earth's crust. Such cracks we often find in studying the rocks, where on one side of the crack the beds do not match those on the other side, but a particular bed when it comes to the crack line is not found on the other side where we should expect it to come, but some distance to the right or left. Such cracks are technically known as faults, and the displacement produced is sometimes several thousand feet. Such faults or cracks have occurred in the red sandstone area of the Connecticut River, and are well marked. Similar faults have tilted the western plateaus in great blocks. Indeed, even the very line of displacement and sudden elevation have been sometimes noticed after earthquakes, notably in New Zealand and very recently in Japan, after the earthquake described by Koto, that cost so many lives (Fig. 3).

Now, these jars known as earthquakes spread with wavelike motion and decreasing intensity from their source, like the ripples from a pebble thrown into a pond. By careful study of the time at which the jar arrives at different points and of the direction of disturbance we can form some idea of its source, just as one can tell from the ripples at what point the stone was thrown in, even though too late to see the splash. In Japan, a country much afflicted with earthquakes—although, as a friend writes me, the shocks are commonly so slight that the only attention one pays to them is to stop shaving—their study has been so far advanced that one can actually tell what path a particle describes under the influence of a given quake, and what position it occupied at any moment, and a model of such a path was exhibited at the Chicago Exposition.

Let us suppose, for example, that the shock started from the

FIG. 3.—VIEW FROM KOTO'S REPORT ON THE CAUSE OF THE GREAT EARTHQUAKE IN CENTRAL JAPAN, IN THE JOURNAL OF THE COLLEGE OF SCIENCE OF THE IMPERIAL UNIVERSITY, Vol. V. The view shows the fault to which that earthquake is attributed. The displacement caused by it is very noticeable on the road.

center of the earth. If we neglect the slight bulging of the earth at the equator, and suppose it a perfect sphere, the shock of the earthquake wave would reach every point of the earth's surface at the same time. It would tend to throw objects vertically upward. Moreover, the intensity of violence would be equal at every point. Now, we can see from the diagram (Fig. 2) that the nearer the surface the source, the smaller will be the area of practically simultaneous first arrival (A, B), the smaller will be the area of vertical shock, and the more rapidly will the intensity decrease from a point of the surface directly over the source (E).

From such considerations the depths of the sources of various earthquakes have been computed. For example, Schmidt computed that the Charleston earthquake started from a depth of no less than one hundred kilometres, say sixty miles. Unfortunately, there has been much difficulty in getting reliable facts enough for these estimates, and Dutton, who investigated the same earthquake for the United States, made it but twelve or eighteen miles deep. But whether it be one depth or the other does not affect what we wish to show—namely, that the earth is capable of cracking to a depth such that if the earth's heat increases at anything like the ratio that it does near the surface, it must there be more than white hot, and would be molten and freely fluid, except for the counteracting effect of pressure. If, then, the earth is solid at this depth, pressure has more effect than heat and keeps the earth solid. Barus has shown by experiment that for the basic rocks pressure tends to solidify. Moreover, the most basic rocks we know, those apparently from the greatest depths, contain fragments of chrysolite, etc., whose rounded and corroded outlines and often blackened edges show plainly that they have been in process of dissolving in the lava. They therefore may represent fragments of deep-seated rocks which have liquefied when pressure has been relieved by cracks and the eruption of lava following thereon.

The fact that we find the rocks in some places crumpled in folds and recrystallized has been by some taken to indicate that such rocks had been buried so deep beneath the surface as to be remelted. But recent investigations, by cutting thin sections of such rocks and studying them under the microscope, have shown that a rock may be thoroughly changed into different minerals, differently interwoven, and may be folded and contorted in most complex fashion, without for a moment being molten or ceasing to be crystalline. Recent experiments have also shown that we may account for the folds and crumplings without supposing a thin, flexible crust lying over a fluid interior; while, on the other hand, there are very numerous faults or cracks, where one part has slidden down on the other, that can hardly be accounted for except by supposing our earth solid (or very thick in crust), cooling and contracting unequally.

As to other arguments for the fluidity of the earth, we have seen that volcanic phenomena carefully studied go against the idea of one central reservoir for the lavas. It is, of course, natural to think of a cooling globe as having a solid crust and molten interior, but it is quite possible that solidification started at the center, just as even now in the nebulous stars the condensation from gaseous to liquid state proceeds from central points or nuclei.

We may say, then, in summing up, that there are no valid arguments against the conclusion to which all the facts point, that the earth is at heart an intensely hot but practically solid mass of iron.

CLIMATE AND HEALTH.*

By Dr. CHARLES FAYETTE TAYLOR.

IN the divisions of land and water, the situations of the continents, the seas, and the islands in the seas; the mountain ranges and the rivers which have their sources in them; the elevations and depressions of the more even surfaces, together with procession of the seasons and the earth's diurnal revolutions, we have some of the conditions for a great variety of climates. Proceeding from the equator toward the poles or moving along the surface of the earth in any direction, man, who seems to be the toughest animal on the face of the earth, can so adjust himself to varying climatic conditions as to exist in fairly good health almost anywhere, from the steaming equatorial jungles to the regions of perpetual ice and snow, as well as in intermediate locations where often heat and cold vary from one extreme to the other in rapid succession. And yet men live and thrive in nearly all lands and under the most diverse conditions, and with intelligent self-adjustment to their environment they may live well and live out their allotted times as a general rule. While the human race is exceedingly flexible, and can adapt itself rapidly to very diverse conditions, such adaptations, be they rapid or relatively slow, are not accomplished without an expenditure of energy to correspond with the functional modifications thus brought about. We call the process acclimatization, and the person, after subjection to the process, we say is acclimatized. That is to say, the functional activities of such a person have become adjusted to his environment; his functions have learned to harmonize with the

* Read before the New York Academy of Medicine, October 4, 1894.

temperature, food, humidity, and other influences affecting him. The effect on the individual varies according to his susceptibility and the degree and intensity of the factors acting on him. In some cases sluggish functional activities are energized with a tonic effect. But when that is the case it does not follow that the new climate is necessarily intrinsically better than the one from which he came. In other cases the effect of climate change often proves atonic, depressing, and injurious; but a bad effect on an individual does not prove that the climate is necessarily worse than the one to which he was formerly accustomed. It may happen that influences, good in themselves, may be injudiciously employed: as, if a person requiring a cooler climate, such as that of the coast of Maine, for instance, should try Labrador, and it should be more than he could bear; or, if one needed a milder climate and should find Para too depressing. Even the relatively slight difference between the European and American sides of the Atlantic often proves serious to the immigrant during the process of acclimatization, and many succumb, though it is probably true that the majority of immigrants find themselves invigorated in their new conditions of life on this side of the Atlantic.

My object is to call your attention strongly to the well-known fact that change of climate and its attendant circumstances, even when not of any extreme character or degree, does produce an impression more or less profound on the vital processes, and that the nature, degree, and general therapeutic or pathological character of these influences should be more carefully studied than they have thus far been studied, so that when consulted by our patients we may have some definite advice to give in regard to locations best suited to the inquirer's special needs; or, if we can not do so much, we ought at least to be able to give our patients some very positive ideas as to the kind of climate to seek, and especially what to avoid. For instance, California is seven hundred and seventy miles long. It embraces, according to Dr. Remondino, at least seven climates, distinctly different from each other, and all very different from the climatic conditions existing on this side of our continent. What is the sense in telling a patient with a hole at the top of his lung to "go to California" without instructing him in regard to the location to which he should go, or at least what kind of climate he should look for? Without some specific information such a patient is likely to drop into a place better calculated to shorten than to prolong his days. To be sure, all the climates of California are characterized by a dryness exceeding what is known in the east, and this fact gives some relative advantages. But unquestionably the air may be too dry in certain localities for certain cases. Is it not too much to expect a patient to find out what the doctor who sends him away from home and friends himself does not know? Besides, there are many constituent elements which enter in to make up what we call "climate." The first of these to be mentioned is usually the thermometrical readings, and the "mean" temperature is generally quoted as proof positive of superiority when it varies a few degrees one way or the other from that of another locality with which it is compared. Now, the truth is, that to know the mean temperature of a place, and to know only that, is to know very little about its climate. The physiological effects of a climate must necessarily include the degree of humidity, the force and direction of the prevailing winds, the sunshine and cloudiness; the fogs and their characteristics—whether thin or dense, high or low, whether coming down from the mountains or rolling in from the sea; besides other unmeasurable influences not seen though felt: all these and more must be appreciated in order to give the single factor of relative temperature any positive quality whatever. For instance, the mean temperature of the seven hundred and seventy miles along and near the coast of California varies but a few degrees, though the extremes vary much. But the physiological effects of the climates of different areas vary greatly. There are stiff northwest winds from off the Pacific, carrying a thin, swift-moving fog that chills an invalid to the bone, during July and August in San Francisco. To correspond to the sensations, the thermometer there lies like a cheap watch, and should be twenty degrees lower. A few miles back from the coast, with less wind and little fog, one's bodily comfort is perfect, and life is worth living, though the unlucky thermometer persists in recording nearly the same average as when you had been shivering on the coast. I conclude that the physiological influence of a given temperature below a certain degree, say below sixty, with the wind ten or fifteen miles an hour, is equal to at least ten or fifteen degrees lower in scale. On the other hand, a thermometrical showing of 90° and over is not uncomfortable if there is a gentle breeze and little humidity, but with a strong wind becomes a sirocco, when prostrations are numerous, and, if long continued, many aged and feeble die under its influence. In one of the interior valleys of California I have seen the thermometer indicate 100° to 110° F. for days and weeks together, and no one complained of the heat as excessive, while all labor of man and beast went on as usual, and prostrations are unknown. I refer to the temperature in the shade. In the sun, where men work, it must be ten or fifteen degrees higher. In New York, when summer heat approaches 90° we expect many prostrations and some deaths. I am not trying to show that 110° of heat in California with no prostrations is a better climate than New York at 90° and many prostrations, but to illustrate the principle that we must know much more about a climate than what the thermometer can tell us before we know very much about it. I kept a record of the temperature in Martinique, one of the Windward Islands lying in 14° north latitude, and it never went above 86° F., nor so high but two or three times during a residence of three seasons, and once so late as the 1st of July. But no sensible person would dare to expose himself to the mid-day sun with the same impunity that he could in this latitude and a corresponding temperature. The ever-present humidity, bordering on saturation, in the tropics is an important modifying element to be taken into account.

Again, temperature may depend on latitude or on altitude; but it is not a matter of small moment which the cause may be. Sixty degrees of heat at the level of the sea and on the seashore are very unlike in physiological effect to 60° in the dry and rarefied air of an elevated inland situation. There is no doubt that considerable moisture in the air favors the growth of minute organisms, and decomposition of matter takes place rapidly under the influence of heat and moisture. On the other hand, a dry air retards decomposition, and, if sufficiently dry, prevents it entirely, no matter how hot it may be. The Sacramento Valley is very hot in the summer, but it is also dry, so that friends of mine would kill a beef and elevate the carcass by means of rope and pulley to the top of a tall pole, let it down from time to time to cut from it, and it would keep perfectly sweet until it was all eaten up. A good illustration of conditions retarding or favoring the growth of minute organisms may be seen during the orange harvest in portions of California. The altitude of Redlands, California, averages about fifteen hundred feet above sea level. Fogs seldom reach there, the sun shines clear more than three hundred days of the year, and there is not a speck of mildew on any fruit. But go forty miles nearer the sea and seven or eight hundred feet down nearer the sea level, and at every station you will see many people washing oranges. More fogs, denser air, less sunshine, more humidity favor fungous growths. On the high table lands of the central portions of the continent, at an altitude of six or eight thousand feet, as in Wyoming, where a friend lives, milk does not "sour" or change under a week or ten days, and the carcasses of dead cattle, of which there are many, give no offensive stench, but slowly dry up and waste away, showing that comparatively few organic germs exist there, and that the conditions for their rapid propagation are unfavorable. From the facts just stated—and they are representative facts—it would be too hasty to conclude that the higher and drier locality is essentially more healthy than the lower and moister locality, even for consumptives, until we have mastered and estimated the quality and energy of the other meteorological influences. There is another fact which has come under my personal observation which must be taken into consideration. It is that life in those elevated nonmicrobian regions is not without its drawbacks. Whether it is due to the increased action of the heart in the rarefied atmosphere, the constant hammering of the nerves by the winds and the fierce sunshine, or all these and other causes, people in those regions have a thin and tired look, and it is found useful and often necessary, especially in cases of women and children, to visit lower, damper, and more germ-laden regions in order to recuperate. It is important that the air we breathe should contain as few disease germs as possible; but it is still more important that we should breathe an air and live under such climatic conditions as shall most conduce to such general bodily vigor as will resist the entrance of disease germs into the organism, or destroy them if an entrance is once effected. It is quite conceivable that a dry atmosphere containing few microbes may be too dry for an irritable mucous membrane, and set up catarrhs which may furnish nesting places for disease germs; while a moister, softer air, though holding many more microbian elements, may be more advantageous, at least in certain cases. In these latter days, in the wonderful strides which have been made and are constantly being made in bacteriology, perhaps we are in some danger of losing sight of meteorology in its relations to health and disease. It seems to me that climatology has heretofore to a large extent resolved itself into a search for some place where consumptives can not die. There is no such place. There is no place where the ever-present bacillus may not get in its deadly work. The chief question in climatology in its relation to health should be, "In what climate, or by what changes and influences of different climates, can we be best invigorated for good existence in the location where we are obliged to live the greater portion of our lives?" Many other causes besides tuberculosis men die of. Among civilized people, especially among our pushing Americans, debility, nervous exhaustion in one form or another, from overactivity of brain or body, render multitudes asthenic and vulnerable to the invasion of disease. We say that such cases need to be "toned up." This is undoubetdly true, but there are many cases in which the first step in "toning up" should properly be to tone them *down*. By that I mean that it is necessary to diminish the unnecessary expenditure of energy which has become a fixed habit of life. We all, as a rule, are too prodigal of our resources, and squander vast quantities in excess of what the occasion requires. It is amazing to see people, intelligent about ordinary things, traveling for their health at a rate that suggests that they have been shot out of a gun. Many do, of course, get a limited benefit in the change of subjects of thought, but they often mistake change of feeling due to excitement for recuperation. We need to learn how to stop. Instead of rushing across the face of the earth in the delusive hope of finding health on the other side, we need to learn how to sit down and make ourselves comfortable where we are. A man who had lived to a great age in health and contentment was asked to give some simple rule of life out of his experience. In reply, he said, "The only rule I can give is, 'Always keep comfortable.'" I feel confident that a well-selected residence in the tropics from time to time will prove helpful in acquiring habits of reposefulness. Tropical heat is not oppressive, as many who have not tried it seem to suppose. It is very different from the same temperature as indicated by the thermometer during a northern summer. One does not fret about the tropical heat as he is apt to do here, but is inclined to keep quiet, lie down and sleep a good deal during the daytime as well as profoundly all night. Wakefulness is a rarity. The relief from nervous tension and irritability is inexpressibly delightful. The increased action of the skin relieves and gives needed rest to overworked kidneys, the air passages are bathed by a moist, bland, nonirritating, warm air, no chilly draughts scourge the nerve centers into activities wasteful of energy, morbid appetites are allayed, digestion is improved in sympathy with increased skin activity, and the poor invalid begins to feel that, after all, life may be worth living. It is a delusion, born of constant assertions of the advocates of negro slavery before the war, that white people can not work in the tropics. The island of Porto Rico was originally settled by Catalonian peasants, and the major part of the farm labor has from the beginning till now—say for approaching four hundred years—been done by white men. True, negro slavery was introduced there, but of a milder type than in the other islands; and the blacks never amounted to much more than one third of the population, and they rapidly mixed with their Spanish colaborers beside whom they worked. The facts are still more startling in regard to the Spanish Main. Along the coasts of Central America the mahogany cutters, called "Indians," are mostly of mixed negro blood; and along the unhealthy shores of the Magdalena River, or wherever the sugar cane is cultivated, negro slaves were introduced, and their descendants, largely mixed with the Indian race, still remain. Even in Brazil the negroes and their descendants are confined to a few provinces, and never to exclude white labor; and in numbers the African blood constitutes but a small proportion of the ten or twelve millions in that country—certainly not enough to influence the following statement: From the southern border of the United States through Mexico, the republics of Central America, Colombia, Venezuela, Ecuador, Peru, Bolivia, Chili, Paraguay, Uruguay, the larger part of Brazil, Argentina, down to Patagonia, with the exceptions above mentioned, there is not now and there never has been any farm labor but white farm labor since the settlement of that vast continent; and the widest portion is directly under the equator. I do not include the Indians in this statement, because when wild they do not work in the sense here meant, and when brought under the influence of the Spanish and Portuguese civilization they immediately mix with and become essentially one with their white coworkers. I do not deny that there are pestilential lagoons which are more pestilential than any similar territory to be found north. But I do not believe that, shunning local conditions which would be bad anywhere, and worse in the tropics, well-selected locations are unhealthy because of tropical heat and moisture, except in certain cases. On the other hand, I believe that almost all elderly people and a large number of overworked and tired-out persons would find that tropical life costs a largely diminished outlay of energy with a corresponding husbanding of nervous and metabolic forces. In illustration of the foregoing statement I give the following facts:

The island of Dominica lies in fifteen degrees north latitude and contained twenty-nine thousand people in 1885. Dr. Nicholls, the chief medical officer of the island, whom I personally know, made a report to the managers of the Colonial Exhibition held in London in the year 1886, in which he stated that the death rate of the preceding year was fifteen and a half per thousand of the population—that is to say, the death rate in this small island, deep in the tropics, was less by ten per thousand than the average for New York city. The people are mostly blacks. Further inquiries revealed the fact that there were, at that time, three hundred and ninety-one white people—men, women, and children—and that there had been two deaths among them during the previous year: one from apoplexy and one, a nun, died from phthisis, which she had brought from England, she having come to the island in the hope of benefit to her health. In fact, there was not one death among the whites from any disease generally supposed to be especially tropical. The death rate is higher in some of the other islands, but not higher, according to the best information I could get, than in northern communities from the same classes of diseases. It should also be remembered that many of the West India Islands are in a deplorably bad sanitary condition, exposing them to be scourged from time to time by importations of yellow fever, smallpox, and such like epidemics, when, of course, the death rate is largely increased. The foregoing applies more especially to the Windward Islands, which possess some conspicuous advantages over the Greater Antilles, in that they lie in the path of the northeast trade winds, and, being small, the winds sweep over them as over the deck of a ship. There is no alternating sea breeze and land breeze, because there is not sufficient land to be heated by day to form an upward current, and to cool by night and form a downward and outward current; but there is always a gentle movement of the air toward the west, without the intervals of calms which characterize the Greater Antilles. But any of the West India Islands, no doubt, furnish many locations in good sanitary condition where the intelligent invalid may find bodily and mental repose, and let his muscles relax and take comfort, while his enfeebled skin, long constringed by cold and debilitated by clothing, is stimulated by genial warmth to doing its long-neglected duty, for a time at least, while the kidneys, heart, and lungs are given a much-needed rest.

It should be understood that I do not think all cases would be benefited by a sojourn in a tropical climate, but I feel assured that for a large number of carefully selected cases no resource of climate can be so promotive of improved metabolism as a well-selected location and suitably regulated life during several winter months in the tropics, from time to time, especially if closely followed by a change to a higher latitude or altitude and cooler locality during the following summer.

Not least among the advantages of a tropical climate for a temporary sojourn in certain cases is the change of food which is, or at least ought to be, always effected. It would be a very unwise proceeding to subsist upon a diet essentially the same as one is accustomed to at home. In the first place, there are not many of our American stomachs that do not need a rest, and one of the objects to be sought in living in a warm climate is to give the overworked stomach a chance to recuperate; not only because there is no necessity for the same amount and quality of food to be digested, but we can find in the fruits of a country food which is not only very easily digested, but which supplies nearly all the requisites for wholesome nutrition under the changed conditions. The best fruits of the tropics are very perishable—so much so that we never see them in New York. Now, I am not advocating an exclusively fruit diet; but I think when people from the north go to the tropics for "climatic therapeutics" they should make it a point to eat very sparingly of meats and even farinaceous food, and endeavor to supply Nature's wants by using largely of the fruits of the country—especially those soft, sweet, and perishable fruits which do not last more than a day or two. Thus we have, besides the influences of steady warmth and moisture, the added advantage of a change of diet, which is no small factor in modifying the metabolism which we seek.

I have spoken of the Windward Islands as being especially desirable during the three or four months of the so-called "dry season," or from December to May, and of the whole West India Islands as furnishing desirable locations for climatic rejuvenation. The West Indies are especially interesting because communication is so easy and constant and relatively cheap; they are practically at our door, and it seems to me that they should be studied more. The Spanish Main also furnishes a great variety of especially desirable locations which can be used for the same purposes; but in speaking to the question of climate in "therapeutics" my object is not to advocate any particular point, but to illustrate the general subject.

When one has become rested by a some months' sojourn in a tropical region, and, as the season advances, goes north instead of sweltering in New York or other corresponding place, it would be well to go to the seashore or to the mountains, where he would receive another form of tonic to his already partially recuperated energies. In that way we should be using the climate as an essentially "therapeutic means." *

The larger number of invalids and tired-out people will continue to go to Europe for their change, and undoubtedly that is the better course for the majority, and, when properly managed, the "therapy of climate" may be sufficiently realized in that manner in most cases. I do not include those people who travel for pleasure only, or where change of climate is the secondary object, though in many instances even those persons do reap real advantage from the considerable change in food, air, and the surrounding conditions of life. There are many advantages to Americans in visiting Europe, not the least of which is the change of interests which new and different objects for contemplation furnish, and that fill the mind without taxing it to the temporary displacement of the business, political, domestic, or other cares and anxieties which are apt to hold our American mind in a tenacious grip from sheer force of habit. With three thousand miles of ocean behind us, it is not easy to talk "shop" with the neighbor at our elbow during the ten minutes some people devote to their lunch or dinner, and we are almost obliged by prevailing custom to take a reasonable time at meals and be quiet about it. I believe that the climate of Europe is no better than ours, and in some respects not so good. I am told that life-insurance statistics—the most reliable of all—show that the life expectation is somewhat longer among American risks

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* For more detailed information in regard to the West Indian climate, I refer those interested in the subject to several articles in The Times and Register, by Dr. William F. Hutchinson, beginning in the number for September 6, 1890.

than in European; and there seems to be no evidence among athletes or race-horses that bodily vigor is not equal here, to say the least, to anything across the water. But there is a difference in meteorological conditions, and this difference may be very effectually used to invigorate and improve the metabolism in a large number of cases if we keep this object steadily in mind and manage toward the accomplishment of this end. There is not only the mental relaxation not possible here in the midst of ordinary pursuits, but the change of climatic conditions, though not so great as a change to tropical lands, is still considerable—quite enough, when properly utilized, in connection with mental and bodily rest, change of food and cooking, change of many habits, and the gentle but quite positive mental tonic of new scenes and new interests. With some important exceptions to be presently noticed, I do not think it makes very much difference where our American tired-out or half invalids go, provided they actually get rest and always keep comfortable. Of course, I do not include those thousands who are always on the rush, "doing" Europe. Among other influences there is no doubt, in my mind, of the great therapeutic value in many cases of well-regulated courses of mineral waters, when the cases and the waters are carefully selected and as carefully directed to the peculiarities of each case. Nothing could be more reprehensible, from the therapeutic point of view, than for an American family to turn itself loose in Carlsbad, for instance, and drink haphazard of these powerful waters—powerful for harm as well as for good—without the advice of a competent physician, experienced in their use and effects, as I have been told our brethren sometimes do. My experience with physicians at some half dozen European spas has been very satisfactory, and leads me to believe that the local doctors are generally capable, honest men, and that their advice ought to be generally sought and followed with confidence in the use of the waters. But we, on this side, ought to be able to give clear advice, if not as to the particular mineral spring, at least as to the general character of the waters to be sought; and especially it is always important to urge our countrymen not to overdo the matter. I am speaking more especially of that vast horde of tired-out health-seekers who annually cross the Atlantic and for whom there can be no better therapy than judicious change of climate, including mineral waters for a certain number as an added and potent alterative. Taking Carlsbad as perhaps the representative spa of the Continent, I am of the opinion that there are few middle-aged or elderly persons who are not decidedly the better for having their capillaries physicked and their emunctories cleaned out once in a while by a course of Carlsbad water sufficient for that purpose; and it is astonishing what a small quantity of the water will sometimes do it to the extent here contemplated.

There is some danger to the novice in going into semitropical regions in being unacquainted with and unprepared for the degree of apparent cold which he is likely to find to his great surprise. And when he looks at the thermometer he is further surprised to see it so high while his feelings indicate a much lower temperature. He is still more astonished to notice that the natives do not mind the cold that makes the novice shiver. The fact is that without his accustomed fire and housewarming facilities, and subjected to air currents, the practical temperature in its physiological effects is much lower than the thermometer registers. In Spain, Italy, and in general along the Mediterranean shore, they have a semitropical climate during eight or nine months of the year, during which time the native inhabitants hold their calorifacient function in reserve, and when they reach their short and moderately cold season they have no difficulty in drawing sufficiently on their reserve heat-making power. The man from the north has no such reserve, and what he has the temperature is not sufficiently stimulating to call into full activity. He has used up his caloric in the greater cold of the north. People from the extreme south enjoy their first northern winter. I met, in Teneriffe, an intelligent captain of a whaling ship who had several times fished in the Bering Sea. He said it is customary for whalers to make up for loss of men from desertions by taking on South Sea islanders. He said they bear the cold and hardships of the north as well as New Bedford whalemen, and in proof related the following incident: One morning, when far north, he noticed on coming on deck one of his South Sea islanders entirely naked taking a bath. There was a strong wind blowing, and it was so cold that the water he dashed over him froze as it struck the deck. The man seemed to enjoy it, though he had never seen frozen water or snow before. There are good reasons why people of the north with impaired stamina should not expect to bear exposure so well as natives of semitropical regions and should make themselves, in regard to temperature, more comfortable than would be sufficient for the natives.

Northern people should be particularly careful in going to a climate with a temperature too low for comfort without a fire and too high for comfort with a fire. Even the increased sunshine is not sufficiently constant, and all rooms do not face the south. No matter what natives may say, Americans ought always to have the means for heating when occasion requires, and a southern aspect to their rooms everywhere in southern Europe, if they are at all sensitive to cold, irrespective of the thermometer, or else travel north till they come to fireplaces, stoves, ovens, or other means for artificial warmth. Inquiry into the sanitation not only of residences but of the towns should never be neglected. I suppose the climate of the southern and southeastern coast of Spain is perhaps the most genial on the Mediterranean, and equally the most dangerous for Americans to abide in on account of the lack of proper drainage and other attention to sanitation. But the same may be said of much of the coast except on portions of the Riviera, where in certain places much improvement has been and is being effected in that respect.

There are generally good reasons for many of the customs and habits of the natives of any region, and there will be found advantages in adopting many of their ideas and methods so far as practicable. Along the Riviera people flock indoors with the going down of the sun: and there is good reason for it. At Nice, I have seen the thermometer register a fall of 25° F. within an hour as the sun neared the horizon. Such sudden cooling might be dangerous to an American dyspeptic with his limited power of reaction. Going indoors reduces this difference of temperature. Right across the Gulf of Lyons, in Barcelona, Spain, in nearly the same latitude and about the same mean temperature, the habit of the people is to be out of doors in the evening, promenading, visiting theaters and *cafés*, and the ladies doing their shopping till midnight and after. They find evening the best time for many purposes because there is very little change between the temperatures day and night. My thermometer was hung in an alley which the sun never reached, and all I could make it do was to record the extreme difference of two degrees between six o'clock in the morning and two o'clock in the afternoon during a week. I was still a thermometer dupe at that time. I have since broken my thermometers, and they will never endanger my sanity any more.

But it is not always convenient or even possible for one needing the therapeutic advantages of change of climate to go to Europe, nor is such a change necessary or even desirable in many cases. There is a great deal of as good climate as the world affords in our own country; and almost any change from low to high temperature, from damp to dry, from low to high altitudes, from seashore to mountains, from regions of high cultivation to the balsamic air of primeval forests or the reverse, can be had without the fatigue and expense of long sea voyages and wide stretches of turbulent sea between the traveler and anxious friends at home. The "sunny south" offers much that is admirable both in quality and variety of climate suited to various conditions. The main idea should not be the search for the perfect climate which does nowhere exist, but the question should be, "What change is indicated for the case in hand?" The question, to be properly answered, necessarily includes a knowledge of the region in which the individual has been living. Shall an inhabitant of Virginia go south or north for the winter? Or, had he better go west, or northwest, or southwest? Shall a New-Yorker go to Florida, and, if to Florida, shall it be into the tonic Atlantic breezes of the eastern shore, or the milder and softer air of the Gulf coast? Does this person's condition and meteorological surroundings indicate a change to the rarefied air of Colorado or to the denser atmosphere of Tennessee, Michigan, or Minnesota? Ought the change to be to the moist breezes and frequent rains of Washington in the northwest or to the constant sunshine and more even temperature of southern California in the semitropical southwest? If the Pacific slope seems indicated, shall it be in the coast cool winds or the warm and calm interior valley? Or, had we not better make a new climate of our own? The bosom of great Ocean furnishes a variety of climates all its own. In former days a sea voyage was much resorted to for chronic invalids, and with decided advantages in many cases. A life at sea, if at all prolonged, has the disadvantage of leaving too many comforts behind to be recommended for any but the young and comparatively robust. It is said that three hundred miles from land the air is free from living germs. Many persons have returned from long voyages in health entirely restored.

But we need not go to sea, or go abroad, or even to the south, or to the wide west. We can make a climate of our own if we properly work for that end. It is not even necessary to rattle over ten miles of pavement in order to get a change of air. We have it right there on the veranda; we can have it fresh from the outside grand air, by opening the windows and opening them wide till all the stale air in the room is blown out and all the room is filled with ozone. We can change our food at home if we like. I know a man who almost rejuvenated himself by living on little else than fish, oysters, and clam juice for three months. We can regulate the temperature and take a sun-bath whenever the sun shines. And we can stop fretting if we are sufficiently determined to do so. Actions are but the evidence of a predetermination. Why not determine to change our climate, when there is benefit to be derived from such change?

It has always been the unsolved puzzle of my professional life that so many people insist on reaching out to a distance for much that can be had better right at hand if they would but open their hand and take it. This is especially so in regard to climate and changes of climate. Notwithstanding positive directions to the contrary, many a child in pain with joint disease has been taken out miles over rough pavements "for the air," while every jolt was agony, when the same air could be had in his bedroom, with pleasure and safety, by bundling him up and opening the windows and keeping them open. It is against the law to live in cellars, but we make cellars of our rooms by keeping them filled with impure air. I do not inveigh, as it is the fashion to do, against the temperature at which our American houses are kept; a higher temperature is a necessity of our climate; but some one has yet to secure a fortune and the blessings of mankind by devising a system which will keep our houses always filled with living, moving, fresh air, and that will oblige everybody to attend to this matter as he ought.

And here I wish to enter an earnest protest against the practice of sending patients, often far gone with consumption or other wasting disease, away from friends and the comforts of home, without knowledge of what would be best for them, in a fruitless search for health, when, in their enfeebled state, better conditions could be instituted at home where at least they could die in peace. Some, not too far gone, do recover, it is fortunately true, but many lie buried there, and more are sent east in long boxes. On my last trip east, a young girl sat in front of me, whose mother's body accompanied her, and opposite me sat a gentleman and his wife whose daughter's body was also in the baggage car. In neither of these instances had the invalids been more than a short time west. Too many such things are happening for the credit of our profession. Send patients, in time, with a definite intention in the change of climate sought, or do not send them at all.

My object has been to call attention to the many and often difficult questions involved in the therapeutics of climate in its wide and varied significance. Probably no one now lives who is capable of answering all the questions relating to "therapeutics of climate," but they will be answered some day and correctly answered; and when answered it will be found, I believe, as a general thing, that the best climate for consumptives is also the best for other persons in like general physical conditions. Twenty years after our profession more fully realizes the immense value of "climate in therapeutics"—and hundreds of capable men have been studying the subject from that point alone, and valuable material has been created to draw upon—a climato-therapy may be formulated which will give the divine art of healing a new uplifting, not less glorious than that which in our day has attended the labors of Pasteur, Koch, Lister, and others whose immortal services have so enriched the world.

MR. BALFOUR'S DIALECTICS.

BY HERBERT SPENCER.

IN early stages of progress gods, conceived as man-like in so many other respects, are conceived as man-like in their credulity: deceptions being consequently practiced upon them. Sometimes in place of a human being an animal dressed up as a human being is immolated. Among the ancient Mexicans effigies of men were subject to sacrificial ceremonies like those to which actual men had been subject. The Chinese carry the system of sham offerings very far; making paper-models of properties, utensils, and money, and burning them to propitiate the worshiped beings. And there are peoples among whom deceptions of this nature are practiced in the avowed belief that their gods are stupid. So that as the marauding Basuto expects by certain sounds to deceive the gods of the people he is robbing, so, in other cases, the semblance of an offering to a god is supposed to be mistaken by him for the reality.

What is the relevance of these facts? Well, I am reminded of them by observing how easily deluded is that many-headed god to whom in our day multitudinous sacrifices are made (especially of convictions), and before whom so much incense is burnt —the god Demos, I was about to say, but remembering the restricted meaning of the word, let me say instead the apotheosized Public, whose fiat, uttered through its delegates, is thought to be a final criterion of good and evil, right and wrong. For this modern deity is deluded with scarcely less ease than the year-god of the Chinese is supposed to be deluded by paper offerings. Similarly lacking in discrimination, it does not distinguish between a semblance and a reality; and when the process of destroying the semblance has been gone through, it shows, by demonstrations of delight, that it thinks the reality has been destroyed. A good illustration was furnished at the last meeting of the British Association by Lord Salisbury. Beginning his presidential address with the remark that he felt like "a colonel of volunteers" reviewing "an army corps at Aldershot," but shortly assuming the manner proper to a colonel of the guards reviewing the "awkward squad," he set forth what he professed to be the hypothesis of Natural Selection; and then, with an amusing simile, thrust it through, and, as it seemed to the onlooking public, let out its life-blood. Whereupon came through the press rounds of applause, and among readers much throwing up of caps and laughter at the fallacy detected: even comic verses, illustrative of the supposed absurdity, being published. Very curious was it to observe how a doctrine which Mr. Darwin had spent a life in elaborating, and which had been under examination and discussion by the whole biological world for a generation, was thought to be thus readily disposed of by a scholar's mate. Very curious, too, was it to observe the different effects produced in the world of science and in the outer world. Neither in the recent controversy between Dr. Wallace and Professor Henslow, nor in the criticisms of Mr. Bateson's late work, nor in the discussion before the Royal Society on Professor Weldon's experiments and views—all of them concerned with aspects of Natural Selection—is there the slightest sign that Lord Salisbury's attack had produced any impression whatever: a serene disregard showing that its irrelevance was tacitly recognized by all. Meanwhile the extreme improbability that there could be achieved so easy a triumph being overlooked, there was great rejoicing among those who stand by the old; even to the extent that a bishop and a dissenting minister were heard exchanging congratulations on what they supposed to be a defeat of the common enemy!

And now I have to make a remark to which the foregoing illustration is preliminary—the remark that this slaying of effigies entails on those concerned a provoking choice of alternatives. Either the attack must be noticed for the purpose of showing that the thing disproved was not the thing said, in which case time and energy, often much wanted for other purposes, must be spent; or else the attack must be passed by in silence, in which case readers assume that nothing is said because there is nothing to say—that the misstated view is the actual view, and the criticism of it fatal. For it never occurs to them that silence may result from preoccupation or from the belief that controversy is futile, or from ill-health. Once more, after many repetitions, I have myself to choose between the two evils. As the issue raised by Mr. Balfour is important, I reluctantly decide to accept his challenge.

Limitations of time and space oblige me to leave some controverted views of mine undefended; as instance certain ethical and æsthetical ones. I must content myself with saying that those who turn to my own expositions of them will carry away different impressions from those given by Mr. Balfour's burlesques. But before entering on the essential question, something may fitly be said concerning Mr. Balfour's assumptions and his methods. Let us look first at one of his assumptions.

"What remedy remains?" he asks; referring to the inadequacy of reasoning "based upon ordinary experience" to "enable us to break out of the Naturalistic prison-house." "One such remedy consists in simply setting up side by side with the creed of natural science another and supplementary set of beliefs, which may minister to needs and aspirations which science can not meet." * And then, further on, respecting a certain "patchwork scheme of belief," he says—"If and in so far as it really meets their needs I have nothing to say against it, and can hold out small hope of bettering it. It is much more satisfactory as regards its content than Naturalism." †

Is there not in these passages an indirect begging of the question? The title of Mr. Balfour's work is *The Foundations of Belief*. Belief in what? Not in any of those doctrines which he groups together under the name of Naturalism; but in the opposed doctrine, Supernaturalism—belief in a Ruling Power such as that which the current creed asserts. If the existence of such a Power is tacitly assumed by the arguments urged in proof of it, the reasoning is circular. But unless the existence of such a Power is assumed, how can it be assumed that the constitution of things is one which "ministers" to men's "needs and aspirations," or provides a theory which is "satisfactory"? In the absence of the assumption that things have been by some agency prearranged for men's benefit, there seems no reason to expect the order of the Universe to be one which provides for men's mental "needs and aspirations"; and that the truth of a theory may be judged by the degree in which it conforms to such expectation.

Tests furnished by other creeds clearly show this. If a North American Indian, confidently looking forward to a "happy hunting-ground" after death, is told that there is no such place, is the fact that the creed offered to him negatives his hopes a reason for rejecting it? When the baselessness of his belief in an unlimited supply of *houris* to be hereafter provided, is shown to a Mahommedan, may he urge that his "needs and aspirations" can not be otherwise satisfied, and that therefore his faith must be true? Or once more, if to the half-starved and over-worked Hindoo, to whom it is a consolatory thought that by placing himself under the wheel of Juggernaut's car he may forthwith ascend to heaven, there comes the demonstration that he can not thus gain happiness, is the fact that the alternative belief is not "satisfactory" a sufficient ground for adhering to his superstition? Doubtless the needs and satisfactions which Mr. Balfour has in view are of a higher order than those instanced, but that does not alter the issue. The question is whether the comforting character of a belief is an adequate reason for entertaining it; and the answer to this question is not to be determined by the quality of the comfort looked for, as high or low.

The truth is that Mr. Balfour's view, here tacitly implied, is a more refined form of that primitive view which regards things as

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* *The Foundations of Belief*, p. 186. † Ibid., p. 187.

all arranged for human benefit—the Sun to rule the day, the Moon to rule the night, animals and plants provided for food, and the seasons beneficently adjusted to men's welfare. It is the anthropocentric view. But the anthropocentric view does not appear acceptable to one who contemplates things without foregone conclusions. When he learns that millions upon millions of years passed during which the Earth was peopled only by inferior brutes, and that even now three-fifths of its surface are occupied by an ocean-basin carpeted with low creatures which live in darkness, utterly useless to man and only lately known to him; and when he learns that of the remaining two-fifths, vast Arctic and Antarctic regions, and vast desert areas, are practically uninhabitable, while immense portions of the remainder, fever-breeding and swarming with insect pests, are unfit for comfortable existence; he does not recognize much adjustment to the wants of mankind. When he discovers that the human body is the habitat of thirty different species of parasites, which inflict in many cases great tortures; or, still worse, when he thinks of the numerous kinds of microbes, some producing ever-present diseases and consequent mortality, and others producing frightful epidemics, like the plague and the black death, carrying off hundreds of thousands or millions, he sees little ground for assuming that the order of Nature is devised to suit our needs and satisfactions. The truth which the facts force upon him is not that the surrounding world has been arranged to fit the physical nature of man, but that, conversely, the physical nature of man has been molded to fit the surrounding world; and that, by implication, the Theory of Things, justified by the evidence, may not be one which satisfies men's moral needs and yields them emotional satisfactions, but, conversely, is most likely one to which they have to mold their mental wants as well as they can. The opposite assumption, tacitly made by Mr. Balfour, obviously tends to vitiate his general argument.

I have sometimes contended, half in jest, half in earnest, that, having but a given endowment of any mental faculty, its possessor can not use it largely for one purpose without partially disabling it for other purposes; and that, conversely, great economy in one direction of expenditure makes possible an excess in some other direction. It seems to me that, in his manifestations of doubt and faith, Mr. Balfour affords some support to this hypothesis. Of his extreme economy of belief here is an illustration.

After first quoting from me the sentence:—"To ask whether science is substantially true is much like asking whether the sun gives light"; he goes on:—"It is, I admit, very much like it. But then, on Mr. Spencer's principles, *does* the sun give light? After due consideration we shall have to admit, I think, that it does not." And he then proceeds to argue that the proposition is doubtful, or indeed untrue, because I hold that certain elements of it—matter, space, time and force—are, when fundamentally considered, incomprehensible. Now this, which at first sight appears to be simply a vicarious skepticism, proves, on inquiry, to be a skepticism of Mr. Balfour himself. For since, as shown on p. 284, he holds the same view that I do respecting these "ultimate scientific ideas," what he calls *my* principles are, in this region, *his* principles. So that, making the substitution, the sentence should run:—"But then, on my principles, *does* the sun give light?" The statement that the sun gives light is in his view not a certainty but the contrary.

Turn now to Mr. Balfour's converse attitude. As a result of economies of belief, like the foregoing, he is able to regard as necessary certain assumptions which seem to me to have no warrant. The following passages from p. 302 supply an example:—

> "The ordered system of phenomena asks for a cause: our knowledge of that system is inexplicable unless we assume for it a rational Author. . . .
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> "We can not, for example, form, I will not say any adequate, but even any tolerable, idea of the mode in which God is related to, and acts on, the world of phenomena. That He created it, that He sustains it, we are driven to believe. How He created it, how He sustains it, it is impossible for us to imagine."

Here, then, is implied the belief, apparently regarded as unquestionable, that while one ultimate difficulty can not be allowed to remain without solution, another may be allowed so to remain. But why, if it must continue "impossible for us to imagine" the mode of operation of the cause behind "the ordered system of phenomena," may it not continue "impossible for us to imagine" the nature of that cause? If we are obliged to assume the cause to be "a rational Author," since otherwise our knowledge of "the ordered system of phenomena is inexplicable," why must we not assume a certain mode of action by which "He created" and "sustains" "the ordered system of phenomena," since otherwise the creation and sustentation of it are inexplicable? To me it seems an indefensible belief that while for one part of the Mystery of Things we must assign an explanation, all other parts may be left without explanation. If the constitution of matter defies all attempts to understand it, if it is impossible to understand in what way feeling is connected with nervous change, if wherever we analyze our knowledge to the bottom we come down to unanalyzable components which elude the grasp of thought, what ground is there for the belief that of one part of the mystery, and that the deepest part, we must and can reach an explanation? Surely there is a strange incongruity in holding that we have here a certainty while denying to be certain that the sun gives light.

A considerable portion of *The Foundations of Belief* is occupied by a discussion of the relative claims of Reason and Authority. Certainly, in whatever other ways Mr. Balfour's argument tends to discredit Reason, it does not here discredit it by example; for in general and in detail it is in this case characterized by philosophic grasp, clear discrimination, and unusual lucidity of statement. But while agreeing with him in his estimate of the relative shares of Authority and Reason in determining our beliefs, and while holding as he does that life would be impossible if all our beliefs had to be formed by Reason without the aid of Authority, I would emphasize the fact of which he is himself conscious, that it is impossible to go completely behind Reason; for if any other ruler is raised to the throne, in part or for a time, it is by Reason that this is done. Reason can not be essentially discredited by Reason: the attempt ends in suicide. In one case only—that, namely, in which the question is between the verdicts of Reason and those of simple Perception, chiefly of objective existence—may Reason, estimating its own powers, voluntarily abdicate; since critical examination of its processes shows that it can not take even a first step toward discrediting the intuitions which yield the consciousness of external existence without tacitly positing these intuitions as data, and connoting the coexistence of subject and object by all the words it uses;* and that, consequently, all it can do in this sphere is to explain incongruities so as to harmonize these intuitions with one another and with itself. But while this limitation holds where the opposition is between mediate and immediate knowledge, it does not hold where the opposition is between two kinds of mediate knowledge—the verdicts of Reason and those of Authority. Hence, in estimating the relative claims of Reason and Authority we have to bear in mind that the supremacy of Reason is exercised in the act of choosing the Authority. How, exercising this supremacy, does it make the choice? Clearly by comparing the degrees of trustworthiness of authorities as ascertained in experience. That we do this when the authorities are individual men is undeniable. We ask how often their respective statements have been verified, and how often the guidance they have severally yielded has proved good. If, looking back, we see that the statements made by the one have habitually corresponded with facts, and that the advice given by him has been shown by the result to be wise, while many statements of the other have been disproved at the

* *Principles of Psychology*, §§ 388–412.

same time that his suggestions have been misleading or impracticable, Reason obliges us to accept the first authority rather than the second. And if we have to select one of two conflicting masses of authority of the kind Mr. Balfour so well describes as largely influencing our beliefs apart from Reason, we must determine their respective claims to our confidence in a similar way. What are the authorities between which we have to choose? Briefly characterized, Mr. Balfour's book is a plea for Supernaturalism *versus* Naturalism, and unless his section insisting on the "beneficent part" which Authority plays in the production of beliefs is without any *raison d'être*, it is clear that the aggregate of influences composing the authority which supports Religion is set against the aggregate of influences by which Rationalism, considered by him as a form of authority, is supported. The authorities which uphold Theology and Science respectively are the two in question. Let us, then, observe what happens when we test their relative values as we test the relative values of individual authorities.

From the days when Chaldean priests began to record eclipses, and after a time partially discovered the cycle they follow, and were so enabled to foresee their recurrence with approximate truth, down to our own day, astronomical knowledge has been growing ever more exact and more extensive, until now the celestial motions are so perfectly known, that a transit of Venus or an occultation of Jupiter by the moon, fulfills expectation to the minute. So is it throughout: the previsions of the chemist having reached such a stage that, foreseeing the possibility of an unknown compound which must have certain properties, he proceeds to form it, and creates a substance which has never before existed, answering to his anticipations. If from this ever-increasing verification of scientific statements and inferences we turn to the guidance Science has afforded, allied evidence everywhere surrounds us. Led by Science mankind have progressed from boomerangs to 100-ton guns, from dug-out canoes to Atlantic liners, from picture-writing on skins to morning journals printed twenty thousand per hour; and that over all the developed arts of life Science now presides scarcely needs saying.

With the Authority of Science, thus daily becoming greater, contrast now the opposed Authority. Have the propositions constituting current Theology been rendered more certain with the passage of time and the advance of knowledge, or has the contrary happened? Assyrian and Egyptian records, discovered of late years, have, indeed, served to confirm certain statements contained in the Bible; and so have tended to verify the natural part of the Hebrew story. But this yields no more reason for accepting its supernatural part than does proof that there occurred the feuds and conquests described in the Norse sagas yield reason for believing in Thor and Odin. Add to which, that if these agreements with Assyrian and Egyptian records tend to verify the Hebrew religion, then, conversely, it might be held by Assyrian and Egyptian priests, did any now exist, that such agreements, verified their religions. Apart, however, from historic statements, thus proved true, investigations, scientific and literary, have served more and more to disprove, or to make doubtful, those parts of the biblical narrative which constitute its Theology. It needs but to contrast past confidence in them with present doubts and disbeliefs, to see that statements of this class have not, like those of Science, become gradually clearer and more certain, but the reverse.* Nor is confidence increased when we ask whether its *guidance* has been successful. After nearly two thousand years of Christian teaching and discipline, how near are we to that ideal life which Christian leading was to bring us to? What must we think of the sentiment implied in the saying of a glorified prince, repeated by a popular emperor, lauding "blood and iron—a remedy which never fails." Among the peoples who socially insist on duels, what advance do we see toward the practice of forgiving injuries? Or, turning from private to public transactions, what restraint do we find upon the passion of international revenge—revenge by the great mass insisted upon as a duty. How much moralization can we trace in the contrast between the practice of savages, whose maxim in their inter-tribal feuds is—"Life for life," and the practice of Christian nations, who in their dealings with weak peoples take as their maxim—"For one life many lives." Toward the foretold state when swords shall be beaten into plowshares, how much have we progressed, now that there exist bigger armies than ever existed before. And where are the indications of increased brotherly love in the doings of Christian nations in Africa, where, like hungry dogs round a carcass, they tear out piece after piece, pausing only to snarl and snap at one another.†

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* Even while I write there comes to me, in *The Academy*, for April 27th, 1895, sufficient illustration in the following remarks, made by a learned biblical critic, the Rev. Prof. Cheyne:—"There is, indeed, no reason, since the Tell-el-Amarna discoveries, to doubt that religious myths of Babylonian origin found their way into Canaan long before the entrance of the Israelites, and were adopted by the Israelitish conquerors; but it may be reasonably held, (1) that the creation-myth in that early age was less developed than that which lies at the root of Gen. i.; (2) that some of its elements had lost much of their life by the time of Amos; (3) that renewed intercourse with Assyria and Babylonia resulted in the revival of the old myth, perhaps with new elements; and (4) that religious teachers in Judah adopted and adapted this and other myths."

† If it be complained that while emphasizing failures in guidance I have ignored successes, by omitting to name the good conduct in private life which has been fostered, I

Clearly, then, by the never-ceasing verification of its *dicta* and by the increasing efficiency and wider range of its guidance, Science is gaining a greater and greater Authority; at the same time that the Authority of Theology is being decreased by the discrediting of its statements and by its unsuccessful regulation of conduct. Hence if Reason, whenever it abdicates in favor of Authority, has to choose between the two, it is compelled to accept the Authority of Science rather than that of Theology, where they are in conflict. So far from strengthening his own position by showing how large a share Authority has, and ought to have, in determining our beliefs, it seems to me that Mr. Balfour strengthens the position of his opponents.

Not unfitly introduced by the foregoing considerations, Mr. Balfour's assault on the fundamental position held by me may now be dealt with. He supposes that he has shown it to be untenable, and is thought to have done so by others. Here are the relevant passages. After describing me as holding that "beyond what we think we know, and in closest relationship with it, lies an infinite field which we do not know, and which with our present faculties we can never know, yet which can not be ignored without making what we do know unintelligible and meaningless," he proceeds :—

"But he has failed to see whither such speculations must inevitably lead him. He has failed to see that if the certitudes of science lose themselves in depths of unfathomable mystery, it may well be that out of these same depths there should emerge the certitudes of religion; and that if the dependence of the 'knowable' upon the 'unknowable' embarrasses us not in the one case, no reason can be assigned why it should embarrass us in the other.

"Mr. Spencer, in short, has avoided the error of dividing all reality into a Perceivable which concerns us, and an Unperceivable which, if it exists at all, concerns us not. Agnosticism so understood he explicitly repudiates by his theory, if not by his practice. But he has not seen that, if this simple-minded creed be once abandoned, there is no convenient halting-place till we have swung round to a theory of things which is its precise oppo-

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reply that, though unquestionably some effect has been produced, there is reason for doubting whether the effect has been great. I have to point out once more, what I have repeatedly pointed out (*Principles of Sociology*, §§ 324, 327, 330–2, 437, 573–4; *Principles of Ethics*, §§ 128, 141, 155, 159, 191), that if we wish to see exemplified in full measure the virtues especially claimed as Christian, we must look among sundry uncivilized peoples classed as Heathens—peoples who do exercise the virtue of forgiveness, whose truthfulness is a proverb, who are absolutely honest, whose goodness is such that in one case it is described as like a romance. The distinctive trait they have in common is that they are perfectly peaceful. We find among them no Christian creed, but only Christian conduct. They do not preach to neighboring tribes an impossible altruism and then treat them with unscrupulous egoism.

site: a theory which, though it shrinks on its speculative side from no severity of critical analysis, yet on its practical side finds the source of its constructive energy in the deepest needs of man, and thus recognizes, alike in science, in ethics, in beauty, in religion, the halting expression of a reality beyond our reach, the half-seen vision of transcendent Truth." (p. 288–9.)

On these passages my first criticism is that they exemplify the process described at the outset—the spearing of an effigy which is alleged to be the reality. For when the doctrine represented as mine is compared with the doctrine which is actually mine, it becomes manifest that Mr. Balfour's spear does not touch it at all. Nowhere have I either directly or indirectly denied that out of the "depths of unfathomable mystery there *may* . . . emerge the certitudes of religion;" and it would be wholly inconsistent with my expressed views were I to deny that there may. The conclusion that by the nature of our intelligence, we are forever debarred from forming any conception of the Reality which lies behind Appearance, has the inevitable corollary that we can assign no limits to the possibilities within it. This I have not only implied, but long ago asserted. Witness the following passage:—

"Though I have argued that, in ascribing to the Unknowable Cause of things such human attributes as emotion, will, and intelligence, we are using words which, when thus applied, have no corresponding ideas; yet I have also argued that we are just as much debarred from *denying* as we are from *affirming* such attributes: since, as ultimate analysis brings us everywhere to alternative impossibilities of thought, we are shown that beyond the phenomenal order of things, our ideas of possible and impossible are irrelevant."—*Nineteenth Century*, July, 1884.

After thus showing that I am unharmed, because untouched, by Mr. Balfour's thrust, I might leave the matter without further remark. But remembering that, much more important than the personal question is the impersonal question lying behind, it seems proper that I should make a counter-attack; for, in opposition to my supposed negation, Mr. Balfour places not only an affirmation but something more than an affirmation. Against my wrongly-assumed assertion that there *may not* emerge, he does not simply put the assertion that there *may* emerge, but he unobtrusively puts the assertion that there *does* emerge. This substituted statement, which he tacitly makes, is a totally different one; and while I admit the *may* I demur to the *does*. Without pausing to ask what is the evidence that there *does*, it will suffice if I examine the proposition itself, and see whether it is a thinkable one—whether the terms in which it is expressed have real meanings, or are merely symbols having no meanings corresponding to them.

Thinking, truly so called, implies mental representation of the things and processes named; and nearly all incorrect thinking is due to imperfect representation or to non-representation. This is so with thoughts about concrete things, and still more with thoughts about abstract things. If, to an inadequately instructed person, I show a hyperbola and a parabola, and tell him that the sides of the last will obviously meet sooner than the sides of the first, he will not improbably believe my erroneous statement; and, if he does so, it will be because he fails to figure in thought the characters of the two curves. Did he mentally represent them distinctly, he would see that the sides of neither can ever meet. Or if, to such a person I say that, linear dimensions being the same, an eight-sided cube contains more matter than a six-sided cube, he may vaguely think that I am right. If he accepts my false statement, why does he do so? Simply because he has not formed true mental images of the things named. Did he imagine them, or try to imagine them, he would discover that there exists no such thing as an eight-sided cube. Turning to statements about physical phenomena, we have a vivid illustration of sham thinking in the assertion, not unfrequently made concerning some remarkable phenomenon—"Oh, it is caused by electricity:" an assertion which, in both speaker and hearers, leaves a contented feeling that they understand the matter: the truth being that none of them have the remotest idea what electricity is, and none of them have the remotest idea how electricity, did they know its nature, could produce the effect observed. What they take to be their ideas are simply pseud-ideas. And if in the field of sensible experience there is a prevalence of these pseud-ideas, still more widely do they prevail in the fields of theology and metaphysics. Examples are not far to seek.

In Mr. Balfour's proposition that out of the "depths of unfathomable mystery," there "emerge the certitudes of religion," there are two essential elements—that which emerges, and the process of emergence. The primary religious certitude, as implied by his argument, is the existence of "a rational Author" for "the ordered system of phenomena"—an existence which he thinks more certain than the existence of an "independent material world" (p. 237). If, now, the thought of "a rational Author" has emerged out of the "depths of unfathomable mystery," it must, if it is distinguishable from the mere blank form of a thought, have some definable characters; and unless Mr. Balfour considers himself, and men who have similar thoughts, to be fundamentally different from men in general, we must say that thoughts having like characters have emerged into human consciousness at large. I will not ask what happens if we contemplate all the implications, and observe the multitudinous conceptions of gods which the multitudinous races of men have entertained. It will suffice if I take the conceptions which have arisen in races that have entertained the system of religious beliefs Mr. Balfour defends. Without dwelling on the contrasts between the conceptions of God current in early Hebrew times and those current in later Hebrew times, and without dwelling on the contrasts between the highly anthropomorphic ideas which prevailed in mediæval days throughout Europe and those less anthropomorphic ones which prevail in our days, it will suffice to name, side by side, the diverse conceptions existing among ourselves at present. There is the conceived divine character which most Protestants and all Catholics imply by the belief in an eternal hell; and there is that widely different one implied in the followers of Maurice, who reject that belief. There are the views of Trinitarians and Unitarians, so definitely unlike; and there are two other widely unlike views—that of the Quakers, and that of their fellow Christians who laugh at them for believing that the Christian ideal must be conformed to. Now, if from the "depths of unfathomable mystery" the conception of "a rational Author" of "the ordered system of phenomena" has emerged into human consciousness, there arises in the first place the question—How come there to have so emerged the different conceptions which men have entertained from early days when God was said to have appeared to various persons, down to our late days when theophany is nonsense? Then, seeing that many of these conceptions are in direct antagonism, there arises the question—How are we to decide which must be rejected? And once more, if out of all of them one only has truly emerged, in what manner shall we identify it? To all which unanswerable inquiries add one more. Assuming that the conception of "a rational Author," as existing in Mr. Balfour and those who are on the same high plane of thought, is the only true one, then, if possession of this conception is to be shown, it is requisite that there should be specified some mentally-representable traits which constitute it. And if the asserted traits are unrepresentable—if being, as they must be, abstractions of human attributes existing unlocalized and multiplied by infinity, they are unthinkable—then the assertion of their existence becomes nothing but the blank form of a thought—expresses a pseud-idea.

A kindred result is reached if, not content with the word "emerges," we try to imagine a process answering to that word. The word implies some medium out of which some existence previously concealed gradually appears—at first vaguely and at last distinctly. Can Mr. Balfour say that, apart from any impressions given to him in the course of education and subsequent culture, such a representable emergence has taken place in him? If so, one implication is that his mind differs, not in elevation only, but in nature, from certain minds which have been so placed as to prevent communication of theological ideas from without; for it has been shown that among deaf-mutes who have received no religious instruction, no idea of God exists.* Hence, in the absence of proof to the contrary, we must say that that high conception of a deity which exists in the minds of Mr. Balfour and others has had an historical origin. By what steps has it been reached? Beginning with the days when, as we are told, God walked in the garden of Eden, there has been a gradual falling away of human attributes—first of all the physical structure and accompanying needs, such as those which Abraham ministered to; then the lower desires and passions which later Hebrew books imply; until through many changes—now reactions toward cruder and coarser ideas, and now advances toward more refined ones—there has been formed the present conception, in which there remain only certain highest intellectual and moral traits, possessed in a degree transcending human imagination. So that, in fact, the movement of thought by which the existing consciousness has been reached is exactly the reverse of the movement alleged by Mr. Balfour. The word "emerges" implies progress from the imperceptible, through the vague, to the distinct; whereas the actual progress has been from the distinct, through the more and more vague, to the imperceptible, or rather to the scarcely conceivable, or literally inconceivable. So that when collated with the implied change, the word "emerges" is also found to stand for a pseud-idea.

The difference between Mr. Balfour's consciousness of that which lies behind Appearance, and the consciousness of those he opposes (or, at least, of such of them as do not assume that there can be Appearance without anything which appears), is that whereas he persists in supposing himself to have thoughts when, under close examination, all the components of thoughts have vanished, they candidly admit that with the vanishing of such components all thoughts have ceased; leaving only a consciousness which can not be put into any form. Not only have they dropped those early conceptions which imply that the Power manifested in thirty millions of suns made a bargain with Abraham—not only have they ceased to believe that such inferior passions as jealousy, anger and revenge can be felt by an Energy which pervades infinity; but they have surrendered themselves to the final conclusion that not even the highest mental attributes conceivable by us, can be predicated of that Existence which fills all Space for all Time.

It is not that they *wish* to do this, but that they *must*: self-

* *Ecclesiastical Institutions*, chapter i.

deception is the alternative. There is no pleasure in the consciousness of being an infinitesimal bubble on a globe that is itself infinitesimal compared with the totality of things.

Those on whom the unpitying rush of changes inflicts sufferings which are often without remedy, find no consolation in the thought that they are at the mercy of forces which cause, indifferently, now the destruction of a sun and now the death of an animalcule. Contemplation of a Universe which is without conceivable beginning or imaginable end and without intelligible purpose yields no satisfaction. The desire to know what it all means is no less strong in the agnostic than in others, and raises sympathy with them. Failing utterly to find any interpretation himself, he feels a regretful inability to accept the interpretation they offer.

STUDIES OF CHILDHOOD.

IX.—FEAR (*continued*).

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IN my last article I gave a general account of children's fears. In this account I purposely reserved for special discussion two varieties of this fear—namely, dread of animals and of the dark. As the former certainly manifests itself before the latter, I will take it first.

It seems odd that the creatures which are to become the companions and playmates of children, and one of the chief sources of their happiness, should cause so much alarm when they first come on the scene. Yet so it is. Many children at least are at first put out by quite harmless members of the animal family. We must, however, be careful in distinguishing between mere nerve-shock and dislike, on the one hand, and genuine fear on the other. Thus a lady whom I know as a good observer tells me that, though when her boy was fifteen months old his nerves were shaken by the loud barking of a dog, he had no real fear of dogs. With this may be contrasted another case, also sent by a good observer, in which it is specially noted that the aversion to the sound of a dog's barking developed late and was a true fear.

Æsthetic dislikes, again, may easily give rise to quasi fears, though, as we all know, little children have not the horrors of their elders in this respect. The boy C—— could not understand his mother's scare at the descending caterpillar. A kind of æsthetic dislike appears to show itself sometimes toward animals of peculiar shape and color. Black animals, as sheep and cows, seem more particularly to come in for these childish antipathies.

At first it seems impossible to understand why a child in the fourteenth week should appear to shrink from cats.* This is not, so far as I can gather, a common occurrence at this age, and one would like to cross-examine the mother as to the precise way in which the child had its first introduction to the domestic pet. So far as one can speculate on the matter, one would say that such early shrinking from animals is probably due to their sudden unexpected movements, which may well disconcert the inexperienced infant accustomed to comparatively restful surroundings.

This seems borne out by another instance, also quoted by Preyer, of a girl who, in the fourth month, as also in the eleventh, was so afraid of pigeons that she could not bring herself to stroke them. The prettiness of pigeons, if not of cats, ought, one supposes, to insure the liking of children; and one has to fall back on the supposition of the first disconcerting strangeness of the moving animal world for the child's mind.

Later shrinkings from animals show more of the nature of fear. It is sometimes said that children inherit from their ancestors the fear of certain animals. Thus Darwin, observing that his boy, when taken to the zoölogical gardens at the age of two years and three months, showed fear of the big caged animals, whose form was unfamiliar to him (lions, tigers, etc.), infers that this fear is transmitted from savage ancestors whose conditions of life compelled them to shun these deadly creatures. But, as M. Compayré has well shown,† we do not need this hypothesis here. The unfamiliarity of the form, the bigness, together with the awful suggestions of the cage, would be quite enough to beget a vague sense of danger.

So far as I can ascertain, facts are strongly opposed to the theory of inherited fear of animals. Just as in the first months a child will manifest something like recoil from a pretty and perfectly innocent pigeon, so later on children manifest fear in the most unlikely directions. In The Invisible Playmate we are told of a girl who got into her first fright on seeing a sparrow drop on the grass near her, though she was not the least afraid of big things, and on first hearing the dog bark in his kennel said, with a little laugh of surprise, "Oh! coughing."‡ A parallel case is sent me by a lady friend. One day when her daughter was about four years old she found her standing, the eyes wide open and filled with tears, the arms outstretched for help, evidently transfixed with terror, while a small wood louse made its slow way

* Quoted by Preyer, *op. cit.*, p. 127. The word he uses is "*scheuen.*"

† Evolution intellectuelle et morale de l'Enfant, p. 102. ‡ See pp. 26, 27.

toward her. The next day the child was taken for the first time to the "Zoo," and the mother, anticipating trouble, held her hand. But there was no need. A "fearless spirit" in general, she released her hand at the first sight of the elephant, and galloped after the monster. If inheritance plays a principal part in the child's fear of animals, one would have expected the facts to be reversed. The elephant should have excited dread, not the harmless insect.

As this story tells us, children's shrinkings from animals have much of the caprice of grown-up people's. Not that there is anything really inexplicable in these odd directions of childish fear, any more than in the unpredictable shyings of the horse. If we knew the whole of the horse's history, and could keep a perfect register of the fluctuations of "tone" in his nervous system, we should understand all his shyings. So with the child. All the vagaries of his dislike to animals would be cleared up if we could look into the secret workings of his mind and measure the varying heights of his courage.

That some of this early disquietude at the sight of strange animals is due to the workings of the mind is seen in the behavior of Preyer's boy when at the age of twenty-seven months he was taken to see some little pigs. The boy on the first view looked earnest, and as soon as the lively little creatures began to suckle the mother he broke out into a fit of crying and turned away from the sight with all the signs of fear. It appeared afterward that what terrified the child was the idea that the pigs were biting their mother; and this gave rise in the fourth and fifth year to recurrent nocturnal fears of the biting piglets, something like C——'s nocturnal fear of the wolf.* To an imaginative child strongly predisposed to fear, anything suggestive of harm will suffice to beget a measure of trepidation. A child does not want direct experience of the power of a big animal in order to feel a vague uneasiness when near it. His own early inductions respecting the correlation of bigness and strength, aided as this commonly is by information picked up from others, will amply suffice. To this may be added that the swiftness of movement of the dog, as well as the knowledge soon gained that it can bite, is apt to make this animal especially alarming. So, too, the sudden pouncing down of a sparrow might prove upsetting as suggesting attack; and a girl of four may be quite able to imagine the unpleasantness of an invasion of her dainty person by a small creeping wood louse which, though running slowly, was running toward herself, and so to get a fit of shudders.

It is, I think, undeniable that imaginative children, especially

* See Preyer, *op. cit.*, p. 130.

when sickly and disposed to alarm, are subject to great terror at the thoughts of the animal world. Its very vastness, the large variety of its uncanny and savage-looking forms, appearing oftentimes as ugly distortions of the human face and figure—this of itself, as known from a picture book, may well generate many a vague terror. We know from folklore how the dangers of the animal world have touched the imagination of primitive races, and we need not be surprised that it should make the heart of the wee weakly child to quake. Yet the child's shrinking from animals is less strong than the impulse of companionship which bears it toward them. Nothing is prettier perhaps in child-life than the pose and look of a small boy as he is getting over his trepidation at the approach of a strange big dog and "making friends" with the shaggy monster. The perfect love which lies at the bottom of children's hearts toward their animal kinsfolk soon casts out fear; and when once the reconciliation has been effected it will take a good deal of harsh experience to make the child ever again entertain fear.

Fear of the dark—that is, fear excited by the actual experience or the idea of being in the dark, and especially alone—and the actual dread of dark places, as closets and caves, is, no doubt, very common among children, and seems indeed to be one of their commonly recognized characteristics. Yet it is by no means certain that it is "natural" in the sense of developing itself instinctively in all children.

It is generally agreed that children have no such fear at the beginning of life. A baby of three or four months, if accustomed to a light, may very likely be disturbed at being deprived of it; but this is some way from a dread of the dark.*

Fear of the dark seems to come on when intelligence has reached a certain stage of development. It apparently assumes a variety of forms. In some children it is a vague uneasiness, in others it takes the shape of a more definite dread. A common variety of this dread is connected with the imaginative filling of the dark with the forms of alarming animals, so that the fear of animals and of the dark are closely connected. Thus in one case reported to me a boy between the ages of two and six used at night to see "the eyes of lions and tigers glaring as they walked round the room." The boy C—— saw his *bête noire* the wolf in

* A mother sends me a curious observation bearing on this. One of her children when four months old was carried by her upstairs in the dark. On reaching the light she found the child's face black, her hands clinched, and her eyes protruding. As soon as the child got back to the light she heaved a sigh and resumed her usual appearance. This child was in general hardy and bold and never gave a second display of terror. This is certainly a curious observation, and it would be well to know whether similar cases of apparent fright at being carried in the dark have been noticed.

dark places. Mr. Stevens, in his note on his boy's ideas of the supernatural, remarks that when one year and ten months old he was temporarily seized with a fear of the dark at the time when he began to be haunted by the specter of "Cocky." * It is important to add that even children who have been habituated to going to bed in the dark in the first months are liable to acquire the fear.

This mode of fear is, however, not universal among children. One lady, for whose accuracy I can vouch, assures me that her boy, now four years old, has never manifested a dread of darkness. A similar statement is made by a careful observer, Dr. Sikorski, with reference to his own children. † It seems possible to go through childhood without making acquaintance with this terror, and to acquire it in later life. I know a lady who only acquired the fear toward the age of thirty. "Curiously enough," she writes, "I was never afraid of the dark as a child; but during the last two years I hate to be left alone in the dark, and if I have to enter a dark room, like my study, beyond the reach of the maids from downstairs, I notice a remarkable acceleration in my heartbeat and hurry to strike a light or rush downstairs as quickly as possible."

There is little doubt that when the fear is developed it is apt to become one of the greatest miseries of childhood. We can faintly conjecture, from what Charles Lamb and others have told us about the specters that haunted their nights, what a weighty, crushing terror this may become. Hence, we need not be surprised that the writer of fiction has sought to give it a vivid and adequate description. Victor Hugo, for example, when painting the feelings of little Cosette, who had been sent out alone at night to fetch water from a spring in the wood, says she "felt herself seized by the black enormity of Nature. It was not only terror which possessed her, it was something more terrible even than terror."

Different explanations have been offered of this fear. Locke, who, when writing on educational matters, was rather hard on nurses and servants, puts down the whole of these fears to these wicked persons, "whose usual method is to awe children and keep them in subjection by telling them of Raw Head and Bloody Bones, and such other names as carry with them the idea of something terrible and hurtful, which they have reason to be afraid of when alone, especially in the dark." ‡ Rousseau, on the other hand, urges that there is a natural cause. "Accustomed as I am to perceive objects from a distance, and to anticipate their impressions in advance, how is it possible for me, when I

* Mind, xi, p. 149. † Quoted by Compayré, *op. cit.*, p. 100.

‡ Thoughts on Education, § 138.

no longer see anything of the objects that surround me, not to imagine a thousand creatures, a thousand movements which may hurt me, and against which I am unable to protect myself ?" *

Rousseau here supplements and corrects Locke. For one thing, I have ascertained in the case of my own child, and in that of others, that a fear of the dark has grown up when the influence of the wicked nurse has been carefully eliminated. Locke forgets that children can get terrifying fancies from other children and from all sorts of suggestions unwittingly conveyed by the words of respectable grown people. Besides, he leaves untouched the question why children should choose to dwell on these fearful images in the dark rather than on the bright, pretty ones which they also acquire. Mr. R. L. Stevenson has told us how happy a child can make himself at night with such pleasing fancies. Yet it must be owned that darkness seems rather to favor images of what is weird and terrible. How is this ? Rousseau gets some way toward answering the question by saying (as I understand him to say) that darkness breeds a sense of insecurity. Not that a child lying in his cot is likely to be troubled that he can not see what is at the other end of the room. I do not think that it is the inconvenience of being in the dark which generates the fear; a child might, I imagine, acquire it without ever having had to explore a dark place.

I strongly suspect that the fear of darkness takes its rise in a sensuous phenomenon, a kind of physical repugnance. All sensations of very low intensity, as very soft vocal sounds, have about them a tinge of melancholy—*tristesse*—and this is especially noticeable in the sensations which the eye experiences when confronted with a dark space, or, what is tantamount to this, a black and dull surface. The symbolism of darkness and blackness, as when we talk of "gloomy" thoughts, or liken trouble to a "black cloud," seems to rest on this effect of melancholy.

Along with this gloomy character of the sensation of dark, and not always easy to distinguish from it, there goes the craving of the eye for its customary light, and all the interest and gladness which come from seeing. When the eye and brain are not fatigued—that is, when we are wakeful—this eyeache may become an appreciable pain; and it is probable that children feel the deprivation more acutely than grown persons, owing to the abundance of their visual activity as well as to the comparatively scanty store of their thought resources. Add to this that darkness, by extinguishing the world of visible things, would give to a timid child tenacious of the familiar home surroundings a

* Émile, Book II.

peculiarly keen sense of strangeness and of loneliness, of banishment from all that it knows and loves. The reminiscences of this feeling, described in later life—as that of Mr. James Payn, in his recently published volume, Gleams of Memory—show that it is the sense of loneliness which oppresses the child in its dark room.

This, I take it, would be quite enough to make the situation of confinement in a dark room disagreeable and depressing to a wakeful child even when in bed and there is no restriction of bodily activity. But this sense of banishment through the blotting out of the familiar scene would not, I take it, amount to a full, passionate *dread* of darkness. It seems to me to be highly probable that a baby of two or three months might feel something of this vague depression and even this craving for the wonted scene, especially just after the removal of a light; yet such a baby, as we have seen, gives no clear indications of fear.

Fear of the dark arises from the development of the child's imagination, and might, I believe, arise without any suggestion from nurse or other children of the notion that there are bogies in the dark. Darkness is precisely the situation most favorable to vivid imagination; the screening of the visible world makes the inner world of fancy bright by contrast. Are we not all apt to shut our eyes when we try to "visualize" or picture things very distinctly? This fact of a preternatural activity of imagination, taken with the circumstance emphasized by Rousseau that in the darkness the child is no longer distinctly aware of the objects that are actually before him, would help us to understand why children are so much given to projecting into the unseen, dark spaces the creatures of the imagination. Not only so—and this Rousseau does not appear to have recognized—the dull feeling of depression which accompanies the sensation of darkness might suffice to give a gloomy and weird turn to the images so projected.

But I am disposed to think that there is yet another element in this childish fear. I have said that darkness gives a positive sensation: we *see* it; and the sensation, apart from any difference of signification which we afterward learn to give to it, is of the same kind that is obtained by looking at a dull, black surface. To the child the difference between a black object and dark, unillumined space is as yet not clear, and I believe it will be found that children tend to materialize, or, to use a rather technical word, "reify"—that is, make a thing of darkness. When, for example, a correspondent tells me that darkness was envisaged by her when a child as a crushing power, I think I see traces of this childish feeling. I seem able to recall my own childish sense of a big black something on suddenly waking and opening the eyes in a very dark room.

But there is still something else to be noticed in this sensation of darkness. The black field is not uniform, some parts of it showing less black than others, and the indistinct and rude pattern of comparatively light and dark changing from moment to moment, while now and again more definite spots of brightness may form themselves. The varying activity of the retina would seem to account for this apparent changing of the dark scene. What, my reader may not unnaturally ask, has this to do with a child's fear of the dark? If he will recall what was said about the facility with which a child comes to see faces and animal forms in the lines of a cracked ceiling or the veining of a piece of marble, he will, I think, recognize the drift of my remarks. These slight and momentary differences of blackness, these fleeting rudiments of a pattern, may serve as a sensuous base for the projected images: the child's excited fancy sees in these faint differentiations of the black, formless waste definite forms. These will naturally be the forms with which he is most familiar, and since his fancy is tinged with melancholy they will, of course, be gloomy and disturbing forms. Hence we may expect to hear of children seeing the forms of terrifying living things in the dark. Here is an instructive case. A boy of four years had for some time been afraid of the dark, and indulged by having the candle left burning at night. On hearing that the London Crystal Palace had been burned down he asked for the first time to have the light taken away, fear of the dark being now cast out by the bigger fear of fire. Some time after this he volunteered an account of his obsolete terrors to his father. "Do you know," he said, "what I thought dark was? A great, large, live thing, the color of black, with a mouth and eyes." Here we have the "reifying" of darkness, and we probably see the influence of the comparatively bright spots in the attribution of eyes to the monster, an influence still more apparent in the instance quoted above, where a child saw the eyes of lions and tigers glaring as they walked round the room. Another suggestive instance here is that given by M. Compayré, in which a child, on being asked why he did not like to be in a dark place, answered, "I don't like chimney-sweeps." * Here the blackness with its dim suggestions of brighter spots determined the image of the black chimney-sweep with his white flashes of mouth and eyes.† I should like to observe here paren-

* *Op. cit.*, pp. 100, 101.

† It is supposable too that disturbance of the retina giving rise to subjective luminous sensations, as the well-known small bright moving disks, might assist in the case of nervous children in suggesting glaring eyes.

thetically that we still need to learn from children themselves, by talking to them and inviting their confidence when the fear of the dark is first noticed, how they are apt to envisage it.

When imagination becomes abnormally active, and the child is haunted by alarming images, these, by recurring with greatest force in the stillness and darkness of the night, will add to the terrifying associations of darkness. This is illustrated in the case of the boy Stevens, who was haunted by the specter of "Cocky" at night. Dreams, especially the horrible nightmare to which nervous children are subject, may invest the dark with a new terror. A child suddenly waking up, and with open eyes seeing the phantom-object of its dream against the dark background, may be forgiven for acquiring a dread of dark rooms. Possibly this experience gives the clew to the observation already quoted of a boy who did not want to sleep in a particular room because there were so many dreams in it.

If the above explanation of the child's fear of the dark is correct, Rousseau's prescription for curing it is not enough. Children may be encouraged to explore dark rooms and, by touching blindlike the various objects, rendered familiar with the fact that things remain unchanged even when enveloped in darkness—that the dark is nothing but our temporary inability to see things; and this may, no doubt, be helpful in checking the fear when reflection is possible. But a radical cure must go further, must aim at checking the activity of morbid imagination—and here what Locke says about effects of the terrifying stories of nurses is very much to the point—and in extreme cases must set about strengthening shaky nerves.

I have probably illustrated children's fears at sufficient length. Without trying to exhaust the subject I have, I think, shown that fear of a well-marked and intense kind is a common feature of the first years of life, and that it assumes a Protean variety of shapes.

Much more will, no doubt, have to be done in the way of methodical observation, and more particularly statistical inquiry into the comparative frequency of the several fears, the age at which they commonly appear, and so forth, before we can build up a theory of the subject. One or two general observations may, however, be hazarded even at this stage.

The thing which strikes one most, perhaps, in these early fears is how little they have to do with any remembered experience of evil. The child is inexperienced and, if humanely treated, knows little of the acute forms of human suffering. It would seem at least as if he feared, not because experience has made him apprehensive of evil, but because he is constitutionally and instinctively nervous, and possessed with a feeling of insecurity. This feeling of weakness and insecurity comes to the surface in presence of what is unknown, in so far as this can be brought by the child's mind into a relation to his welfare—as disturbing noises and the movements of things, especially when they take on the form of an approach. The same thing is, as we have seen, illustrated in the fear of the dark. This fact, that children's fears are not the direct product of experience, is expressed otherwise by saying that they are the offspring of the imagination. They are afraid because they fancy things, and it will probably be demonstrated by statistical evidence that the most imaginative children (other things being equal) are the most subject to fear.

In certain of these characteristics, at least, children's fears resemble those of animals. In both alike fear is much more an instinctive recoil from the unknown than an apprehension of known evil. The shying of a horse, the apparent fear of dogs at certain noises, probably, too, the fear of animals at the sight and sound of fire—so graphically described by Mr. Kipling in the case of the jungle beasts—illustrate this. Animals, too, seem to have a sense of the uncanny when something apparently uncaused happens, as when Romanes excited fear in a dog by attaching a fine thread to a bone which he was accustomed to drag about with him and, by surreptitiously drawing it from him, giving to the bone the look of self-movement. The same dog was frightened by soap bubbles. According to Romanes, dogs are frightened by portraits. It is to be added, however, that in animal fears the influence of heredity is clearly recognizable, whereas in children's fears I have regarded it as doubtful.*

Another instructive comparison is that of children's fears with those of savages. Both have a like feeling of insecurity and fall instinctively in presence of a big unknown—e. g., at the first sight of the sea—into the attitude of dread. In the region of superstitious fear more particularly we see how in both a gloomy fancy forestalls knowledge, investing the new or unexplored with alarming traits.

Lastly, children's fears have some resemblance to certain abnormal mental conditions. Idiots, who are so near normal childhood in their degree of intelligence, show a marked fear of strangers. More interesting, however, in the present connection is the exaggeration of the childish fear of new objects which shows itself in certain mental aberrations. There is a characteristic dread of newness, "neophobia," just as there is a dread of water. †

While, however, these are the dominant characteristics of chil-

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* On animal fears, see Romanes, Animal Intelligence, p. 455 f.; Preyer, *op. cit.*, p. 127 ff. and p. 135; Perez, First Three Years of Childhood, p. 64 ff.

† See Compayré, *op. cit.*, pp. 99, 100.

dren's fears, they are not the only ones. Experience begins to direct the instinctive fear impulse from the very beginning. How much it does in the first months of life it is difficult to say. In the aversion of a baby to its medicine glass or its cold bath one sees perhaps more of the rude germ of passion or anger than of fear. Careful observations seem to me to be required on this point, at what definite date signs of fear arising from experience of pain begin to show themselves in the child. Some children at least have a surprising way of not minding even considerable amounts of physical pain—the misery of a fall, a blow, a cut, and so forth, being speedily forgotten. It seems doubtful, indeed, whether the venerable saw, "The burned child dreads the fire," is invariably true. In many cases apparently a good amount of real agony is necessary to produce a genuine fear in a young child.* This tendency to belittle pain is not unknown, I suspect, to the tutor of small boys. It may well be that a definite and precise recalling of the misery of a scratch or even of a moderate burn may not conduce to the development of a true fear, and that here, too, fear, when it arises in all its characteristic masterfulness, is at bottom fear of the unknown. This seems illustrated by the well-known fact that a child will often be more terrified by a first experience of pain, especially if there is a visible hurt and bleeding, than by any subsequent prospect of a renewal of the catastrophe. Is not the same thing true, indeed, of older fears? Should we dread the wrench of a tooth extraction if we experienced it often enough and had a sufficiently photographic imagination to be able to estimate precisely the intensity and duration of the pain?

Much the same thing shows itself in the cases where fear can be clearly traced to experience and association. In some of these it is, no doubt, remembered experience of suffering which causes fear. A child that has been seriously burned will dread a too close approach to a red-hot poker. But in many cases of this excitation of fear by association it is the primary experience of fear itself which is at the bottom of the apprehension. Thus a child who has been frightened by a dog will betray signs of fear at the sight of a kennel, at a picture of a dog, and so forth. The little boy referred to above, who was afraid of the toy elephant that shook its head, showed signs of fear a fortnight afterward on coming across a picture of an elephant in a picture book. In such ways does fear propagate fear in the timid little breast.

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* On this point there are some excellent observations made by Miss Shinn, who points out that physical pain, when not too severe, is apt to be lost sight of in the new feeling of personal consequence to which it gives rise.—Notes on the Development of a Child, Part II, p. 144 ff.

One can not part from the theme of children's fears without a reference to a closely connected subject, the problem of their happiness. To ask whether childhood is a happy time, still more to ask whether it is the happiest, is to raise perhaps a foolish and insoluble question. Later reminiscences are in this case rather treacherous evidence to build upon. Children themselves, no doubt, may have very definite views on the subject. A child will tell you with the unmistakable marks of profound conviction that he is *so* unhappy. But, paradoxical as it may seem, children really know very little about the matter. At the best they can only tell you how they feel at particular moments. To seek for a precise and satisfactory solution of the problem is thus futile. Only rough comparisons of childhood and later life are possible.

In any such comparison the fears of early years claim, no doubt, careful consideration. There seem to be people who have no idea what the agony of these early terrors amounts to. And since it is the unknown that excites this fear—and the unknown in childhood is almost everything—the possibilities of suffering from this source are great enough:

> "Alike the good, the ill offend thy sight,
> And rouse the stormy sense of shrill affright."

George Sand hardly exaggerates when she writes, "Fear is, I believe, the greatest moral suffering of children." In the case of weakly, nervous, and imaginative children, more especially, this susceptibility to terror may bring miserable days and yet more miserable nights.

Nevertheless, it is easy here to pass from one extreme of brutal indifference to another of sentimental exaggeration. Childish suffering is terrible while it lasts, but happily it has a way of not lasting. The cruel, distorting fit of terror passes and leaves the little face with its old sunny outlook. It is not remembered, too, that although children are pitiably fearful in their own way, they are, as we have seen in the case of the little Walter Scott, delightfully fearless also as judged by our standards. How oddly fear and fearlessness go together is illustrated in a story sent me. A little boy fell into a brook. On his being fished out by his mother, his sister, aged four, asked him, "Did you see any crocodiles?" "No," answered the boy, "I wasn't in long enough." The absence of fear of the water itself was as characteristic as the fear of the crocodile.

It is refreshing to find that in certain cases, at least, where older people have done their worst to excite terror, a child has escaped its suffering. Prof. Barnes tells us that a Californian child's belief in the supernatural takes on a happy tone, directing itself to images of heaven, with trees, birds, and other pretty things, and giving but little heed to the horrors of hell.* In less sunny climes than California children may not perhaps be such little optimists, and it is probable that graphic descriptions of hell fire have sent many a creepy thrill of horror along a child's tender nerves. Still, it may be said that, owing to the fortunate circumstance that children have much less fear of fire than many animals, the imagery in which eternal punishment is wont to be bodied forth does not work so powerfully as one might expect on a child's imagination. Then it is noticeable that children in general are but little affected by fear at the sight or the thought of death. The child C—— had a passing dread of being buried, but his young, hopeful heart refused to credit the fact of that far-off calamity. This, too, is no small deduction to be made from the burden of children's fear.

Not only so, when fear is apt to be excited, Nature has provided the small, timorous person with other instincts which tend to mitigate and even to neutralize it. It is a happy circumstance that the most prolific excitant of fear, the presentation of something new and uncanny, is also provocative of another feeling—that of curiosity, with its impulse to look and examine. Even animals are sometimes divided in the presence of something strange between fear and curiosity; † and children's curiosity is much more lively than theirs. A very tiny child, on first making acquaintance with some form of physical pain, as a bump on the head, will deliberately repeat the experience by knocking its head against something, as if experimenting and watching the effect. A clearer case of curiosity overpowering fear is that of a child who, after pulling the tail of a cat in a bush and getting scratched, proceeded to dive into the bush again. ‡ Still more interesting here are the gradual transitions from actual fear before the new and strange to bold inspection. The behavior of one of these small persons on the arrival at his house of a strange dog, of a colored foreigner, Hindu, or some other startling novelty, is a pretty and amusing sight. The first overpowering shyness and shrinking back to the mother's breast, followed by cautious peeps, then by bolder outreachings of head and arms, mark the stages by which curiosity and interest gain on fear and finally leave it far behind. Very soon we know the small, timorous creatures will grow into bold, adventurous lads, loving nothing so much as to probe the awful mysteries of flame and gunpowder and other alarming things.

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* Pedagogic Review, ii, 3, p. 445.

† Some examples are given by Preyer, *op. cit.*, p. 135.

‡ Miss Shinn, *op. cit.*, p. 150.

One palliative of these early terrors remains to be touched on, the instinct of sheltering or refuge-taking. The first manifestations of what is called the social nature of children are little more than the reverse side of their timidity. A baby will cease crying at night on hearing the familiar voice of mother or nurse, because a vague sense of human companionship does away with the misery of the black solitude. A frightened child probably knows an ecstasy of bliss when folded in the protective embrace of a mother's arms. Even the most timid of children never have the full experience of terror so long as there is within reach the secure base of all their reconnoitering excursions, the mother's skirts.

Happy those little ones who have ever near them loving arms within whose magic circle the oncoming of the cruel fit of terror is instantly checked, giving place to a delicious calm!

How unhappy those children must be who, timid and fearsome by Nature, lack this refuge—who are left much alone to wrestle with their horrors as best they may, and are rudely repulsed when they bear their heartquakings to others—I would not venture to say. Still less should I care to suggest what is suffered by those unfortunates who find in those about them not comfort, assurance, support in their fearsome moments, but the worst source of terror. To be brutal to these small, sensitive organisms, to practice on their terrors, to take delight in exciting the wild stare and wilder shriek of terror, this is perhaps one of the strange things which make one believe in the old dogma that the devil can enter into men and women. For here we seem to have to do with a form of cruelty so exquisite, so contrary to the oldest of instincts, that it is dishonoring to the savage and to the lower animals to attempt to refer it to heredity.

To dwell on such things, however, would be to go back to a pessimistic view of childhood. It is undeniable that children are exposed to indescribable misery when they are delivered into the hands of a consummately cruel mother or nurse. Yet one may hope that this sort of person is exceptional—something of which we can give no account save by saying that now and again in sport Nature produces a monster, as if to show what she could do if she did not choose more wisely and benignly to work within the limitations of type.

THOREAU, in relating some of his experiments in making maple sugar—when he got an ounce and a half of sugar from four quarts and a half pint of sap—says that he "had a dispute with father about the *use* of my making this sugar when I knew it could be done, and might have bought sugar cheaper at Holden's. He said it took me from my studies. I said I made it my study, and felt as if I had been to a university."

THE ARMADILLO AND ITS ODDITIES.

By CHARLES H. COE.

THOSE who have seen the armadillo only in pictures, or stuffed specimens in museums, can form but a slight idea how odd and interesting the animal is in life. With an ardent love of natural history, and with exceptional opportunities for indulging my tastes in this direction, I have been the possessor of many pet animals; but none, I can truly affirm, have interested me more by their odd forms and curious habits than a pair of armadillos.

I named my armored pets Jack and Jill, for they are a perfect pair, male and female, now nearly three years old. They were brought from Brazil, having been captured there by men who make it their business, with the aid of native hunters, to secure rare forms of animal life for menageries, zoölogical gardens, and private fanciers.

So rarely are armadillos seen in captivity, and so little has been written about them, that I am sure a reasonably full and detailed description of the animal in general and my pets in particular will prove interesting and instructive.

The armadillo belongs to two different genera, known as *Dasypus* and *Tatusia*, the former name being applied to several South American species, and the latter to those which inhabit North America. They all belong to the order *Edentata*, or toothless animals, which order also includes the sloths and ant-eaters. All these are characterized by the absence of front teeth, while the molars or grinders are not true teeth, being without regular roots or enamel.

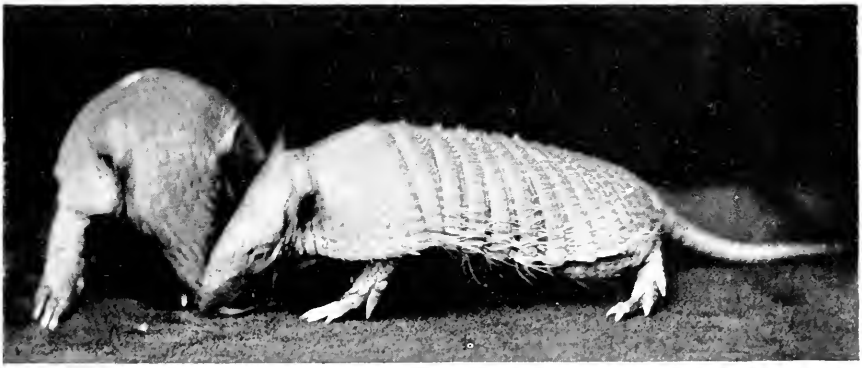
Long ages before man appeared upon the earth, as we learn from fossil remains found in its strata, this order was represented by gigantic forms now known as the glyptodon and the megatherium. The former, a huge creature sometimes thirteen feet in length, was related to the armadillo, but its armor was in one solid piece instead of plates and movable bands. The megatherium ("great beast"), a still more enormous animal of the ancient world, was not covered with armor, but was nearly allied to the sloth. It often attained a length of over eighteen feet.

The musical Spanish name *armadillo*, meaning "little armed one," is applied to many species, from the smallest, no larger than a rat, to the giant armadillo, which measures four and a half feet in length from tip to tip, the tail being eighteen inches long.

All the species are confined to the American continent, ranging from southern Texas to the Argentine Republic. Some species inhabit the low coasts of Peru and Chili, others the elevated plateaus of the Andes, the forests of Brazil, and the barren plains of Central America and Mexico.

From the imperfect structure of its back teeth, which vary in number from twenty-eight to thirty-six, according to the species, and which curiously interlock with each other, it will be seen that the armadillo can only eat the softest food, both animal and vegetable, such as insects, worms, carrion, fruit, and tender roots. Some species are more exclusively vegetarian than others. Those which make the flesh of animals a part of their diet can only eat it after it has become putrid, or, in the case of my pets, after it has been cooked until very tender.

In certain South American countries where cattle are frequently killed for their hides only, and the carcasses left on the ground, the armadillo feasts on putrid flesh. It burrows under a fresh carcass and waits patiently until decay has taken place. It



Jack and Jill.

then eats its way into the body, finally leaving nothing but the dry bones and skin. In this habit the armadillo resembles certain insects, such as ants and carrion beetles.

The giant armadillo has a still more repulsive habit, sometimes burrowing into human graves when opportunity offers. In such localities graves are commonly protected from the ravages of these ghouls by stones or heavy planks.

The smaller armadillos often enter the nests of ants, but more for the purpose of securing the larvæ than the perfect insects. The tongue, though not long and extensile like that of the true ant-eater, is slender, tapering, and flexible, and can be protruded a short distance from the mouth. It is further adapted for securing insects by a glutinous saliva.

It is amusing to see an armadillo eat, to hear it smack its lips, and to notice its evident enjoyment of its food. Both in its wild state and in captivity it is a hearty eater and often becomes very fat. The flesh of the animal is highly prized by the natives, but its rank flavor generally repels other residents. It is usually placed upon the table roasted whole, as we prepare a young pig.

On many of the dry and barren plains of Central America the armadillo is the only mammal. There, like the Florida gopher, it shares its burrow with a fellow-tenant, the deadly rattlesnake, which it does not seem to dread in the least. The snake, on the other hand, though it could easily insert its fangs into the armadillo's skin between its bands and plates of armor, seems to know better than to harm its good-natured landlord. Wild creatures often seem thus to tolerate one another's presence, and even to have a friendly understanding which man can not fully comprehend.

The various species of living armadillos differ in the number of movable bands of armor, and are named accordingly. The common species of Central America, Mexico, and southern Texas is the nine-banded armadillo (*Tatusia novemcincta*). My pets, Jack and Jill, belong to the South American species (*Dasypus sexcinctus*), and my description of them will therefore apply to the six-banded armadillo in general.

The two sexes resemble each other closely in size, structure, and outline. The total length of both Jack and Jill is nineteen inches, including the tail, which is six inches. The girth of the body is twelve inches, and it is plump and rounded like that of a puppy or young pig. When the legs are straightened, as in walking, the highest part of the back is six inches from the ground.

The head, three inches and a half in length and conical in shape, is covered above with a single plate of armor which extends on the sides to the eyebrows and lengthwise from a point three quarters of an inch from the end of the nose to a line drawn between the ears. Next behind the ears is a movable transverse band of armor nearly three fourths of an inch in width, separated from the head plate in front of it and from the next band behind it by a narrow space of chocolate-colored, rough, wrinkled, and pliable skin. Following this is another plate over the shoulders, two inches in width at the top, and gradually widening as it extends downward to the neck under the ears.

Now follow one after another the six movable bands from which this species is named. They are all alike, each three fourths of an inch in width, and separated from one another by similar spaces of leathery skin, as above described. Behind these six bands is the posterior plate, four inches wide and ending at the roots of the tail. The tapering tail has four movable bands, followed by a continuous plate extending to the tip.

Besides the armor thus described as protecting the head, back, sides, and tail, there is a similar coating on the outer surfaces of the legs. The six body bands and the four tail bands are composed of small polygonal pieces, joined together, slightly resembling certain parts of an alligator's skin. The other parts of the armor differ somewhat from these in shape, being more irregular.

It will be seen that the armadillo's protecting coat of mail is by no means firm and immovable like the shell of the tortoise, but is comparatively flexible, thus securing to the animal considerable freedom of movement, quite in contrast to the unwieldy awkwardness of the tortoise. When the armadillo's feet are drawn up under the body, this protecting coat reaches to the ground, overhanging like a cloak lightly thrown over the animal.

We read how the warrior of ancient time, though incased in a heavy coat of mail, was sometimes "pierced between the joints of the harness." A similar fate may befall our "little armed one." Even so puny a creature as the mosquito is enabled to annoy it by attacking the naked skin between the plates and bands. The tiny insect's partiality for this animal is so great, attracted doubtless by the abundant blood coursing through its plump form, that it even follows the armadillo into its burrow on its bloodthirsty errand.

The under parts of the animal, including the chin, breast, belly, and the inner sides of the legs, are covered only by skin. This is of the same color as that between the bands, and resembles in roughness the skin of a plucked chicken, being also naked with the exception of a few scattered hairs. The ears and the end of the nose are also without armor. A few bristly hairs appear on the skin between the bands of armor, and there is quite a tuft under each eye. The hair on the back and sides is pure white; on all other parts, jet black.

The ears are an inch and a quarter in length, round, and always erect. The eyes are small, black, and piggish in expression, with oddly wrinkled lids. The armadillo is chiefly nocturnal in its habits, sleeping much during the day; accordingly, we find the eyes weak and unable to bear strong light. The smell and hearing, on the contrary, are very acute.

The legs are short and stout. Both fore and hind feet have five toes, which are provided with powerful, slightly curved nails from one fourth to one inch long, those on the fore feet being the longest. With these instruments the armadillo not only burrows in the ground with wonderful ease and rapidity, but it can clutch an object, or the earth even, with a powerful grip. In walking on firm ground or on a floor, the nails only of the fore feet touch the surface, and but little more of the hind feet, although the latter are plantigrade when the animal is standing still.

The six-banded armadillo, in common with most of the species, is one of the most timid and inoffensive of all creatures, not even surpassed in this respect by the guinea pig. It is never known to defend itself, much less to make an assault. The absence of incisors and canine teeth renders it incapable of biting, and it has no offensive odor to warn off molesters. Its strong claws, strange to say, are never used as weapons of combat.

Some species are said to be able to outrun a man, but the six-banded armadillo can not run faster than a man can walk. It has a habit when pursued of quickly dodging and doubling like a rabbit. Failing in all other means of escape, it simply puts its head between its fore feet, tucks its tail and feet away, and rolls itself into a ball, after the common habit of our porcupine and opossum. In this position it may be punched and kicked about with apparently the same freedom from feeling that is displayed by these animals in similar circumstances. Not all of the species, however, resort to this expedient. Some are enabled to expand and flatten their bodies until they lie on the ground extended like a board, somewhat after the habit of the snake known as the spreading adder.

If the armadillo can not reach its burrow before an enemy is upon it, it often escapes by digging its way into the ground—a feat which it is enabled to accomplish in an incredibly short space of time, vanishing before the very eyes of its pursuer. Persons unused to hunting the armadillo sometimes grab its retreating tail, thinking thus to draw out its owner. Failure invariably attends such efforts. The animal simply continues its course into the earth, leaving its tail in the hands of the astonished hunter!

The great strength which thus enables the armadillo to resist withdrawal resides chiefly in its wonderful feet and claws. It simply stiffens its legs and firmly implants its long toe-nails in the ground. The back and sides of the animal are at the same time forced against the top and sides of the burrow, wedging its body in the hole so tightly that six men could scarcely draw it out. It would be like pulling up a sapling tree by its roots. I have noticed a similar bracing movement, by a stiffening of the legs, in the Florida gopher or land tortoise, a creature which has some habits in common with the armadillo.

Hunters have three methods of getting the armadillo out of its hole: by drowning it out, by smoking it out, and by digging. Sometimes all three expedients prove unsuccessful, the rapid burrowing of the animal enabling it to escape. The surest way is to continue digging until the fugitive is exhausted.

Hunters frequently resort to stratagem by taking advantage of the nocturnal habits of the armadillo and capturing it when it emerges from its hole at nightfall. Or they watch near its burrow on a moonlight night and pounce upon it suddenly when it returns from a foraging trip. Dogs are often employed to trail the creature when away from its home. When overtaken, of course, it offers not the slightest resistance.

In Central America the armadillo is frequently domesticated to rid houses of insect pests. They also make as nice pets as one could desire; no animal is cleaner or less objectionable about the house. They are as desirable in this respect as well-trained cats or lapdogs, and there could be no higher praise than this.

It is not merely the odd forms and ways of my rare pets that have made them the objects of my peculiar interest. I have been equally charmed with their intelligence and with their evident attachment to myself. If, when they are near me, I suddenly move away from them, they come trotting at my heels in their comical way as fast as their short legs can carry them.

Their gait is always a walk or brisk trot, never a gallop. Most of their movements when in motion resemble those of little pigs. They have learned to answer to their names, and come quickly when called. Curiosity is a prominent characteristic of the animal; if allowed free scope, they will explore every part of a strange place, trying to run their sharp noses into every opening. Much of the daytime is spent in sleeping. In lying down one generally rests its head and fore feet on the neck or back of the other, in a very affectionate manner.

Their attachment for each other is remarkable, all the more noticeable when one becomes separated from the other. If I shut Jack up in a basket, Jill goes round and round outside, at times standing on her hind feet and reaching to the top with her nose. When Jack is finally liberated they put their heads together for a few moments, and then off they go on one of their tours of exploration.

The spirit of science, said President Brinton at the American Association, is modest in its own claims and liberal to the claims of others. The first lesson which every sound student learns is to follow his facts and not to lead them. New facts teach him new conclusions. His opinions of to-day must be modified by the learning of the morrow. He is at all times ready and willing to abandon a position when further investigation shows that it is probably incorrectly taken. He is in this the reverse of the opinionated man, the hobby-rider, and the dogmatist. The despair of a scientific assemblage is the member with a pet theory, with a fixed idea, which he is bound to obtrude and defend in the face of facts. Yet even toward him we are called upon to exercise our toleration and our charity, for the history of learning has repeatedly shown that from just such wayward enthusiasts solid knowledge has derived some of its richest contributions. So supreme, after all, is energy that error itself, pursued with fervid devotion, yields a more bountiful harvest than truth languidly cultivated.

HERBARIA IN THEIR RELATION TO BOTANY.*

By JOHN P. LOTSY, Ph. D.

THE offer of Captain Donnell Smith to Johns Hopkins University of his valuable herbarium and library gives us an excellent opportunity to consider what such herbaria are, how they are brought together, and what is their purpose. We intend, furthermore, to show what they accomplish in botany and what botany does besides.

The importance of Captain Smith's gift will then be evident, and the value of a well-equipped botanical department to the Johns Hopkins and to the community at large will also be clear. The references to flowers and trees in ancient poems show that the beauty of vegetable Nature was fully appreciated at an early period, and agriculture requires the rudiments of a scientific knowledge of plants; but the first systematic attempts to study botany scientifically owe their origin to the desire to know more of plants in their relation to medicine. There are few plants which have not at some time been supposed to have great medicinal value, as the number of those designated *officinalis* clearly indicates.

The first systematic study of plants in their relation to medicine was in the Athenian Republic, and Theophrastus, Dioscorides, Pliny, and Galen are especially known for their writings on this subject. During the middle ages the science of the Greeks was forgotten, and interest in their investigations was not revived till the sixteenth century. By this time the old Greek texts had become greatly obscured by imperfect translations, and it required much patience and care to recognize plants from their descriptions. The botanists of the sixteenth century, like Bock, Fuchs, and Mattioli, working in Germany, found another difficulty in the circumstance that plants of their country differed widely from those in Greece. This, together with the imperfect state of the old descriptions, gave rise to frequent mistakes in identification. Some other authors, however, would notice the error, and disputes often arose, which sometimes became violent. The great value of this work to us is that it showed the necessity for more exact descriptions of plants, and this, combined with the occasional finding of new plants of a supposed or real value to medicine, gave rise to those large parchment-bound, queer-looking old volumes on botany which, besides the descriptions, often contained very beautiful pictures of the plants. These were then called

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herbaria, a significance being given to the word which it has now lost. It soon became painfully evident that very good and conscientious descriptions, even when accompanied by accurate plates, were yet not adequate to express all those delicate details which the living plant showed. So some of the authors found a way to keep the plants they had described, at first for their own reference, and for this purpose dried them carefully, glued them on sheets of paper, and put the name on this paper. Preserved in this way and arranged alphabetically for easy reference, these specimens formed a supplementary confirmation of their descriptions which was readily accessible. This was what we now call a *herbarium*—in other words, a collection of well-preserved, carefully named dry plants. If the description of an author who had a collection of this sort was called in question, it was an easy thing for him to send his original plant to some third botanist, who could decide whether he was right. Afterward it was recognized by those who described new plants that it would be of great importance to them if they could have the originals of the descriptions of their fellow-botanists. So a system of interchange of originals arose, which is now carried on between botanists all over the world. A trained and competent botanist who finds an opportunity to study the flora of regions which are little known may by this means become possessed of all the most instructive and remarkable plants that are known to science.

So a modern botanist no longer collects, as was formerly done, only one or two samples of every plant, but one or two hundred—of rare species often two thousand—because every specimen he has will enable him to obtain some new one in exchange.

The difficulties of collecting in the present time may be estimated from this. To collect four thousand plants in a tropical climate means not only to find, dry, and name these under the most unfavorable conditions, but to prepare perhaps forty thousand, all the duplicate specimens being used in exchange.

For a long while plants were named by any word which took the fancy of its author, and were arranged in the alphabetical order of the names. Soon, however, it was found that a better disposition was desirable, as nobody could look over such extensive alphabetically arranged collections, and students began to assort the plants in such a way that those which had certain characteristics in common were grouped in classes. So, for example, all kinds of grasses, all kinds of trees, all kinds of shrubs were put together, etc. Such a beginning of classification and unconscious recognition of relationship was begun by Lobelius and Bauhin, extended by Cæsalpin, and completed by Linnæus.

Linnæus, besides, saw the necessity of bringing together all the descriptions of plants already existing, and of wording them in such a way that, without losing anything essential in the description, they should occupy the smallest possible space. Such a condensed description is now known as a diagnosis.

When he had accumulated a considerable number of diagnoses he saw that it was difficult to find one's way through them, and he set about arranging them after some of the most striking characteristics which did not necessarily indicate relationship, but were simply as a means of classification and recognition. He took for this first the number of stamens, bringing all plants with one stamen in the flower together, all with two, three, four, five, ten, etc., into their several classes, in this way creating the groups of the *Monandra, Decandra, Polyandra,* etc.

Having done this, he recognized that a subdivision of these groups was desirable; that many plants with the same number of stamens yet differed considerably among one another; and these smaller groups he called *genus,* plural *genera.* Such a genus now, for example, is the buttercup, which he called *Ranunculus.* He saw that further subdivision could take place, and that there were a great many plants which, though evidently all buttercups, yet differed sufficiently to be distinct. So he resolved to give every plant two names, the first one being the genus name, here *Ranunculus,* the second one expressing some property of that particular kind of *Ranunculus,* and thus indicating the species. Thus he found, for example, that one buttercup had an acrid taste, and he called it the acrid buttercup—in Latin, *Ranunculus acris;* that another one always grew on marshy places; he called it the marsh buttercup—in Latin, *Ranunculus palustris,* etc.

Latin names were used simply as a matter of convenience, as it was much easier to know one Latin name than a dozen names in a dozen different languages for the same plant. Linnæus's system was consequently one of mere convenience and thoroughly artificial.

It had, however, already been recognized that certain plants belong naturally together, as grasses, for example, while Linnæus's system often placed two grasses very far apart. This conception of relationship, however, could not be expressed well before Darwin had shown that plants had not always been as they are now, but that the higher plants had gradually been developed from the lower ones. Then an entirely different system arose—a system which expressed the relation of plants in the way of a genealogical tree; this system is generally known under the name of the natural system. It is after this natural system, which expresses our conception of the blood relation between the different plants, that our present herbaria are arranged, and it is their object to show us at all times not only the plants described, but also the family relation between these different plants.

In Linnæus's time a botanist was regarded as somebody who could name at sight any plant presented to him, and the best botanist was the one who was most proficient in this. We are justified, however, in requiring a few other things from a good botanist. The recognition of the family relations between different plants gave rise to the comparing of their different organs, to the study of their development, to inquiring what conditions had influenced an organ in such a way that it became modified, to the search for the equivalents of the organs of the higher plants among the lower ones; all of which constitute that branch of botany which now is known as morphology.

The recognition of yet finer details created our histology.

The closer acquaintance with plants induced scientific men to observe their habits, their distribution, and how they lived; and this is plant physiology in its widest sense.

For the study of the botanical system, morphology, and geography, a herbarium like that of Captain Smith is of the greatest advantage. For physiological purposes, quite other things—as exact instruments, hothouses to keep living plants, etc.—are necessary.

Physiology is that part of botany which has had most practical value. The fertilizing with artificial manures is entirely founded upon it, for it never could have become known if careful experiments in the laboratory had not shown what substances were necessary to each particular kind of plant. Consequently, all agricultural experiment stations are practically based on plant physiology.

This plant physiology, or the science of the normal life of the plant, gave rise to the study of the plant under abnormal—in other words, diseased—conditions, and so the science of plant pathology, on which our knowledge of the diseases of our crops and the way to prevent or cure them is based.

Last, and not least, the study of those very smallest plants, the bacteria, made an enormous change in our treatment of sick human beings; the study of the parasitic molds has done an important service to our fish industries; so the influence of modern scientific botany is felt in fields that seem to the casual observer to have no connection with vegetation, and the scope of this science is no longer confined to what for years was its only object—the naming of plants.

PROFESSIONAL INSTITUTIONS.

III.—DANCER AND MUSICIAN.

By HERBERT SPENCER.

IN an essay on The Origin and Function of Music, first published in 1857, I emphasized the psycho-physical law that muscular movements in general are originated by feelings in general. Be the movements slight or violent, be they those of the whole body or of special parts, and be the feelings pleasurable or painful, sensational or emotional, the first are always results of the last: at least, after excluding those movements which are reflex and involuntary. And it was there pointed out that, as a consequence of this psycho-physical law, the violent muscular motions of the limbs which cause bounds and gesticulations, as well as those strong contractions of the pectoral and vocal muscles which produce shouting and laughter, become the natural language of great pleasure.

In the actions of lively children who, on seeing in the distance some indulgent relative, run up to him, joining one another in screams of delight and breaking their run with leaps, there are shown the roots from which simultaneously arise those audible and visible manifestations of joy which culminate in singing and dancing. It needs no stretch of imagination to see that when, instead of an indulgent relative met by joyful children, we have a conquering chief or king met by groups of his people, there will almost certainly occur saltatory and vocal expressions of elated feeling, and that these must become, by implication, signs of respect and loyalty—ascriptions of worth which, raised to a higher power, become worship. Nor does it need any stretch of imagination to perceive that these natural displays of joy, at first made spontaneously before one who approaches in triumph as a benefactor and glorifier of his people, come, in course of time, to be observances used on all public occasions as demonstrations of allegiance; while, simultaneously, the irregular jumpings and gesticulations with unrhythmical shouts and cries, at first arising without concert, gradually by repetition become regularized into the measured movements we know as dances and into the organized utterances constituting songs. Once more, it is easy to see that out of groups of subjects thus led into irregular ovations, and by and by into regular laudatory receptions, there will eventually arise some who, distinguished by their skill, are set apart as dancers and singers, and presently acquire the professional character.

Before passing to the positive evidence which supports this interpretation, it may be well to remark that negative evidence is furnished by those savages who have no permanent chiefs or rudimentary kings; for among them these incipient professional actions are scarcely to be traced. They do indeed show us certain rude dances with noisy accompaniments; but these are representations of war and the chase. Though the deeds of celebrated warriors may occasionally be simulated in ways implying laudation of them, there do not commonly arise at this stage the laudations constituted by joyous gesticulations and triumphant songs in face of a conqueror. At later stages ceremonies of this primitive kind develop into organized exercises performed by masses of warriors. Thus among the Kaffirs the war-dances constitute the most important part of their training, and they engage in these frequently; and it is said that the movements in the grand dances of the Zulus resemble military evolutions. So, too, Thomson writes that the war-dance of the New Zealanders approximated in precision to the movements of a regiment of European soldiers. Clearly it is not from these exercises that professional dancing originates.

That professional dancing, singing, and instrumental music originate in the way above indicated, is implied by a familiar passage in the Bible. We are told that when David, as general of the Israelites, "was returned from the slaughter of the Philistines"—

"The women came out of all cities of Israel singing and dancing to meet king Saul with tabrets, with joy, and with instruments of music; and the women answered one another as they played, and said 'Saul hath slain his thousands and David his ten thousands'" (I Sam., xviii, 6, 7).

Here the primitive reception of a conquering chief by shouts and leaps, which has, along with semi-civilization, developed into more definite and rhythmical form, vocal and saltatory, is accorded both to a reigning conqueror and to a conqueror subordinate to him. But while on this occasion the ceremony was entirely secular, it was, on another occasion, under different circumstances, predominantly sacred. When, led by Moses, the Israelites had passed the Red Sea, the song of Miriam, followed by the women "with timbrels and with dances" exhorting them "sing ye to the Lord, for he hath triumphed gloriously," shows us the same kind of observance toward a leader (a "man of war," as the Hebrew god is called) who is no longer visible, but is supposed to guide his people and occasionally to give advice in battle. That is, we see religious dancing and singing and praise having the same form whether the object of them is or is not present to sight.

Usages which we find in existing semi-civilized societies, justify the conclusion that ovations to a returning conqueror, at first spontaneous expressions of applause and loyalty, gradually pass into ceremonial observances used for purposes of propitiation. It becomes the policy to please the ruler by repetitions of these songs describing his great deeds, and of the dances expressive of joy at his presence. Describing the Marutse, Holub says:—

"All the musicians [of the royal band] were obliged to be singers as well, having to screech out the king's praises between the intervals in the music, or to a muffled accompaniment of their instruments."

So, Schweinfurth tells us that at the court of king Munza, the Monbutto ruler, there were professional musicians, ballad-singers, and dancers, whose leading function was to glorify and please the king. And in Dahomy, according to Burton, "the bards are of both sexes, and the women dwell in the palaces . . . the king keeps a whole troop of these laureates." Official praises of this kind are carried on by attendants not only of the king but of subordinate rulers. In processions in Ashantee, "each noble is attended by his flatterers, who proclaim, in boisterous songs, the 'strong names' of their master;" and on the Gold Coast, "every chief has a horn-blower, and a special air of his own." Similarly we learn from Park that among the Mandingos there are minstrels who "sing extempore songs in honor of their chief men, or any other persons who are willing to pay them:" showing us an unobtrusive divergence from the original function. Winterbottom indicates a like divergence.

"Among the Foolas there is a set of people called singing men, who, like the ancient bards, travel about the country singing the praises of those who choose to purchase renown."

Passing beyond Africa we read that in Madagascar "the sovereign has a large band of female singers, who attend in the courtyard, and who accompany their monarch whenever he takes an excursion." Raffles, too, says that in Java there are three classes of dancing-girls, who perform in public: 1. The concubines of the sovereign and of the hereditary prince. These are the most skillful. 2. The concubines of the nobles. 3. The common dancing girls of the country. In these cases we are shown that while saltatory and vocal forms of glorification, at first occasional and spontaneous, have become regular and ceremonial; and while those who perform them, no longer the people at large, have become a specialized class; two further changes have taken place. Instead of being both singers and dancers, as the primitive celebrants were, these permanent officials have become differentiated into the two classes, singers and dancers; and, if not of the singers, yet of the dancers we may remark that their performances, ceasing to be expressions of welcome and joy before the ruler, have grown into displays of agility and grace, and are gone through for the purpose of yielding æsthetic pleasures. Among the Hebrews this development had taken place in the time of Herod, when the daughter of Herodias delighted him by her dancing; and a like development is shown at the present day throughout India, where troops of bayaderes are appendages of courts.

That laudatory dancing and singing before the visible ruler are associated with like observances before the invisible ruler, the Hebrews have shown us. To the case of the prophetess Miriam and her companions, may be added the case of David dancing before the ark. Hence we shall not be surprised to find such facts among other semi-civilized peoples. Markham, describing a Puharrie festival, and saying of a certain receptacle that "in it the Deity is supposed to dwell," adds that "upon this occasion the deptha, or ark, is brought forth with much solemnity, and the people decked out with flowers and ears of corn dance around it." In an account of the Bhils we read, concerning a class of men called *Barwás* who are votaries of the hill-gods, that—

"Their powers are, however, dormant, till they are excited by music; and for this reason, they have a class of musicians connected with them, who are proficient in numerous songs in praise of the hill-deities. When the recitation of these songs has kindled the spark of spiritual fire, they begin to dance with frantic gestures."

An analogous use of dancing occurs in Abyssinia. The duties of priests "consist in reading the prayers, chanting, administering the sacrament, and dancing; the latter being indulged in during religious processions." That the dancing is in this case imported into the quasi-Christian religion by adoption from some previous religion (a like adoption being common with Roman Catholic missionaries) is a conclusion supported by an instance from a remote region. Describing the usages of the Pueblos, Lummis says:—

"The *cachinas* or sacred dances which were in vogue before Columbus, still survive; but now they are applied to the festivals of the Church, and are presumed to be as grateful to *Tata Dios* as to the Sun."

But the way in which singing and dancing before the visible ruler differentiate into singing and dancing before the ruler no longer visible, is best seen in the early records of civilized races. To the above illustrations furnished by Hebrew history may be added various others. Thus I Samuel x, 5, tells of "a company of prophets coming down from the high place with a psaltery, and a tabret, and a pipe, and a harp before them;" and, according to some translators, dancing and singing. Again in I Chronicles ix, 33, we read of certain Levites that "these are the singers, chief of the fathers of the Levites." And in Psalm cxlix, there is the exhortation:—"Let them praise his name in the dance: let them sing praises unto him with the timbrel and harp:" worship which was joined with the execution of "vengeance upon the heathen."

This association of dancing and singing as forms of worship, and by implication their more special association with the priesthood, is not so conspicuous in the accounts of Egypt; probably because the earlier stages of Egyptian civilization are unrecorded. According to Herodotus, however, in the processions during the festival of Bacchus, the flute-player went first and was followed by the choristers who chanted all the praises of the deity. Naming also cymbals and flutes and harps as used "in religious ceremonies;" Wilkinson says that "the sacred musicians were of the order of priests and appointed to the service, like the Levites among the Jews." Songs and clapping of hands are mentioned by him as parts of the worship. Moreover the wall-paintings yield proofs. "That they also danced at temples, in honor of the gods, is evident from the representations of several sacred processions." Wilkinson is now somewhat out of date, but these assertions are not incongruous with those made by later writers. The association between the temple and the palace was in all ways intimate, and while, according to Brugsch, one steward of the king's household "was over the singing and playing," Duncker states that "in every temple there was a minstrel." So too, Tiele, speaking of Im-hotep, son of Ptah, says—

> "The texts designate him as the first of the Cher-hib, a class of priests who were at the same time choristers and physicians."

But Rawlinson thinks that music had, in the days of historical Egypt, become largely secularized:—"Music was used in the main as a light entertainment . . . The religious ceremonies into which music entered were mostly of an equivocal character."

Similar was the genesis which occurred in Greece. A brief indication of the fact is conveyed by the statement of Guhl and Koner that all the dances "were originally connected with religious worship." The union of dancing and singing as components of the same ceremony, is implied by Moulton's remark that—

> "'Chorus' is one example amongst many of expressions that convey musical associations to us, but are terms originally of dancing. The chorus was the most elaborate of the lyric ballad-dances."

And that the associated use of the two was religious is shown by the description of Grote, who writes:—

> "The chorus, with song and dance combined, constituted an important part of divine service throughout all Greece. It was originally a public manifestation of the citizens generally . . . But in process of time, the per-

formance at the chief festival tended to become more elaborate and to fall into the hands of persons expressly and professionally trained."

In like manner Donaldson tells us "that music and dancing were the basis of the religious, political, and military organization of the Dorian states:" remarking also that—

"The preservation of military discipline and the establishment of a principle of subordination, not merely the encouragement of a taste for the fine arts, were the objects which these rude legislators had in view; and though there is no doubt that religious feeling entered largely into all their thoughts and actions, yet the god whom they worshiped was a god of war, of music, and of civil government."

On which statement, however, we may remark that it contains a species of error common in historical interpretations. It is erroneously assumed that these dances were introduced by legislators, instead of being continuations of observances which arose spontaneously. How in Greece there early began the secularization of music is shown by the traditions concerning the religious festivals —the Pythian, Olympian, etc.—which presently furnished occasions for competitions in skill and strength. The Pythian games, which were the earliest, exhibited the smallest divergence from the primitive purpose; for only musical and poetical contests took place. But the establishment of prizes shows that out of the original miscellaneous chorus had arisen some who were marked by their more effective expressions of praise and finer vocal utterances. And on reading that out of those who played accompaniments to the sacred songs and dances, some became noted for their skill, and that there presently followed at the great Greek games prizes to the best performers on flutes, trumpets, and lyres, we see how there arose also that differentiation of instrumentalists from vocalists which presently became pronounced. Says Mahaffy concerning a performance about 250 B. C.—

"This elaborate instrumental symphony was merely the development of the old competitions in playing instruments, which had existed at Delphi from very early days."

Hence, after a time, a complete secularization of music. Besides musical performances in honor of the gods, there grew up in later days performances which ministered solely to æsthetic enjoyments. Distinguishing the sacred from the secular, Mahaffy says the first "were quite separate from the singing and playing in private society, which were cultivated a good deal at Athens, though not at all at Sparta, where such performances were left to professional musicians."

Parallel evidence is furnished by Roman history. We read in Mommsen that—

"In the most ancient religious usages dancing, and next to dancing instrumental music, were far more prominent than song. In the great procession, with which the Roman festival of victory was opened, the chief place, next to the images of the gods and the champions, was assigned to the dancers, grave and merry. . . . The 'leapers' (*salii*) were perhaps the most ancient and sacred of all the priesthoods."

So, too, Guhl and Koner write:—

"Public games were, from the earliest times, connected with religious acts, the Roman custom tallying in this respect with the Greek. Such games were promised to the gods to gain their favor, and afterward carried out as a sign of gratitude for their assistance."

Congruous with this statement is that of Posnett, who, after quoting an early prayer to Mars, says—

"This primitive hymn clearly combined the sacred dance . . . with the responsive chant; and the prominence of the former suggests how readily the processional or stationary hymn might grow into a little drama symbolizing the supposed actions of the deity worshiped."

Here we see a parallelism to the triumphal reception of David and Saul, and are shown that the worship of the hero-god is a repetition of the applause given to a conqueror when alive in celebration of his achievements: the priests and people doing in the last case that which the courtiers and people did in the first. Moreover in Rome, as in Greece, there eventually arose, out of the sacred performances of music, secular performances—a cultivation of music as a pleasure-giving art. Says Inge—

"In republican days a Roman would have been ashamed to own himself a skilled musician. . . . Scipio Æmilianus delivered a scathing invective in the senate against schools of music and dancing at one of which he had even seen the son of a Roman magistrate."

But in the days of the Cæsars musical culture had become part of a liberal education; and we have, in illustration, the familiar remembrance of Nero as a violinist. At the same time "trained choirs of slaves were employed to sing and play to the guests at dinner, or for the delectation of their master alone."

On tracing further the evolution of these originally twin professions, we come upon the fact that while, after their separation, the one became almost wholly secularized, the other long continued its ecclesiastical connections and differentiated into its secular forms at a later date. Why dancing ceased to be a part of religious worship, while music did not, we may readily see. In the first place dancing being inarticulate, is not capable of expressing those various ideas and feelings which music, joining with words, is able to do. As originally used it was expressive of joy, alike in presence of the living hero and in the supposed presence of his spirit. In the nature of things it implies that overplus of energy which goes along with elated feeling, and does not serve to express the awe, the submission, the penitence, which form large parts of religious worship in advanced times.

Naturally then dancing, though it did not in the middle ages wholly disappear from religious worship, practically fell into disuse. One part only of the original observance survived—the procession. Alike in the triumphal reception of a returning conqueror and in the celebration of a god's achievements, the saltatory actions were the joyous accompaniments in a moving stream of people. But while the saltatory actions have ceased the moving stream has continued. Moreover there have survived, even down to our own day, its two original forms. We have religious processions, now along the aisles of cathedrals and now through the streets; and besides other secular processions more or less triumphal, we have those in which either the ruler or the representative of the ruler is escorted into the city he is approaching by troops of officials and by the populace: the going out to meet the judges, who are the king's deputies, shows us that the old form *minus* the dance is still extant.

A further fact is to be noted. While dancing has become secularized it has in part assumed a professional character. Though, even in the earliest stages, it had other forms and purposes than those above described (as shown in the mimetic representations of success in the chase, and in primitive amatory dances), and though from these, secular dancing has been in part derived; yet if we bear in mind the transition from the dancing in triumphal processions before the king, to dancing before him as a court-observance by trained dancers, and from that to dancing on the stage, we may infer that even the forms of secular dancing now familiar are not without a trace of that origin we have been following out.

Returning from this parenthesis and passing from the evidence furnished by ancient civilizations to that furnished by the pagan and semi-civilized peoples of Europe, we may first note the statement of Strabo concerning the Celts.

There "are generally three divisions of men especially reverenced, the Bards, the Vates, and the Druids. The Bards composed and chanted hymns; the Vates occupied themselves with the sacrifices and the study of nature; while the Druids joined to the study of nature that of moral philosophy."

And the assertion is that these bards recited the exploits of their chiefs to the accompaniment of the harp. The survival of pagan observances into Christian times probably gave origin to the class distinguished among the Scandinavians as "skalds" and among the Anglo-Saxons as harpers and gleemen. Thus we read:—

"The gleemen added mimicry . . . dancing . . . tumbling, with sleights of hand. . . . It was therefore necessary for them to associate themselves into companies."

"Soon after the conquest these musicians lost the ancient Saxon appellation of gleemen and were called ministraulx, in English minstrels."

Moreover in the old English period the minstrel "was sometimes a household retainer of the chief whom he served, as we see in the poem of Beowulf." And since it was the function of the minstrel now to glorify his chief and now to glorify his chief's ancestors, we see that in the one capacity he lauded the living potentate as a courtier, and in the other capacity he lauded the deceased potentate as a priest lauds a deity.

While, with the decay of the worship of the pagan gods, heroes, and ancestors, some music became secularized, other music began to develop in connection with the substituted religion. Among the Anglo-Saxons, "music was also cultivated with ardor. . . . Permanent schools of music were finally established in the monasteries, and a principal one at Canterbury. So, too, was it under the Normans: "great attention was now paid to Church music, and the clergy frequently composed pieces for the use of their choirs." And then in the fifteenth century—

"Ecclesiastical music was studied by the youths at the Universities, with a view to the attainment of degrees as bachelors and doctors in that faculty or science, which generally secured preferment."

But the best proof of the clerical origin of the musical professor during Christian times, is furnished by the biographical notices of early musicians throughout Europe. We begin in the fourth century with St. Ambrose, who set in order "the ecclesiastical mode of saying and singing divine service;" and then come to St. Gregory who in 590 arranged the musical scales. The tenth century yielded Hucbaldus, a monk who replaced the two-lined stave by one of more lines; and the eleventh century the monk Guido d'Arezzo, who further developed the stave. A differentiation of sacred into secular was commenced in the twelfth century by the Minnesingers: "their melodies were founded on the Church scales." Developed out of them, came the Meistersingers, who usually performed in churches, and "had generally a sacred subject, and their tone was religious." "One of the first composers who wrote in regular form" was Canon Dufay of the Cathedral of Cambrai in 1474. The sixteenth century brought Lasso, who wrote thirteen hundred musical compositions, but whose *status* is not named; and then, showing a pronounced secularization, we have, in the same century, Phillipus de Monte, Canon of Cambrai, who wrote thirty books of madrigals. About that time Luther, too, "arranged the German mass." In the next century we have the distinguished composer Palestrina who, though originally a layman, was elected to priestly functions; and the priest, Allegri, a chorister and composer. At later dates lived Carissimi, chapel-master and composer; Scarlatti also *maestro di capella*. France presently produced Rameau, church-organist; and Germany two of its greatest composers—Handel first of all capellmeister in Hanover and then in England; and Bach, who was primarily an organist, and who, "deeply religious," developed "the old Church modes" into modern forms. Among other leading musicians of the eighteenth century were Padre Martini, and Zingarelli, both chapel-masters; and there flourished during the same period the Abbé Vogler, and Cherubini, a chapel-master. To all which cases abroad should be added the cases at home. Beginning in 1515 with Tallis "the father of English Cathedral Music," we find him called "gentleman (chorister) of the Chapel Royal." In the same century comes Morley, chorister, "epistler," and "gospeller," who, thus semi-priestly, composed secular music; Byrd, a similar functionary similarly characterized; Farrant, also clerical in character; and a little later Gibbons, an organist but largely a writer of secular music. In the next century we have Lawes, "epistler" of the Chapel Royal composer of sacred music; Child, chorister, organist, and sacred composer; and Blow, the same. Then come the four generations of Purcells, all connected with the Church as choristers and organists; Hilton, organist and parish clerk, and writer of secular as well as sacred music; and Croft, organist, chief chorister, and composer, secular and sacred. And so with later composers, Boyce, Cook, Webbe, Horsley, who, still in part Church-functionaries, are chiefly known by their songs, glees, and catches.

We must not, however, ignore the fact that though out of the cultivation of music for purposes of worship, music of the more developed kinds originated, there independently grew up simple popular music; for from the earliest times emotions excited by the various incidents of life have prompted spontaneous vocal expression. But recognition of this truth consists with assertion of the larger truth that the higher developments of music in modern times, arose out of elaborated religious worship, and were for a long time the productions of the priest-class; and that out of this class, or semi-secularized members of it, there were eventually differentiated the composers and professors of secular music.

One further differentiation which has accompanied the last has to be noted. The musician's art, developed by the priestly class in the service of the church, and gradually influencing the simple secular music existing among the people, began to evolve out of this the higher forms of music we now know. Whether or not the popular dances in use during recent centuries had arisen *de novo*, or whether, as seems more probable, they had descended with modifications from the early dance-chants used in pagan worship, inquiry discloses the remarkable fact that out of them have grown the great orchestral works of modern days. The *suites de pièces* of Bach and Handel were originally sets of dances in different times; and these have developed into the successive movements of the symphony, which even now, in the occasional movement named "minuet," yields a trace of its origin. And then, along with these developments of music, has taken place one further differentiation—that of composer from performer. Though some performers are also composers, yet in large measure the composer has become an independent artist who does not himself, unless as conductor, take part in public entertainments.

In this case, as in other cases, the general process of evolution is exemplified by the integration which has accompanied differentiation. Evidence furnished by ancient civilizations must be postponed to the next chapter as more closely appertaining to it. Here we may content ourselves with indicating the illustrative facts which modern days furnish.

Beyond the unorganized body of professed musical performers and beyond the little-organized body of professors and teachers of music, there is the assemblage of those who, having passed examinations and acquired degrees in music, are marked off more distinctly: we see the increased definiteness which accompanies integration. There are also the multitudinous local musical societies; the local musical festivals with their governing organizations; and the several incorporated colleges, with their students, professional staffs, and directors.

Then as serving to unite these variously-constituted groups of those who make the musical art a profession, and of those who give themselves to the practice of it as amateurs, we have a periodical literature—sundry musical journals devoted to reports and criticisms of concerts, operas, oratorios, and serving to aid musical culture while they maintain the interests of the teachers and performers.

THE curious fact is noticed by Prof. Basil Hall Chamberlain that in the Japanese Archipelago vegetation diminishes instead of increasing in rankness as one travels south. In Yezo the summer grasses and tall weeds are higher than the head of a horseback rider; in central Japan the grass is seldom taller than a man on foot; in Great Luchu everything is much lower still. There are no tall grasses, comparatively few bamboos, and few thickets of any sort. The country is parklike.

A MEDICAL STUDY OF THE JURY SYSTEM.

By T. D. CROTHERS, M. D.

THE uncertainty of jurors, and the capricious, whimsical character of their verdicts, are accepted as inevitable, and explained as part of the natural weakness of the mind. It is assumed that, if the facts are clearly presented, a jury will give a common-sense verdict, which will approximate the truth and human justice. Where they fail, it is due to the confusion of testimony, the misrepresentation of counsel, and the general perversion of facts. Many thoughtful men consider the judgment of twelve men, who are disinterested, superior and on general matters of dispute of far more reliable character than the judgment of one trained man. Yet literally, the verdicts of twelve men, based on the same set of facts, differ widely, and can never be anticipated; and, whether wise or unwise, are clearly due to other influences than the commonly supposed conflict of facts and motives of truth and justice.

While it would be difficult to doubt the motive and intent of the average juror to be just and fair in his conclusions, it would seem that certain conditions and surroundings make it impossible in most cases to either understand the case in question or the principles of equity involved. The theoretical and ideal jury to whom are daily referred questions of life and death, and often momentous interests concerning families and individuals, is never seen in real life. The delusions of the court room, that the twelve men set apart for this duty are endowed with a large and sufficient mental capacity for the discernment of justice, is far from being true in reality.

From a medical and scientific point of view, the average twelve men who are appealed to by the counsel and judge to wisely determine the issue of a case are usually incompetent naturally, and are generally placed in the worst possible conditions and surroundings to even exercise average common sense in any disputed case.

In a noted trial at Hartford, Conn., out of a panel of one hundred jurors, twelve men were finally selected after a long, searching inquiry. Five of them were farmers, who worked hard every day in the open air, men who were unaccustomed to think or reason, except in a narrow way along their surroundings and line of work. These men all swore that they had not read any details of the case, although it occupied a large share of public attention and had been discussed freely in all the papers. They were muscle workers, with but little mental exercise, living on coarse, healthy food, and sleeping from early evening to early morning. Of the rest of the jury, one was a blacksmith and two were mechanics, all steady workers; one was a horse trader, one a groceryman, one a retired farmer and trader, and the last man was an ex-railroad man who had no business. Every one of this jury was accustomed to be in the open air, and had not read details of the case, although he had heard it talked over. Not one of these men would have been chosen to take charge of any trust, or to decide on any matter outside of his everyday life—simply because, on general principles and from common-sense observation, he would have been considered clearly incompetent.

For ten days this jury was confined from five to six hours a day, listening to the testimony of the mental capacity and motives of the maker of a will that was disputed. Of course, they disagreed; and had they reached a unanimous verdict, its wisdom and justice would have been a matter of accident.

In a celebrated case tried in an interior town in New York, a most complicated chain of circumstantial evidence, involving the questions of concealed motives of unusual acts and conduct, of blood-stains, of the accuracy of chemical and microscopical work, of different opinions of competent men, was submitted to a jury of the following persons: one carpenter, one wagon-maker, three coopers, two farmers, one groceryman, one contractor, and three nurserymen. These men all testified that they had not formed an opinion on the case, although it had been town talk for months. Not one of them could naturally have given an intelligent opinion on any of the issues of the case, even if they had been presented in the most impartial, simple manner by the judge. When two opposite views were urged by opposing counsel, in an adroit partisan manner, the most uncertain mental confusion would be inevitable.

This particular jury was not only incompetent naturally and by want of training to discriminate facts that were unfamiliar, but its members were unaccustomed to consider any range of facts compared with others to determine which were true.

In a third celebrated case, a jury composed of four fishermen, two shipbuilders, two stonecutters, one clerk, two merchants, and two persons of no business, was asked to decide on the facts of one of the most mysterious cases of poisoning. A number of expert witnesses and shrewd lawyers extended this case two weeks, and gathered a mass of statements that only the most astute judge could have disentangled. These jurymen were not only bewildered, but were mentally palsied by the appeals of counsel.

The methods of selecting jurors are thus literally open doors for the defeat of the very purposes of justice. The ostensible purpose in the selection of a jury is to secure men of honesty, intelligence, and courage to reach unbiased conclusions in accord with the facts. In reality the practice is to gather men who can be influenced by the counsel—men possessing some defect and weakness which can be taken advantage of by one side or the other. The issue of the case will depend on the influences which can be brought to bear on the jury. Usually, jurors are rejected when they swear that they have formed an opinion; but when they assert that such opinions are subject to change from evidence and are not fixed, they are accepted. The real qualifications would seem to be availability, credulity, ignorance, and possibility of personal influence by persuasion, flattery, and appeals to some personal bias that may be known. Each counsel is interested in selecting twelve men he can influence to his view of the case, or, in the court language, "men he can handle readily." It is unfortunately true that jury duty is evaded by the best men, and to a large extent the men who are willing to serve in this capacity are more or less incompetent. In the cities, idle men and professional jurors are always available. In country towns, farmers, mechanics, and others find the jury duty a recreation, and a not unpleasant change from the monotony of their life. While these men are superior to the city jurors in honesty, they are less able or accustomed to the confinement of rooms and the emotional appeals of partisans.

It is evident to any general observation that the average jury is unable to pass judgment on, or even to comprehend in any adequate way, many of the questions submitted to it—such as motives and capacity of the mind and the power of control; the analysis of conduct, and the conditions and influences which have been dominant in certain acts; the application of the law, and the distinctions of responsibility and accountability; the distinctions of science as to the meaning of certain facts, or the recognition and discrimination of facts from the mass of statements. To this incapacity are added the passionate appeals of opposing counsel, who draw the most opposite conclusions from the same set of facts. Then the judge charges that if they shall find such and such conditions to be true, they shall bring in such and such a verdict; and if such and such conditions are not true, another verdict must be given. This brings them into a state of the most bewildering mental confusion, from which only the trained judge could extricate himself. The wonder is that they are able to reach any verdict that even approximates the levels of human justice.

These facts are recognized by all observing men, and have been the subject of serious discussion for a long time. It has not occurred to any one to consider the conditions and surroundings of the jury who are to decide the great questions of life and death so often submitted to them. Practically and literally the twelve men of uncertain intelligence, and doubtful capacity and training essential to determine the disputed questions, are placed in the most adverse hygienic conditions for healthy brain and functional activity. Supposing these men to have fair average intelligence with honesty of purpose, they are placed always in a close, badly ventilated court room, and are obliged to sit in one place for five or six hours a day; in cases of capital crime they are housed at some hotel at night, and have changed diet, changed sleeping rooms, imperfect exercise, continuous mental strain, and this may be continued for a week, ten days, or even longer. Intelligent and sound brain reasoning would be impossible under these conditions. Even judges, trained to examine and reason from facts along legal lines, display weakness and confusion of mind at the close of a long trial on many occasions.

The practical observation of any jury in some important trial will show after the first day a listless abstraction that slowly deepens into a veritable mental confusion. At times, some one of the jury will appear impressed, but soon he settles back into a prolonged, steady, vacant stare at the counsel and witness. As the case goes on the faces of the jurors become paler, or increase in redness; their eyes lose their intelligence and become vacant or watery. Some show restlessness in their frequent changing positions of body; others become somnolent and inclined to stolidity; others are constrained, and seem to be struggling to keep up some degree of dignity, and imitate the judge in severity of manner. When the counsel flatters them, they start up anew and assume the appearance of more dignity and wisdom. Every lawyer has many curious stories of the schemes and devices to capture juries and jurors. Many of these turn on the debility and confusion of mind which come from changed surroundings and functional disorders resulting from confinement and mental exhaustion.

After the second day all connected ideas of the case become confused; only here and there some fact impresses itself, or some witticism or story that is strange or grotesque, or some conflict of lawyers, or reprimand of the judges. All the rest is vague and uncertain. The surprise on the faces of the jury, as the judge and lawyers repeat the testimony of the witnesses, shows that it is new, and they did not hear it at the time it was given. The pleas of opposing counsel often create equal surprise in the faces of the jury. If the jury were to render a verdict after one side had closed, it would be for that side. The same conviction is noted at the close of the arguments of the opposite side. The judge's charge often dispels this conviction for the last speaker, and throws them back into more helpless, confused states. They are told to decide between this and that statement, and if they think this is true, they must find so and so; if that is true, the verdict must be so and so. In reality they have no very clear conceptions of any of the facts the judge has called to their attention. They go to the jury room in a dazed mental state, or possessed with some particular idea that has become fastened in the mind; some idea that has no logical support or sequence in the testimony which has been offered.

The following study of a case that was recently tried indicates conditions that are present far more frequently than would be supposed:

The case was murder, in which an intricate chain of circumstantial evidence pointed to one of three men as guilty. The jury was composed of five farmers, four mechanics, and three merchants. Nine of them were active muscle workers, living in the open air most of the time, and three were actively engaged indoors. The trial lasted eleven days. The jury were boarded at a hotel, and had no exercise except walking to and from the hotel to the court room three times a day. Four of the jury complained of dull headache. On the fourth day, five of the jury had attacks of indigestion, with pain and nausea. One had chills on the night of the same day, and was given quinine freely. Two men had attacks of what was called rheumatism, consisting of pain and stiffness of the muscles, and a physician was called. Eight suffered from insomnia and constipation after the fifth night. All suffered from bad feeling and dizziness while in the court room in the afternoons. Four had coughs and colds, for which rock candy and rye whisky were freely used. Several experienced extreme drowsiness in the court room. The arguments of counsel and the judge's charge occupied a day and a half. After the verdict and the discharge of the jury, four of them were confined to bed for several days. Here were twelve men, suffering from functional disturbances due to bad air, changed surroundings, and auto-intoxications, called to decide the issues of life and death.

In a case of murder and incendiarism, where the verdict of the jury was criticised severely, the following were the facts: The jury was composed of farmers, miners, tradesmen, and mechanics. Four of them were sufferers from cough and influenza; six complained of loss of appetite and headache; one suffered from malaria, so called; and one from a return of an old rheumatic attack. The trial lasted eight days, and most of the time the jurymen were practically sick—made so by the surroundings and changed conditions of living. The diet of hotels, consisting of rich meats and desserts in great variety, is usually different from the average food of the average jurymen, particularly of the working class. The result is always overeating and under-exercise. This alone would quickly break up or disorder the mental activities. In addition to this, the confinement in the bad air of court rooms brings new sources of poisoning, particularly deficient oxidation, which of itself is sufficient to derange the normal brain functions. The crowded rooms at hotels are either overheated and badly ventilated or cold and noisy. The time for retiring and rising varies, and the usual habits of the juryman are changed in every respect. His accustomed food, sleep, and exercise, and his manner of thinking and the subject of his thoughts, all are broken up. He is asked to follow an intricate chain of reasoning, and discriminate the errors, and told that this is true and that is true, and that the law should lead him to some other point. He is flattered, and his pride is roused to do the best he can. He grows more incapacitated daily as the evidence accumulates and his system becomes deranged. Then, in despair, he will suddenly form some conclusion, guided by a fancy for some attorney or some remark by the judge. Perhaps a stubborn member of the jury has formed a conviction on the first day of the trial, and all the rest of the time is passed unconscious of evidence, *pro* or *con*, and in the jury room his very stubbornness wins.

In a noted murder trial at Portland, Me., it was evident that the jury had been impressed favorably to the prisoner. The prosecuting attorney suggested to the sheriff that he invite the jury to church Sunday evening to hear a noted preacher. The topic of the clergyman was, "God's Hatred of Sin, and DIVINE JUDGMENT." The attorney knew the topic and the intense dogmatism of the preacher, and calculated its effect on the jury. A verdict of conviction followed, due almost entirely to the sermon.

The personal characteristics of the jury are often the only doors through which they can be influenced. Religious, political, and social or personal prejudices are often considered by counsel in the presentation of the evidence. In reality, the average juryman becomes more incapacitated to rise above his prejudices, or to reason impartially, every day he is confined to the court room. At the end of a long trial he is utterly unable to form any new views, and nothing remains but his old prejudices, and these are often more fixed than ever.

The following record of a juryman's experience was made by a carpenter of more than average intelligence. He put down each night his impressions: The first day he was impressed with the magnitude of the case and the sadness of the prisoner. He did not sleep the first night, for the reason that four men occupied one room. The air was bad, and two men snored loudly.

The second day he tried to remember all that the witnesses said, and its bearing on the case, and at night was very weary and went to bed early, but was wakened and disturbed by the other jurors. The third day his head ached, and he could with difficulty follow the testimony. His appetite was poor and he was drowsy. The fourth day he was astonished to hear opposing evidence; statements which had been made by apparently honest men were affirmed to be false. He was shocked, and his first impressions and personal interest were disturbed. His head ached, and he felt weak and nervous; his appetite and sleep were broken. The fifth day he gave up all efforts to follow the testimony, or to understand what was said. He felt stupid and excessively tired. The other jurors began to complain of the food and the sleeping rooms, and had several quarrels with each other on religious and political matters. Foolish stories were told, and card-playing and personal boasting filled up the evenings. They all manifested disgust at the trial, and longed for the end, and declared they would never be caught in a similar case. On the sixth day the case was closed. The arguments of attorneys and the judge's charge seemed very dull and wearisome. He felt sick, looked forward to a release, and his interest in the case had died out. He could not understand why so much was said that was contradictory, and why the judge should not tell them the real facts of the case. In the jury room no discussion took place: each one voted "guilty" or not "guilty"; and when they found the majority was "guilty," most of them followed the majority. Two of the minority became angry, and refused to vote for over a day, except in favor of the prisoner. They gave no reasons for their belief, only saying that they were right and the rest of the jury were wrong. Finally, one of these men was accused of having some personal object in voting for the prisoner, and after a short altercation he changed, and the other man followed him, and the verdict "guilty" was agreed upon.

In my experience as an expert witness I have frequently noted the change of feelings in a moderate-drinking juror. If the prisoner was an inebriate, and the crime associated with excessive use of alcohol, the first two days of the trial all moderate-drinking jurymen manifest strong feeling for the prisoner. Later, when they become tired, dull, and debilitated by the surroundings, all this feeling changes to severity and desire to punish, no matter what the evidence may be. All natural sentiments of sympathy and kindness are replaced by the coarser, lower motives, as the brain becomes disordered and weakened. If any of the jury have had a similar weakness or committed a similar crime, they usually urge most severe punishment, and especially after they lose their mental vigor in the bad air of the court room. In some cases the opposite prevails, and jurors are strangely stubborn in their unreasoning convictions for the prisoner. This is naturally the outcome of placing untrained men in positions which they can not fill, and requiring of them clear judgment under circumstances where it is almost impossible to act normally.

WHY CHILDREN LIE.

By NATHAN OPPENHEIM, M. D.

IT is not many years ago that the occurrence of pulmonary tuberculosis in a person stamped the family of the sufferer as tainted. So lax was the common as well as the professional logic, and so imperfect were the observations drawn from experience, that the fact of inheritance clearly seen in some diseases was immediately applied to all cases where there was any ground for the analogy. What was true of one case must necessarily be true of all others that seemed similar; and the growing belief in heredity helped to make this opinion progressively stronger. Even to-day there still remains with thousands of people a belief in the "taint" of a family that has unfortunately had a tubercular disease in one of its members, and the general public is merely beginning to awaken to the distinction between an inherited disease and an inherited *predisposition* to that disease. As a matter of fact there exists between these two things the widest space; indeed, a predisposition may act as a warning, may insure a greater care and a better conformity to laws of right living, so that the threatened persons are often able to avoid dangers which formerly they might have dreaded as inevitable.

Tuberculosis is not by any means the only sickness which carries with it a widespread "taint." In the same way that an almost insuperable objection to a man or a woman contemplating marriage was a "consumptive strain in the blood," so an equally potent obstacle was relation to a lunatic. There are still other parallels between the two cases: one's brother who died of pulmonary consumption cast a cloud upon one's physical reputation; but if that same brother had suffered from a white swelling of the knee (tuberculosis of the joint), it carried but little significance with it. Likewise, mania cursed a whole family in all its ramifications; but marked eccentricity, kleptomania, or wrong conduct amounting to what we now call moral insanity would be entirely harmless, would be strictly confined to the person in whom it appeared.

This lack of knowledge and the consequent laxity in judgment have wide-reaching results. Outside of those immediately apparent they influence so intimately our methods and standards of education and culture that they call for more attention than has yet been given them. It is particularly in regard to education and the environment of children that I make these remarks, because here the effects act most powerfully for good or bad. Every day I see children who exhibit these educational distortions, many of which seem to a certain extent superfluous. And nothing is more common than to find children, with an evidently rudimentary conception of truth, who willfully and often for no reason make exaggerated or false statements, who seem really to deceive themselves as well as others, who make their relatives miserable by threatened lack of responsibility, which, spreading out in many ways, points to an unhappy or disgraceful life.

This fear is so common that the majority of people, I fancy, have felt it more or less. It is so natural to regard truth as the foundation of our whole moral structure, to look upon it as the loveliest product of a fine character, that any deviation from it must necessarily be held as most unfortunate. I should be similarly impressed if I did not feel certain that the fear is often wrongly placed, that this habitual telling of falsehood has its origin, not in viciousness or a spontaneous desire to deceive, but rather in causes for which the person is not entirely responsible; which, on the contrary, are the natural results of natural causes.

The origin is to be sought among the fundamental workings of the mind; it begins with our first attempts at perception, our first uses of words. A word is always a more or less complex idea composed of more than one sort of image. According to our innate tendencies these will be predominant as visual or speech or writing or auditory images. They are elements which every one's judgment in expression must use, and the variations give each person his individuality. Most of us think in speech conceptions; we hear rather than see our thoughts. It is only occasional that we find a man who sees a mental image of a concept, who clothes his thoughts in written words. When we do, we have found an artist who sees and remembers thoughts as well as things as definite memory pictures. Again, there is a class who speak or write their thoughts internally, but the thought or the thing is always expressed in letters. This association of thought with writing movements is most often found in those of a decidedly literary tendency, whose concepts appear to their consciousness as printed lines. Of course, it goes without saying that no one is absolutely confined to any one method. It is merely the predominance which is sufficiently marked to give a trend of individuality.

All these methods are simply the internal process of speech, they are the body of our concepts. Likewise there must be an external process, our method of expression—words. But it is not entirely essential that words should accompany the conceptions, and as a matter of fact we find in certain nervous conditions just exactly this state of affairs. And it is just at this point, as we shall very shortly see, that we may look for a frequent cause of the unnecessary, the unexplainable, the habitual lie.

The natural inference is that between the formation of a concept and the rightful expression of it there must be a direct and uninterrupted connection, with the least tendency to interference from cross-currents, with the fewest possible obstacles from exaggerated inhibitions. This condition finds a parallel to a certain extent in the phenomena of producing electric energy, its transmission in a current, and its final exhibition in some palpable way. Now, in order to insure this connection there must be perfect insulation, a perfect protection against opportunities for divergence, a guard and a help for the characteristic activity. In mental workings we have this insulation in memory, the principal property of nerve substance, the result of repeated and continued impressions. As concepts are conveyed through the senses, so the repeated recognition and use of them are provided for by the memory activity; and upon the normal and exact co-ordination of this activity do our mental workings depend. The relation and combination of remembered concepts must be absolutely regular, must coincide with the normal standard in order to give the person an image which will correspond with that of his fellows, which will appeal to them as really true.

But suppose, as most people affirm, that there is a particle of insanity in every one's make-up; let us for the time admit that there are variations from the normal in every man. We are then forced to say that, as the standard of the normal can not vary, it naturally follows that deficiencies are abnormities, are signs of degeneration, are signs which point to a lack of sanity. This does not mean that men so constituted are not fit to be trusted in the general affairs of life or to fill their places in the world. In the same way a man may be weak in the knees and still be capable of locomotion, even though he halt. Nevertheless, such a man is susceptible of mishaps and accidents brought on by natural inability; and, moreover, no one would be justified in punishing him for such accidents. In the same way no one would think of blaming a man because he was color-blind, any more than of punishing a woman because she happened to be unable to distinguish smells. By these analogies we merely conclude that we constantly find variations from the normal occurring spontaneously which nevertheless do not prevent the possessor from mingling with others on the ordinary footing of social and business intercourse. This principle has long been recognized among lower animals, but there is a natural prejudice against applying similar rules to men.

Likewise is this true concerning man from his first growth. He is born with the *possibility* of various characteristics and individual peculiarities. Just exactly what these will be and how far they will develop depend to a considerable extent upon his environment. Of course, it goes without saying that heredity counts for much, although heredity is not everything. Most of all is it not supreme in view of the fact that our system of education and culture has the strongest tendency for leveling, for mediocrity. Our infant education, our school life, domestic life, social life, all tend to trim away whatever of originality—good or otherwise—the individual may possess. Our methods are mainly inhibitory: we are constantly talking about what one must *not* do. The decalogue itself, the declaration of our moral and religious code, is couched mostly in terms of negative command. Thou shalt *not* steal, thou shalt *not* lie, thou shalt *not* worship idols, it says; and this is far different, when reasoned about broadly, from *speak the truth, be honest, love God.*

Given, then, a tendency to variations from the normal, it follows that our principal care should be to ascertain what this normal is, and to conform to it. But, so far as common experience goes, this is the last thing to be carefully worked out. The tendencies to variation are emphasized by the frequent liability to inferior physical conditions. Some of these are so remote that they would be thought of only by the physician-psychologist, while others are of such common occurrence that every practitioner is familiar with them. Now, one of the most striking of these—unfortunately not frequently noticed except in its ultimate exaggerations—is that disturbance of conception produced locally in the cortex of the brain by which the person is unable to distinguish between the internal processes and their external causal conditions. If the ability to differentiate is impaired, an hallucination is present, dependent upon processes in those parts of the brain which preserve memory pictures of the most varied kinds. As the result of this condition we may have expressions and acts which are seemingly at utter variance with the actual premises from which they start. The familiar example of the different views which two knights looking upon opposite sides of a shield take, is an old and trite attempt at explanation of this condition. In many, many cases it is not merely that people in giving conflicting accounts of a fact see isolated and separate parts thereof; very frequently there is a wider basis: the condition—certainly pathological in its results—of broken connection between internal processes and their external causal conditions. Thus, a child may be reproved by a teacher: we should expect that normally there would be a continuity of concepts beginning with the commission of a breach of discipline, followed by correction from the teacher, and ending in improved conduct on the part of the scholar. But frequently this chain is broken. The child fails to recognize the connection between these component parts, or certain parts are obliterated and others exaggerated, or the impression is cross-currented or side-tracked, with the result that the final impression and account of the matter may be widely divergent from the original facts. The conclusion usually is that the child has been willfully lying. Again, the child may see two dogs playing together, and, being subject to abnormal mental processes, comes to his mother with a tale of a horrible struggle between ferocious bears, with imminent danger to himself. The startling element in the matter is that usually the parents either smile indulgently, remarking that the child has a vivid imagination, or on the other hand they will punish him for an attempt at causeless and vicious deceit.

However, I should consider this explanation problematical if it had no further basis than an obscure mental condition. But as soon as one looks carefully at the matter one is strongly impressed by the number of additional conditions which may act in similar ways. Indeed, the matter becomes so plain that we may say, broadly, that any cause which makes for intellectual tenuity has a tendency to bring about this state of things. Recently we have named this psychical trauma, a morbid nervous condition caused by repeated injurious impressions; and it is a fact that beyond distinct mental disorders codified as diseases some of the lower emotional and mental activities may in the same way be markedly injured. We have evidence of this from such signs as nervous digestive disorders, hysterical attacks, loss of sleep otherwise inexplicable, disturbances of flushing and pallor, all of which may be results of psychical effects repeated again and again. These symptoms should not be called diseases, or in any way primary disorders; they are merely natural results which flow from natural causes, just like the loss of self-control in fright or breathlessness from the shock of cold water. The continued repetition of them wears, as it were, a rut in the brain, so that any impulse approaching it slips out of its ordinary path in the direction at once of least resistance and utter distortion. Again, the very faulty methods of our teaching by rote, of mechanical repetition and memorizing, which seems to be the basis of our school system, must necessarily lean toward psychical poverty; and the more these vicious stimuli are repeated, the greater must be the effect toward an unfortunate end.

Still, there are other causes, of a purely physical nature, which doubtless will appeal more strongly to most readers. It is well known that the products of fermentation and putrefaction found as a result of faulty assimilation of food may act as irritants, either in the way of repressing normal impulses or exaggerating feeble sensory impressions, to the end that the relation of concepts may be quite broken, and even go so far as to assume the dignity of full illusions. A full list and explanation of the possible causes of disturbances of the perceptive process would be beyond the scope of this article; although it is distinctly in place, I believe, to mention a few of the most common, simply to give an idea of the wide range which they occupy. Among them are diseases of the eye, such as phenomena which occur in the end distribution of the optic nerve, among which are light phenomena developed in the retina, the so-called light dust of the internal field of vision, and the shadowings and polychrome pictures. These are all aided by processes in the retinal vessels, such as those involving the blood-corpuscles; likewise the pulsations of the central artery, opacities of the cornea and vitreous, and indeed all conditions producing entoptic shadows on the retina may give rise to illusions. And these are not all; in addition we may include catarrhs of the middle ear, irritations of mucous membranes and the skin of the head and face, blows and falls upon the head, as well as morbid changes in the viscera and muscles.

The sum of the matter is this: We constantly see children who lie habitually, and usually for no recognized reason. This habit is commonly looked upon as an indication of spontaneous viciousness. In the majority of cases this opinion has no basis in fact. The children usually are suffering from disorders of mind or body, or both, which radically interfere with the transmission of conceptions and perceptions from the internal to the external processes of expression, so that they are really unable to be more exact than they seem; usually these peculiarities are either neglected or cause severe punishments to be inflicted, with the natural result that they are confirmed and added to by various unfavorable characteristics of cruelty, revenge, slyness, and *actual* deceit.

Lying does not necessarily mean viciousness, nor is truth to be regarded merely as a saving means of grace. On the contrary, many a child may be led to forget the lie simply by being placed in proper physical and mental environments.

THE result of an experiment instituted to determine the effect of rhythm on the visibility of a succession of optical signals, tried by M. Charles Henry at the Dépôt des Phares, France, is to show that it is possible to increase the range through which an optical signal will carry by adjusting the succession of flashes according to a sufficiently complex nonrhythmical law.

MORBID HEREDITY.

By M. CH. FÉRÉ.

THE study of morbid heredity is full of interest, because the knowledge of its laws may assist us in finding preventive measures against it, and because it may thereby be a means of comforting persons who are under those laws. In seeking a definition of morbid heredity, we first take Sanson's definition of biological heredity as the transmission from ascendants to descendants, by sexual generation, of natural or acquired properties. With acquired properties we may include morbid ones. Heredity of morbid properties seems to obey the same law as heredity of natural properties, for which we may accept Darwin's formulas of—1. The law of direct and immediate heredity, under which parents tend to transmit their physical and moral characteristics to their descendants. 2. The law of predominance of direct heredity, under which the character of one of the two progenitors is predominant in the product. 3. The law of heredity in reversion, racial heredity, which is applicable to the often-observed facts of atavism, or the reappearance in descendants of the characteristics of a more or less remote ancestor; and 4. The law of homochronous heredity, or the reappearance of hereditary characteristics at the same periods of life in ascendants and descendants.

Morbid heredity does not inevitably obey the laws of direct heredity. It is a well-known fact that diseases in morbid families are not usually transmitted with a perfect likeness. The homologous or similar heredity, which is observed chiefly as to mental diseases, is rare as to other diseases. Usually the disease is modified in descent. A diabetic patient produces an ataxic son, or a hysterical daughter, or an epileptic child. John Hunter seems to have anticipated these variations when he maintained the existence not of hereditary diseases proper, but of a hereditary disposition to contract them—a hypothesis which, though somewhat vague, may account for dissimilar heredity and also for the frequent happy absence of heredity. The probability of morbid heredity manifesting itself is increased when both the parents are attainted with the same defect. Consanguineous marriages, which have been charged with being an important factor in the genesis of neuropathy, of deaf-mutism, and of degeneration in general, really are of effect only through the accumulation of heredity. Consanguinity favors the heredity both of good and of bad family qualities. In healthy families it is desirable; in morbid families it should be shunned.

Pathological selection of nervous parties, who seem to be attracted to one another by invincible sympathies, involves the same probabilities of degeneration as morbid consanguinity. It appears with nervous, hysterical, and veneric persons, and with criminals, among whom vice becomes the basis of unions leading to progressive degeneracy.

Some infectious diseases, usually propagated by contagion, may be transmitted to the child by the mother, or even by the father, while the mother remains free from them. The disease being due to a special agent of infection, that is, to a being with an existence of its own, such transmission can not, properly speaking, be regarded as a fact of heredity. The generative agents have served only as vehicles for the morbid agent or its products. What has been transmitted is not a natural characteristic, or even a definitely acquired characteristic, but a strange and accidentally imposed property, susceptible of disappearing or of being destroyed. Transmission of this kind does not correspond with the definition of biological heredity. Direct heredity of certain diseases has attracted the attention of observers of all times, and has been most regularly noticed in mental diseases.

The family defect is very often exhibited gradually. One or more generations manifest slight troubles, which we might call preparatory. Heredity has to be accumulated, capitalized, as it were, before displaying itself as a morbid entity to which we can give a name. We often find individuals among the ancestors of insane persons, individuals subject to overexcitement, enthusiasts, originals, unfortunate inventors, dissipated persons, or men of irregular life or afflicted with mental or moral eccentricities.

Heredity is not manifested in the same degree in all the forms of madness, and is less evident in the acute than in the chronic forms. Mental troubles generally are most likely to transmit themselves by heredity when they are active at the moment of conception. They are less surely transmissible if their activity in the progenitors is suspended at the time, and especially if the first attack does not come on till after the birth of the child. The fact that we occasionally see a person who has not yet been insane transmit the predisposition to become so to his descendants demonstrates that it is not the disease itself, but the aptitude to acquire it that is transmitted. Accumulated heredity often results in the production of individuals distinguished by physical malformations or by abnormal emotionalisms, constituting what are called the physical and the psychical stigmata of degeneracy. Yet we can not say that heredity impresses special characteristics on madness. But persons inheriting morbid tendencies are more sensitive to excitement of every kind, and more frequently suffer acute irritations under the influence of insignificant causes, while most usually these irritations disappear as easily and as abruptly as they came on.

It is now impossible to deny the heredity of mental troubles, as well of those in the case of which we do not know the accompanying anatomical lesions as of those with which we think we are better acquainted, as in general paralysis and senile dementia. Still less doubtful is it that our cases are most frequently not of direct and identical heredity, but usually of what we call collateral and dissimilar heredity. The son may not inherit from his father, and if the nephew inherits, he will generally seem to be afflicted with a different mental affection from that of his uncle. It must, therefore, be understood that what is meant by heredity in mental diseases does not necessarily correspond with the definition of normal biological heredity.

This frequent dissimilarity in the inheritance of madness becomes more clearly defined when we regard the alliances of the psychopathic family. Nervous troubles very different in their manifestations are frequently met with in families of insane. Prichard has given the name of moral insanity to a mental trouble which prompts to abnormal or mischievous acts while consciousness of their moral nature is wanting. This kind of insanity differs from the impulsive insanity, in which the patient is urged to violent, harmful, or criminal acts by a force which, though invincible, leaves him able to appreciate more or less sanely the character of those acts.

Vice and crime are, furthermore, often hereditary, like insanity. More frequently they are met in families combined with the most various mental disorders—insanity, imbecility, idiocy, etc. The combination of insanity and crime is observed not only in the same family, but often, too, in the same person. Physicians of penitentiaries have long insisted on the frequency of mental disorders among the convicts, and have become convinced that the causes of what is called prison-madness are inherent in the prisoners and not in the prison. It has, moreover, been remarked that debauchery and instinctive perversions are often met with in the hereditary antecedents of insane persons.

Not criminality only has family connections with insanity, but the artistic temperament and genius are frequently associated with it. An old writer has said that there never was a great genius who had not some tinge of insanity. Numerous men, illustrious under different titles, have been attacked with various mental troubles, or have belonged to families in which such troubles were common. The frequency of such associations suggested to Moreau de Tours his saying that genius is a nervous disorder. Further, while great men are rarely exempt from a trace of folly, madmen have no less frequently had a share of genius. Thus we sometimes find in the asylums calculators and musicians of remarkable aptitude in their respective lines. M. H. Nordau (Degeneration, 1893) has endeavored to demonstrate the constancy of these associations in a special category of artists and literary men whose imagination seems to rejoice in its departure from common ideas. He is liable to criticism for not having comprehended that the madness of these supposed degenerates consisted simply in seeking to surprise or scandalize, and that at bottom their thoughts were not much different from those of their contemporaries. While this criticism may be just as to M. Nordau, it can not clear the authors concerned from the suspicion of insanity.

Civilization favors the production of exceptional beings, men of genius as well as those most degraded by vice or by mental perturbations. The most civilized nations are as much distinguished by the number of their insane and criminals as by that of their men of talent. Civilization produces variation or excites the tendency to it, and it is manifested chiefly in the masculine sex. The parallel development of insanity, genius, and crime constitutes one of the most interesting illustrations of the tendency to variation which characterizes the evolution of mankind, and which results in a progressive inequality, against which the restrictive laws of individualism are of no avail.

Psychical disorders are often associated in families and individuals with other diseases of the nervous system, either growing out of lesions or not connected with known lesions—nervous affections. The relative frequency or nervous manifestations, whether isolated or associated with nervous or other diseases which we shall consider, is so predominant that all such family morbid manifestations may be designated under the name of neuropathic family.

Nervous diseases may be hereditary, and pass directly from father to son; examples of such are locomotor ataxy, epilepsy, and hysteria; but indirect and dissimilar heredity, as in psychopathies, is more usually observed. Family connections between diseases from lesions of the nervous system and nervous affections are proved by frequent coincidences among relatives, and also by their manifestations in the same person, either at the same time or in different periods of his life. Not rarely, further, are mental and neuropathic troubles met with in the history of the same person; and, moreover, a number of diseases are marked by both classes of symptoms.

The already somewhat chaotic picture of morbid heredity would still be incomplete if we omitted to add that among the members of a nervous family we often meet individuals affected with disorders of nutrition—gout, chronic rheumatism, diabetes—quite often hereditary diseases which, as much by their course as by their relationship, deserve the name of nutritional nervous affections. It should be observed further that other diseases, parasitic or suspected to be so, like tuberculosis and cancer, appear more frequently in the same families. The last coincidence may be explained by the fact that the system of nerves regulating nutrition may, when its activity is weak, diminish the resistance of the organism and favor the action of morbid agents.

The question of morbid heredity is still more complicated by the established facts that in a large number of tainted families there exist individuals wholly exempt, while the exceptional character of their cases can not be interpreted by the uncertainties of paternity; and that a considerable number of affections usually regarded as hereditary or peculiar to the family may appear in a family independently of all heredity. Many diseases are known that merit the title of family disorders and attack several children of a single generation without its being possible to find anything like them in either the paternal or the maternal line. The persistence of healthy individuals in an unhealthy family may be explained by atavism; but the appearance of a family disease without any resemblance among the ascendants constitutes an exception to the laws of normal heredity.

We are justified in charging certain toxic or infectious agents with being capable of determining, by the influence they exercise upon progenitors, the same morbid predispositions as heredity. Thus, we can attribute to chronic alcoholism, to saturnism, to morphinism, and to other habits of intoxication of parents a considerable number of nervous affections and psychopathies which are developed in the children at different ages, and confer upon them characters quite different from the characters of their parents. Acute transitory intoxications may have the same effect; and drunkenness of parents at the moment of conception or during gestation has been charged with producing imbecility, idiocy, epilepsy, and other diseases in the children.

The effect of intoxication by drugs may likewise be induced by emotional intoxication. The acute or chronic emotions of the mother during gestation may undoubtedly have a noxious influence upon the child and determine troubles of development in it, which may be manifested by anomalies of forms or by functional troubles revealing anomalies of structure. Bad food or defective hygiene, acting directly upon the nutrition of the mother, may have the same effects. All these conditions, finally, may be accumulated under certain circumstances.

In short, the predisposition to disease may be hereditary or congenital. Hereditary transmission is, however, not inevitable, and most frequently it is due to very diverse conditions in the nutrition of the progenitors. Some authors have associated the idea of degeneration with that of heredity, and designate a whole category of disorders under the name of hereditary degenerations;

but many persons who exhibit the characteristics of this category have not inherited them. The necessity of this connection between degeneration and heredity ought to disappear along with the notion of inevitable heredity. We may degenerate without a hereditary tendency thereto, and we may escape morbid heredity. Diseases which are developed simply on account of a hereditary or congenital disposition constitute manifestations of a tendency to degeneration. Morel showed long ago that a race of insane, whatever its origin, tends to exhaust itself in the fourth generation. The fact is found to apply to other hereditary diseases. The tendency to become sterile is, like dissimilarity, an indication of the diminishing vitality which constitutes degeneration, and may be found in plant as well as in animal species. Mr. Dixon has shown, as Morel demonstrated for pathological families, that mulatto stocks die out unless they are crossed with negroes or with whites, and the fourth generation usually marks the limit of their continuance. We have, therefore, a right to infer that it is by degeneration that various diseases which rarely arise except in consequence of a morbid predisposition are met with in the same families.

Congenital malformations act also frequently like the diseases with which they are found associated. Teratological heredity includes facts very like those which have been marked in pathological heredity. While we observe such malformations as sexdigitism, syndactyly, and ectrodactyly transmitted directly for several generations, we more usually see different deformities in the same family. This is because the malformation may vary in form and seat according to the age of the embryo in which a disorder of nutrition is produced. It has even been assumed that variation of species may have had a teratological origin; but we are acquainted with very few deformities that have been definitely established. If the tailless cats of Japan and the Isle of Man are of teratological origin, they constitute a unique exception. While we often observe various deformities in the same family, it is not more rare to meet a number of anomalies in the same person—a phenomenon which deserves special attention.

Most of the deformities compatible with life may be coincident with affections of the nervous system; and the patients whose nervous systems are most gravely affected are just those who present multiple deformities; idiots and imbeciles nearly always exhibit congenital anomalies, which likewise frequently occur in deaf-mutes, epileptics, etc. The anomalies found in the insane are less gross, but appear more frequently in proportion as the morphology of that class of patients is more carefully studied. The study of physical anomalies in neuropaths, though they are not less common, is still more frequently neglected. With epileptics who have been attacked at an advanced age, and who had consequently resisted a large number of provocative agencies, fewer anomalies are found than among those who were attacked in infancy or youth. If the former held out against a larger number of occasional causes, it was because they were less predisposed, as they were less abnormal.

Teratological abnormities resemble neuropathies not only in their origin and the characteristics of their hereditability, but there can be found in their genesis, besides heredity, all the defective conditions of generation and gestation that have been charged, and justly, with the faculty of giving rise to disorders of the nervous system—emotions, shocks, defective food, alcoholism or any other intoxication, infections, etc. The greater frequency has been noticed of deformities among natural children in cases of conception during intoxication, disproportion in the age of progenitors, etc.

As the masculine sex appears to present a more marked tendency to variation in respect to development and in mental disorders, so it seems to do likewise as regards morphology. Mr. Francis Warner, who has recently examined fifty thousand children in English schools, found 8·27 per cent of physical anomalies among the boys and only 6·78 per cent among the girls. Functional anomalies were also more frequent among the boys.

Like monstrosity, morbid predisposition is the result of a disturbed evolution. In the same way as in families anomalies in form may manifest themselves in very diverse localizations, so anomalies in structure may be variously seated. It is thus comprehensible how, under the influence of the different conditions that usually provoke the manifestations of hereditary diseases—puberty, menopause, fatigue, physical or moral shocks, intoxications, or infections—we observe diverse affections appearing in the same family, but most usually bearing upon the same system. It is worthy of remark that most of these provocative conditions act simply by virtue of the exhaustion that results from them. Growth is usually included among the conditions favorable to the development of disease; but in reality periods of growth, when the processes of nutrition are most energetic, can be and are nothing but periods of resistance; and the susceptibility to attack is developed in the times following periods of growth, particularly of active growth.

The disturbances in evolution of the nervous system are most important in the consideration of the origin of diseases because that system is dominant in the phenomena of the life of nutrition, as well as in those of the life of relation. These disturbances may account for the numerous varieties of morbid manifestations in pathological families.

The want of resemblance in descent observed in pathological and teratological families evidences the want of embryogenic energy which is so accentuated in those families as to end in sterility after a few generations. The attenuation of embryogenic force which may be signalized by failures of very different elements may serve to interpret what is called dissimilar morbid heredity and that paradoxical heredity designated as collateral morbid heredity.

It should be remarked that dissimilarity in morbid families is not absolutely fortuitous. The head of a family gives rise to offspring suffering from different and differently seated disorders of evolution, that cause various morbid predispositions, the variety of which is, however, not so great but that we can find analogies in the manifestation capable of giving a family resemblance to them. Degeneration, in fact, does not take effect except under a kind of rule. As Morel has well observed, unlike degenerates of one family resemble unlike degenerates of another family to such an extent that, like monsters, they are susceptible, wheresoever they may come from, of a scientific classification. Degeneration has its laws the same as normal evolution; whatever may be its cause, it is manifested under a relatively restricted number of common forms.

The theory of the teratological origin of manifestations of morbid heredity is really the only one that will allow us to explain how very diverse conditions of generation, such as extreme youth or too advanced age of progenitors, disproportion in their ages, permanent or even transitory disorders in their vitality, drunkenness, intoxications, infections, accidental exhaustion of the nervous system, or acquired neurasthenia, can produce the same effects as morbid heredity. We should not, in fact, be surprised at finding that degenerates by heredity are not different from degenerates in consequence of disorders of nutrition in progenitors, since degeneration in general results from embryogenical troubles which are reduced, as a whole, to troubles of nutrition. The teratological theory of morbid heredity and of degeneration permits us to comprehend not only unlikeness in morbid heredity, but also the absence of heredity in diseases of the group presumed to be hereditary, but which might be more correctly called degenerative.

Greater importance attaches to disorders of development, when we regard their consequences, as they are produced at a period nearer the beginning of the evolution. External forms are fixed long before the structure of the organs has reached perfection. Thus in man birth finds some parts of the nervous system—and the most important ones, when the light of relation is regarded—in full development. It is therefore easily comprehensible that evolutionary disorders of the nervous system due to morbid heredity or provoked by influences of the medium may exist without external morbid aberrations. Furthermore, many lesions of the centers met with in neuropathic families in which no external deformities have been found have been attributed to evolutionary troubles of the nervous system.

A race is formed by the fixing of the specific characteristics transmissible by sexual generation. The families and the individuals composing the race transmit to their descendants characteristics of the family and individual characteristics combining themselves in infinite variety to constitute personalities which are yet capable of differing only in limited measure. When the specific qualities that characterize the race cease to be transmitted by heredity; when the children in a family cease to resemble their parents and their brothers and sisters without recovering an ancestral type, and there results a defective change in the adaptation to the physical and social medium, we say that the race is degenerating. By degeneration should be understood the loss of the hereditary qualities that have determined and fixed the characteristics of the race. The characteristic of what is called in human races morbid heredity, which is simply a degeneration, is an abnormal tendency to variation in the posterity, which becomes, in consequence of physical, mental, and moral faults, progressively capable of adapting itself. In the artificial races of domestic animals the result of degeneration is often reversion to a primitive type of the species with capacity to recover the old adaptations. The designation race has in this case been really given to variety, the hereditary qualities of which had not the fixity that characterizes a race. No reversions are observed in the natural races. In the human races in particular degeneration is not manifested, whatever some authors may have said about it, by returns to ancestral forms, but rather by evolutionary disorders bringing on somatic deformities and functional perversions incompatible both with the adaptations now necessary and with ancestral adaptations. Harelip, spina bifida, malconformations of the genital organs, so frequent in degenerates, have nothing to do with ancestral types; and sterility, which is the inevitable outcome of degeneration, can have but little relation to atavism. Considering the matter more closely, we find that the vices in the conformation of degeneration, which we call the stigmata of degeneration, are teratological deformities. If the degenerate fails to give origin to beings that resemble him, it is not because he has acquired the special faculty of transmitting characteristics that do not belong to him, but because degeneration is the dissolution of heredity.

The similarity which we find in the human species among degenerates of different origin—a similarity that permits us to make a classification the scale of which is as a whole narrow enough, has been reproduced in experiments having the provocation of artificial monsters as their object. If the incubation of hen's eggs is disturbed by eccentricities of temperature, if they are warmed too much or not enough, if they are deprived of air, if poisonous substances or substances capable of modifying the nutrition of the embryo—ether, chloroform, alcohol, essences, or nicotine—are introduced into the medium in which they respire, if the same substances are caused to penetrate into the albumen, if they are shaken by abrupt shocks or feeble but repeated blows, monstrosities are generally produced; but it does not appear that any of these causes will provoke exclusively the formation of a special monstrosity. Each of these causes will produce a variety of deformities, any of which may resemble other deformities produced by other causes. In short, the general facts already noticed in degenerating descent may be found in hatches experimentally disturbed—unlikeness in the same families and resemblance of unlike types of one family with those of another.

Besides resulting in ultimate sterility, morbid heredity and degeneration contribute to the destruction of families and races by producing mental and moral differences among them that lead to dissensions and conflicts as mischievous as diseases. When multiple crossings of normal individuals have been effected in a single locality or country, they create in the end both physical resemblances—a family air, a national type—and also psychical likenesses, which entrain a community of tastes and consequently of moral ideas susceptible of becoming fixed for a long series of generations and of constituting a family or national character. The dissolution of heredity, which may be realized either by the introduction of strangers of too different races, or under the influence of native causes of degeneration, is marked both by physical unlikenesses and by the psychical and moral ones that necessarily accompany them. The social discords that spring up among a people like those that so often divide the families of degenerates, taken together, constitute a manifestation of the dissolution of heredity; their source is in a biological fact.

The facts that authorize us to regard morbid heredity or degeneration in general as the consequence of disorders of nutrition during the developmental period of evolution permit us to comprehend the exceptions to the laws of heredity, and consequently to conceive the possibility of securing means of favoring these exceptions and of contending against degeneration.

A strong temptation arises to propose a law prohibiting the marriage of certain categories of degenerates, whereby the natural process of their extinction might be initiated by an artificial sterility. Such a measure would be impracticable, because it would be impossible to fix a limit; and it would certainly be inefficacious in proportion as the temperaments of the persons concerned should be averse to their submission to the laws. The contest may be made by less uncertain processes.

Restoration of a degenerated race—return to mediocrity, as it has been called—may be effected through crossing with individuals of healthy races. M. Sanson has shown, by good examples drawn from zoötechny, that heredity of biological characteristics, and even perhaps of the sex, is generally influenced by the condition of nutrition of the progenitors. The stronger of them attracts the resemblance to his side. It may be assumed that in a union including a morbid factor the healthy factor is in the better position to prevail, and all the more so because it has the atavistic tendency of the other side in its favor. But whether because of the rarity in our time of absolutely healthy elements, or for some other reason, we usually find that, in crossing, the good are more likely to lose than the bad to improve.

There are still other means than happy crossing that may help in the return to mediocrity. Less and less deficient children may be observed to be born in a family of degenerates as the biological conditions of the parents improve. There is nothing surprising in the fact that disorders of nutrition have an injurious influence; all improvements of nutrition may, on the other hand, be accompanied by a correlative amelioration of the products. Generation is, as a whole, the resultant of an excess of nutrition; the lower organisms, absorbing in the medium in which they live more elements than they need for the repair of their losses, increase in volume. When this increase exceeds a certain limit, the individual breaks itself up to form new beings. The process is much more complex in the higher animals, but it is fundamentally the same; and Haeckel has felt free to call reproduction the excrescence of the individual. The best conditions for generation are the best conditions of nutrition. To the regularity of their nutrition is due the regularity of the folding of blastodermic leaflets and the regularity of their further evolution. The arrest of development of a single cell in the earlier periods of evolution is susceptible of determining grave deformations.

Facts observed in human families, in which we see degenerates producing offspring less and less deficient as their own conditions of nutrition improve, indicate that under the influence of a superactivity of nutrition defective organisms might furnish a normal epigenesis. Further, the possibility of combating during the embryonary period the degenerative tendency which is manifested by the delay of development and the frequency of morphological anomalies may be established on the basis of experimental facts which are significant although not very numerous. We find that in the artificial incubation of eggs certain conditions capable of accelerating the normal development are also susceptible of resisting the retarding and deforming influence of disturbing agencies that came into play previous to incubation.

Darwin has remarked that the reproductive function is the most delicate of all, and is also considerably influenced by the medium; in spite of a superabundant alimentation, a large number of wild animals become sterile or produce aborted or deformed offspring by reason simply of being kept in captivity; domestic animals, on the other hand, become more fruitful under the influence of a better *régime*.

If the influences of the medium are reduced simply to modifications of nutrition; if, on the other side, the embryogenic processes are of the same nature as the processes of nutrition in general, we may assume that the influences of the medium which are capable of happily modifying the nutrition of a defective organism are likewise capable of putting it in better conditions to contribute to the development of the embryo.

Finally, observation and experiment indicate that in order to contend with success against morbid heredity and degeneration, which are besides not inevitable, none of the conditions of nutrition, none of the influences of the medium capable of acting on the development should be neglected.—*Translated for The Popular Science Monthly from the Revue des Deux Mondes.*

One day, relates Mr. Murray, the publisher, in Good Words, Mr. Darwin came to the late Mr. Murray with a manuscript. As he laid it upon the table he said: "Mr. Murray, here is a book that has cost me many years of hard labor; the preparation of it has afforded me the greatest interest, but I can hardly hope that it will prove of any interest to the general public. Will you bring it out for me, as you have my other books?" It was the work on Earthworms, which had a large and rapid sale. The incident illustrates the modesty of the man.

A successful experiment in telegraphing by induction without connecting wires has been performed by Mr. W. H. Preece between Oban and Auchnacraig, Scotland, while the submarine cable was broken. A gutta-percha wire a mile and a half long was laid along the ground from Morven, while on the island of Mull use was made of the ordinary overhead wire connecting Craignure with Aros. The distance between the two parallel wires was about three miles and a half. Using a vibrator as transmitter, and a telephone as receiver, the usual messages were successfully dealt with till the cable was repaired.

SKETCH OF WILLIAM CRANCH BOND.

IN seconding the obituary resolutions of the American Academy of Arts and Sciences on the first director of the Harvard College Observatory, ex-President Quincy used these words: "It is not too much to say that the extent of his knowledge, the winning urbanity of his manners, and his exemplary exactness in life and as an observer, in a great degree effected the attainment of those large means and increased powers which ultimately raised to its present prosperous state the observatory over which through subsequent life he watched, and which he left at death honored and improved by his labors and genius." Let us briefly trace the career which could deserve such a testimonial.

William Cranch Bond was born in Portland, Me., September 9, 1789, being the youngest son in a family of several children. His parents, Hannah (Cranch) and William Bond, were natives of England and were married there. The Bond family can be traced to the time of William the Conqueror, by whom Brandon Manor is said to have been granted to the contemporary ancestor of that line. William Bond was born in Plymouth, and became a clock-maker and silversmith. Having been induced to emigrate to America, he located at Portland, then called Falmouth, and engaged in cutting ship timber which he sent to England. In a short time he brought over his family, but the timber business not proving successful, he removed to Boston in 1793 and took up again his former occupation. His shop stood on one of the corners of Milk and Marlboro (now Washington) Streets, the other being occupied by the Old South Church. William C. Bond was then a Boston boy from the age of four years. He had little opportunity to attend school, for the circumstances of the family, as he afterward told Josiah Quincy, "obliged me to become an apprentice to my father before I had learned the multiplication table." But, judging from his later achievements, young William must have been the kind of boy that picks up knowledge, so his lack of set schooling was not so great a misfortune as it might seem.

His eldest sister described him as having been, at the age of fourteen, "a slender boy with soft gray eyes and silky brown hair, quick to observe, yet shrinking from notice, and sensitive to excess." She adds, in reference to his early developed tastes: "The first that I remember was his intense anxiety about the expected total eclipse of the sun of June 16, 1806. He had then no instrument of his own, but watched the event from a house top on Summer Street through a telescope belonging to Mr. Francis Gray, to which somehow he got access. In so doing he injured his eyes, and for a long time was troubled in his vision."

An elder brother writes of him at this early period, "He was the mildest and best tempered boy I ever knew, and his remarkable mechanical genius showed itself very early." He adds that in devising and making bits of apparatus that boys use in their sports, William was chief among his comrades. Before he was fifteen years old he had constructed at odd times a reliable shop chronometer. He had no model to go by, but made it after a description of an instrument used by La Pérouse, the navigator, which he had found in an old French book. Not having a suitable spring to put into it, he contrived to run it by weights. About a year later he made a good working quadrant out of ebony and boxwood, the best materials he had. His son, George Phillips Bond, has thus described this instrument: "It is no rude affair, but every part, especially the graduation, the most difficult of all, shows the neatness, patience, and accuracy of a practiced artist. A better witness to the progress he had already made in astronomy could not be desired. It is all that the materials would admit of, and proves that he must have been, even then, irrevocably devoted to astronomy."

About the time he became of age his father took him into partnership, and the clock-making business was expanded to include the rating, repairing, and making of chronometers. The first seagoing chronometer made in America was made by him in 1812. It at once went into service, and satisfactorily stood the test of a voyage to and from the East Indies. In 1810 the Bonds removed their business to Congress Street, and the family took up its abode in Dorchester.

Mr. Bond regarded his watching of the eclipse when he was seventeen years of age as the event that determined his pursuit of astronomy. Certain it is that he never after then abandoned it. Five years later he first came under the notice of older astronomers, and in this way: Prof. John Farrar, of Harvard College, having caught sight of a comet on September 4, 1811, watched its subsequent progress and published a paper on it in the memoirs of the American Academy. Dr. Nathaniel Bowditch, of Salem, to whom he communicated this discovery, did the same, and the comet was watched also by others. Before presenting his paper to the academy, Prof. Farrar learned that young Bond had seen the comet in the preceding April. He mentioned this fact in the account of his own observations and added the following notes, with which, he says, Mr. Bond had "obligingly favored" him:*

* Much of the material here employed is derived from a historical sketch of the Harvard College Observatory, prepared by Mr. Daniel W. Baker, which first appeared as a series of newspaper articles, and was afterward reprinted in pamphlet form as one of the official publications of the observatory.

"I remarked on the 21st of April a faint, whitish light near the constellation Canis Major projecting a tail about one degree in length, and set down its place as follows: right ascension, 106°; declination, 7° or 8° south. Its motion and the situation of its tail convinced me that it was a comet. I noticed it several times in May, and supposed that its motion was toward the western part of the constellation Leo."

These observations on the comet brought the young chronometer-maker the acquaintance of scientific men and facilities for his favorite pursuit. Up to this time his observations had been made with the rudest appliances. The elder brother already quoted says of these early days: "I suppose it would cause the astronomer royal to laugh could he see the first transit instrument used by us at Dorchester—a strip of brass nailed to the east end of the house, with a hole in it to see a fixed star and note its transit; this in 1813. When we moved into the Hawes house, he procured a good granite block; we dug a deep hole and placed it at the west end of the house, and got Mr. Alger to cast a stand for the transit instrument, a small one, which I think belonged to Harvard College. From this time he began to live among the stars."

Bond's sister also gives an account of the setting up of the first telescope used by him at Dorchester, and says that through it could be seen the satellites of Jupiter and the rings of Saturn. She adds that in the pursuit of astronomy "he had had no assistance whatever, except from the genial kindness of Hon. Josiah Quincy, who had early recognized the future astronomer in the unpretending boy in the watchmaker's shop on Congress Street, and whose kindness and encouragement never failed throughout the subsequent years."

The obstacles in the path of the young astronomer were now rapidly removed. The leading men of science in Boston and vicinity gave him their aid and counsel. "He has mentioned," writes his son, "the names of Dr. Nathaniel Bowditch, Prof. Farrar, and Tutor Clapp as those from whom he received most encouragement to continue the cultivation of astronomy. Upon his friendly intercourse with the eminent mathematician and astronomer first named he often dwelt with peculiar pleasure and warmth of feeling."

Although instruction in astronomy had been given and astronomical observations had been made by the professor of natural philosophy at Harvard for a century or more, the college had not as yet been able to erect an observatory. In 1805 John Lowell, uncle of the founder of the Lowell Institute, had obtained from Delambre in Paris advice as to a building and its equipment. But nothing further was done at that time. Ten years later the college authorities took up the subject anew and appointed a committee to form a plan for an observatory. Mr. Bond was then about to make a trip to England, and his friends Farrar and Bowditch procured for him a commission as agent of the college to obtain information as to the construction and instrumental equipment of the observatory at Greenwich, and to make such drawings as would be needed in constructing an observatory for the college. He was requested also to obtain from the makers the prices of instruments like the principal ones used at Greenwich. "He performed the service," says the writer of the sketch above referred to, "and reported in detail in the following year. That nothing practical came of it for a quarter of a century was not owing to the will but, comparatively speaking, to the poverty of the college.

"This result followed, however, that, upon his return, Mr. Bond constructed the model of an astronomical dome, the operative plan of which was the same as that of the great dome built in 1844, and which has been in satisfactory use at Cambridge to the present time. The chief peculiarity of its mechanism is in the method of rotation by means of smoothly turned spheres of iron. The dome rests on these at equidistant points, and, being set in motion by suitable gearing, the iron balls sustaining its weight roll along a level, circular track of iron, the circumference of which is equal to that of the dome. The method was unlike that previously in use. It appears to have been original with Mr. Bond, as is perhaps evinced by a remark in his report for 1848 referring to the matter: 'If carefully examined, it will be found that this arrangement is as perfect in theory as it is appropriate and convenient in practice.' Experience has shown that spheres of hard bronze are more serviceable than those of iron, and bronze is now used."

While Mr. Bond was abroad, he married, July 18, 1819, his cousin, Selina Cranch, of Kingsbridge, in Devonshire. Returning home, he went to live in Dorchester near his father's residence in a house which he bought. On these premises he erected, about 1823, a small wooden building which he carefully equipped for astronomical observations. This building is meant in the official reference to the "observatory at Dorchester" found in various publications. Its position, as given by Mr. Bond in 1833, was 0° 3′ 15″ east of Harvard Hall in Cambridge.

Mr. Bond now advanced rapidly in his favorite pursuit. "As soon as his circumstances permitted," writes his son, "he imported more perfect apparatus from Europe, and continued to add to his collection until it was the best in the country." In his little observatory "no eclipse or occultation escaped him, though occupied in business during the day in Boston." After gathering for several years materials for investigating the comparative rates of chronometers at sea and on shore, he presented a paper to the American Academy in which he effectually disposed of the scientific question involved, so far as it related to the interests of navigation. Mr. G. P. Bond, who records this, states that his father investigated also the influence of changes of temperature in the presence of large surfaces of iron upon the performance of chronometers, and, "although the conclusions arrived at were at variance with the opinions of men high in authority in such matters, they are now known to be correct."

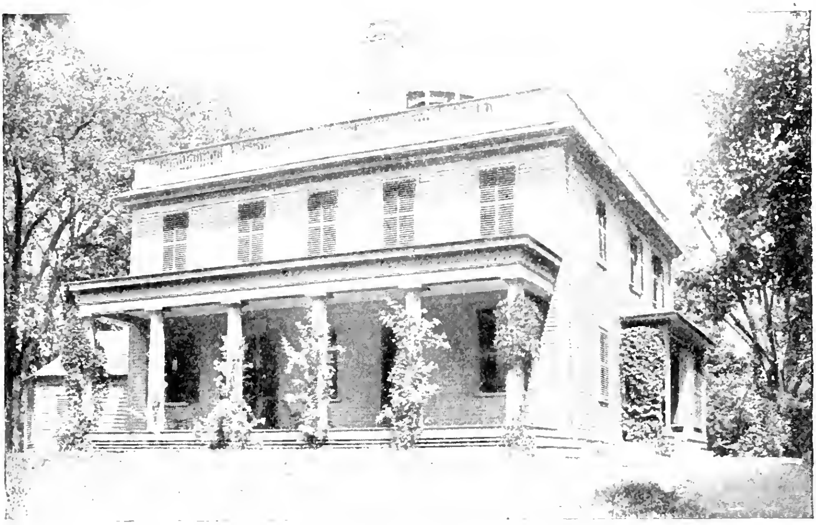
About this time the Navy Department sent out the Wilkes Exploring Expedition, the purpose of which in part was to establish the latitudes and longitudes of uncharted places in distant parts of the world where American commerce was extending, and in part to investigate natural phenomena, including the facts of terrestrial magnetism. In connection with this expedition, Mr. Bond was engaged to make at his private observatory investigations to fix a zero of longitude, whence final reference to Greenwich might be had, and to make a continuous record of magnetic observations at Dorchester for comparison with like records obtained at distant points by the expedition itself. As preliminary to the latter work Mr. Bond tested the magnetic instruments with which the expedition was to be equipped.

Josiah Quincy, who had given Mr. Bond early encouragement, was now President of Harvard College. It occurred to him, to use his own words, "that if Mr. Bond could be induced to transfer his apparatus and residence to Cambridge and pursue his observations there, under the auspices of the university, it would have an important influence in clearing the way for the establishment of an efficient observatory in connection with that seminary."

There was little inducement for Mr. Bond to make the change. His business was prosperous and his home life among friends and neighbors whom he had known for years was very pleasant. The college could offer him no salary—only the use of a house. In his excessive modesty he feared that the arrangement proposed would arouse great expectations that he with the facilities at his command would be unable to satisfy. He made other objections, but all were overcome, and on November 30, 1839, he entered into a contract with the college corporation, agreeing to make the transfer as proposed. A subscription was at once raised for fitting up a dwelling owned by the college to be occupied by Mr. Bond. This building, known as the Dana House, was the first observatory of Harvard College. It still stands upon its original site at the southeast corner of what are distinctively called the college grounds, and is remembered by many Harvard graduates as the residence for a term of years of the Rev. Dr. A. P. Peabody.

Its cupola was placed upon it to accommodate one of Mr. Bond's telescopes, and at that time was suitably domed.

Mr. Bond's chief work at Cambridge for the first two or three years was a continuation and extension of his observations for the Navy Department in regard to the earth's magnetism. He was assisted by his son, W. C. Bond, Jr., whose death in 1842 was regarded as a loss to science. Renewed exertions were now made to secure an adequate observatory and set of instruments. The site was purchased in 1841. A brilliant comet that appeared in 1843 furnished a favorable occasion for raising a subscription. The best telescope that could be produced in Europe, a refractor of fifteen inches aperture, equatorially mounted, was ordered from Merz & Mahler, of Munich, and ground was broken for a pier for it in the summer of the same year. In September, 1844,



THE DANA HOUSE. First observatory of Harvard College.

the instruments were removed from the Dana House to the new observatory, and Mr. Bond entered upon a series of observations for determining the latitude and longitude of the new station.

Mr. Bond's first recorded observation in Cambridge was of date December 31, 1839, and his appointment as director of the observatory dates from February 12, 1840. During the first eight years of his connection with Harvard College he is to be regarded as a benefactor rather than an employee of the institution. The official report for 1846 states that up to that time the labors of Mr. Bond had been "entirely unrequited, except by the gratification of his love of science and of home," and suggest that this devotion to the institution at Cambridge was the more marked in that during the preceding spring he had declined "the almost unlimited offers made to him by the administration at Washington to induce him to take charge of the observatory there." It is known also that frequent expenditures of his own money were made during this period for current expenses and for things convenient in conducting the observatory—sums small severally, no doubt, but considerable in the total. In 1846 a sum equal to the proposed salaries for the next two years was subscribed by citizens of Boston, and in 1849 the official board was able to report that "through a bequest of one hundred thousand dollars made by Edward Bromfield Phillips they should thereafter be relieved from anxiety as to the payment of salaries and current expenses."

The fifteen-inch equatorial was set up in June, 1847, and has done splendid service for now nearly half a century. At last the skill of Prof. Bond was furnished with a fitting implement. In reply to an inquiry from Edward Everett, who had become president of the college the year before, Prof. Bond wrote specifying several interesting things that could be seen with it, and ended by saying: "But I must recollect that you require of me only a brief account of our telescope. The objects revealed to us by this excellent instrument are so numerous and interesting that it is difficult to know where to stop." In a subsequent letter he wrote to the president, "You will rejoice with me that the great nebula in Orion has yielded to the powers of our incomparable telescope." Besides this and other nebulæ the planet Saturn was an early subject of investigation. On September 19, 1848, Prof. Bond discovered the eighth satellite of this planet, which long remained the only addition to the solar system made on the continent of America.

When Bond was determining the position of the Harvard Observatory, Commodore Owen, of the British navy, was making an official survey in New Brunswick and Nova Scotia. The latter, desiring to use the observatory as his zero point, co-operated with Bond in making a transfer of twelve chronometers to and from Greenwich, England. Afterward other chronometer expeditions were conducted by Bond in co-operation with the United States Coast Survey, the final one being in 1855. In the summing up of results, seven hundred and twenty-three independent chronometer records were used. The magnitude of this undertaking, as a whole, surpassed anything ever attempted in any other country.

As early as 1848 Prof. Bond mentions, in his report as director of the observatory, some experiments with the daguerreotype and talbotype processes for obtaining pictures of the sun, which, though encouraging, could hardly be called successful. But in his report for 1850 he is able to say: "With the assistance of Mr. J. A. Whipple, daguerreotypist, we have obtained several impressions of the star Vega. We have reason to believe this to be the first successful experiment ever made either in this country or abroad." Some daguerreotypes of the moon and certain stars were exhibited in the World's Fair of the following year at London, and received a council medal.

The inventive skill which won success for Bond as an artisan appears in certain astronomical appliances and methods devised by him. The great telescope is poised thirteen feet above the floor of the observatory's dome. It has a vertical sweep of more than ninety degrees, and can, of course, make a complete revolution about its axis of support. An observer would evidently have to be something of an acrobat to use it successfully, unless a suitable chair could be obtained. There was none in the world that filled all the requirements, so Prof. Bond invented and made one. It is in use unchanged to this day, and by means of its ingeniously combined wheels, cogs, and pulleys the observer can quickly and easily place himself anywhere along the vertical quarter-circle and horizontal full-circle traversed by the eyepiece of the telescope.

Certain experiments for determining differences of longitude by the aid of the telegraph were undertaken by the Coast Survey in 1848, Prof. Bond being one of the special assistants whose services were secured for this work. While engaged in these experiments the idea occurred to him, as it had to one or more others, of using an automatic circuit interrupter in place of human nerves and muscles as the connecting link between the astronomical clock and the electric wire. Fear of injuring the clock had prevented the use of such a device, but Prof. Bond obtained authority to have a clock made especially for this work, at the expense of the survey. This was done, and the device was found to operate perfectly and without injury to the clock. "But another and far more serious difficulty presented itself," says Prof. Bond, referring to this matter in one of his reports, "in the accurate registry of the beats of the clock after being transmitted by the galvanic circuit; and it was at this point that further progress in the application of this method to astronomical observing was arrested." Attempts to overcome this difficulty were made by various inventors in the course of the next two years, but nothing satisfactory came of it before April 12, 1850, when Bond submitted to the Coast Survey an apparatus invented by him and his sons George P. and Richard F. Bond. It was named at first, from one of its peculiar parts, the "spring governor," but the more comprehensive title of "chronograph" was applied to it later. The apparatus was at once adopted for use by the survey. It was taken by Mr. G. P. Bond on his tour to Europe of the next year and exhibited before the Royal Astronomical Society of England and the

British Association for the Advancement of Science. Through the urgency of Sir David Brewster and others it was set up in the great exhibition of that year in London, where a medal was awarded for it. It was adopted at the Greenwich Observatory soon after, and speedily throughout Europe. The use of the "circuit interrupter" and the "chronograph" together constitute what became known in Europe as "the American method" of recording observations. Through it the errors for which the "personal equation" is a partial remedy are largely eliminated, and a superior definiteness of record is attained.

Soon after the electrical experiments of 1848, the "circuit interrupter" was put to use at Cambridge in transmitting to Boston and other points in New England the true local time. This was the beginning of the Harvard Observatory time-service, which was systematically organized in 1872. This idea was also early adopted at Greenwich.

In 1852 the officers of the Harvard Observatory co-operated with Captain Charles Wilkes in experiments for ascertaining the velocity of the sound from the discharge of cannon under different atmospheric conditions. The object of this investigation was to secure accurate values for some of the data obtained by the exploring expedition, the measurement of distances in some cases having been made by firing cannon.

One of the important events in the latter part of Prof. Bond's directorship of the Observatory was the beginning of the publication of The Annals of Harvard College Observatory. This was made possible by an endowment of ten thousand dollars given in 1855 by Josiah Quincy, ex-president of the college. The first of these noble quarto volumes was issued in the following year, and embodied a review of the work of the preceding years, so that the whole series makes a continuous record from the establishment of the observatory.

Prof. Bond died January 29, 1859, and was succeeded in the management of the Observatory by his son, George Phillips Bond, who had been one of his assistants for many years. The elder Bond had entered vigorously into the scientific life of his time, and his labors were duly appreciated by his associates and contemporaries. He was a member of the American Academy of Arts and Sciences, the American Philosophical Society, and the Royal Astronomical Society of England. From Harvard College he received the honorary degree of A. M. in 1842.

EDITOR'S TABLE.

SOCIAL EVOLUTION.

A RECENT writer, whose work has been very much discussed, tells us that social evolution depends more on the kind of religion a community possesses than on any other circumstance. A given community, provided with a suitable religion, will far outstrip in civilization another more richly endowed intellectually but with an inferior religion. Like all new formulas, this one has been having considerable vogue; and many persons whose strong point is not intellectuality are gratified to think that a snub has been administered to that aggressive quality. What we should like the able author to do would be to supplement his generalization by telling us how the suitability of a religion for purposes of social evolution is to be determined, and also how a community that is not in possession of the right kind of religion is to get into possession of it. Another question which the work undoubtedly suggests is how the right kind of religion is to be maintained in authority against the intellectual influences which the writer seems to say tend to undermine all religions. As Greece and Rome both reached a very high level in civilization, we must presume their religions were relatively superior—at least in the sense of being favorable to social evolution to those of less distinguished races; but their religions decayed. Was any one to blame in the matter? Or was the decay in each case inevitable? Was it a needful preparation for the advent of a still higher form of religion? If so, what is to be done when other forms of religion seem about to undergo transformation? Should we try to arrest the process, or let things take their course?

These are entirely practical questions, on none of which does the author to whom we are referring* throw, or attempt to throw, any light. They are not only practical questions, but they are questions which any thoughtful man finds it impossible not to ask when confronted with Mr. Kidd's formula; and which he feels must be answered in a very definite manner before it can prove of any utility either for the interpretation of history or for guidance in the present. What we would suggest would be an amendment to the formula which we think would greatly increase its applicability both to the past and to the present course of events. If we are allowed to understand by religion the ideal of social duty, then it seems to us very true that social evolution will, in the long run, be mainly dependent thereon. What made Rome great was the social cohesion between her citizens. How this superior degree of social cohesion was in the first place produced would be one of the most obscure of historical problems; but that it existed and was largely the cause of the growth of the Roman power can not be doubted. Devotion to the state and faith in its fortunes were in reality the most important elements in the religion of an ancient Roman. His gods were in the fullest sense civic gods, and as civic—that is to say, local—gods merely he regarded those of other races. The virtues which he esteemed and reverenced were those which made for the strength

* Kidd. Social Evolution.

and well-being of the state; and only in later years, when the ancient forms of faith were undergoing a process of disintegration, did any conception of virtue for virtue's sake, or of the connection of virtue with the wider interests of humanity, dawn on the Roman mind.

In dealing with this subject, however, our object was neither to criticise Social Evolution nor to discourse on the civilization of the ancient Romans: on the contrary, we had an entirely "modern instance" in view. If social evolution depends in large measure on the ideal of social duty existing in each community, it behooves us to consider carefully what ideals are growing up and taking root among ourselves. We believe that, making all abatements for conspicuous evils in the social state, there is a steady evolution taking place—that is to say, that the conditions of social life are improving on the whole from year to year. The principal drawbacks to such evolution are undoubtedly connected with our political life. One of the ablest of our contemporaries makes a duty of holding up the mirror to the evils and scandals which mark the course of politics in this State; and the picture presented is not encouraging. "In the belief," it says, "of nearly all the intelligent portion of our population the meeting of the Legislature in January is simply the opening of a school of vice. As soon as the Speaker is elected the members organize for the sale of legislation in quantities to suit purchasers or for the levy of blackmail." We do not fully indorse these words; but that they should be uttered at all by a responsible journal is significant and lamentable. The question is urgent: What can be done to create a deeper sense of responsibility in the public mind in regard to the conduct of political affairs? No community can permanently afford to have a disreputable legislature. While other agencies are at work to improve and purify the social state, here is one of the greatest magnitude which is operating in an opposite direction—filling the minds of young and old alike with the idea that social duty is an illusion, and that fraud has no meaning when practiced at the expense of the State. We talk of teaching "civics" in our schools, but something more than a school teaching of civics is required. We have vast organizations of a Christian character throughout the land—societies of Christian Endeavor and the like. What are they doing to purify politics? We believe in evolution, but not as a power that will save people from the consequences of neglecting their most important duties; and we think the time has come when communities should help forward their own evolution by conscious efforts to abate what is evil and encourage what is good. We commend the question we have raised to the consideration of all well-intentioned persons. The problem is how to prevent politics from corrupting the character of our citizens and antagonizing the efforts that are made in other spheres for social reform and improvement. It is a question for every one—for the wise and for the ignorant, for the man of science and the man of letters, for the theologian and for the journalist, for the man of business and the teacher of youth. What is needed is a concentration upon it of the attention and will of right-minded persons—of that large majority who have no sinister interests to serve by the abuse of political influence, and who ought to have enough regard for the national well-being to be willing to make some sacrifices on its behalf. If these will but do their duty, a solution of the problem will be found; but if, unfortunately, their other engagements, whether of business, pleasure, or religion, are too pressing to permit them to do so, there is much reason to fear that the poison generated by corrupt politics will seriously affect the whole life and growth of the community.

LITERARY NOTICES

A Manual for the Study of Insects. By John Henry and Anna Botsford Comstock. Ithaca, N. Y.: Comstock Publishing Co. Pp. 701. Price, postpaid, $4.09.

A substantial service has been done to teachers and students of entomology in the preparation of this handsome, systematically arranged work by Prof. and Mrs. Comstock. Besides describing the important insects of each order, the authors have undertaken to provide an analytical key of insect species similar to those which the student of plants finds so helpful and interesting. But while much pains has been taken to render easy the classification of specimens, the mere determination of their names has been treated as a matter of slight importance. The authors warn the reader against expecting in this volume such an approach to completeness as exists in the manuals of flowering plants. A work containing adequate descriptions of all the species in our insect fauna, they say, "would rival in size one of the larger encyclopædias." The general mode of treatment consists of a discussion of the characteristics of each order and the families composing it, with descriptions of the commoner species as illustrations of the several families. Simplicity has been studied in the descriptions, though not at the expense of accuracy, morphological terms have been reduced to a minimum, and so far as possible a uniform nomenclature has been used for all orders of insects. Writers confining themselves to single orders have developed differing nomenclatures, which is confusing to the student in passing from one order to another. Prof. Comstock has made as near an approach as practicable to uniformity in this respect, as a consequence of which, homologies heretofore above the grasp of any but advanced students, as in the wing-veins, are now brought forcibly to the attention of the beginner. The technical terms from Greek and Latin, which are a great bugbear to many beginners in the study of science, have been robbed of half their terrors by marking the syllabic division and the accent of each the first time it occurs. Most of the eight hundred woodcuts in the volume have been engraved from Nature by Mrs. Comstock, who has also furnished a part of the text. An attractive frontispiece in colors represents several butterflies and other insects about a thistle-head and a spray of golden-rod. The book is issued at a low price considering its size, its large number of illustrations, and the excellence of its manufacture.

The Education of the Greek People and its Influence on Civilization. By Thomas Davidson. International Education Series, Vol. XXVIII. New York: D. Appleton & Co. Pp. 229. Price, $1.50.

The purpose of the author in this volume is "to show how the Greek people were gradually educated up to that stage of culture which made them the teachers of the whole world, and what the effect of that teaching has been." After an introductory chapter on the aim and general form proper to education, he outlines the life of the Greeks and its ideals. He traces the Greek citizenship from its patriarchal and tribal origins, and finds *worth*—"the worth of the individual as a member of society"—to be the Greek ideal in life. To this conception was added, when leisure came, the ability to employ that leisure in elevating avocations (diagoge). The nature of education, both before and after the rise of philosophy, is then sketched. In the earlier times much attention was given to physical culture, and for young boys music had almost equal prominence. Competitive exercises evidently were not feared. The mother-tongue and its literature were thoroughly studied, but we find no mention of any time whatever being devoted to the grammars of other languages, dead or living. Youths learned political science by observation of the conduct of public affairs by their elders. After the philosophical era began individual happiness came to rival civic worth as an end of activity, and all sorts of knowledge were cultivated under the tuition of the Sophists. Then came Socrates, who largely counteracted the charlatanry into which the Sophistic teaching had degenerated. Our author next discusses the attempt in Plato's Republic to plan a state with a basis in philosophic principles, and that of Aristotle, whose basis was inductive reasoning. Both of these he sets down as failures. He then shows how Greek culture was influenced by contact with the two great religions of the Eastern world, Zoroastrianism and Judaism, and with the statesmanship of Rome. In conclusion the author affirms that the Greeks, through their scheme of culture, "not only lifted the world out of barbarism, but it requires their influence even to this day to prevent it from falling back into the same." What he regards as the error that was fatal to the Greek civilization was placing philosophy on the throne that should have been given to religion. This book is designed as a guide in teaching, but if it were itself put into the hands of students it would give more insight into Greek thought than digging out many pages telling what number of parassangs the army marched day by day or what was done by "wily Odysseus," aided by "ox-eyed Athenæ."

The Writings of Thomas Paine. Collected and edited by Moncure Daniel Conway. Volumes II and III. New York: G. P. Putnam's Sons. Price, $2.50 a volume.

Political and sociological essays make up these two volumes; Volume II covering the period from 1779 to 1792, and Volume III extending from 1791 to 1803. The most extended of these writings is the Rights of Man, which occupies half of Volume II. The two parts of which it is composed were written in a controversy with Edmund Burke *à propos* of the French Revolution and embody a full and careful statement of republican principles. The same volume contains Paine's pamphlet published in 1782 under the title, Letter to the Abbé Raynal, on the affairs of North America: in which the Mistakes in the Abbé's Account of the Revolution of America are Corrected and Cleared up. Paine was in England or France for fifteen years of the period covered by these volumes, having gone abroad in 1787 to introduce a form of bridge that he had invented. He was active in establishing the French Republic, though opposed to its extreme measures, hence many of the essays in both volumes relate to French affairs Among the American questions treated are: The United States Bank, paper money, the Newfoundland fisheries, and the purchase of Louisiana. Paine's religious writings, his poems, and some letters and scientific fragments are reserved for the fourth volume.

Proceedings of the Society for Psychical Research. Part XXVI. Dr. Richard Hodgson, 5 Boylston Place, Boston, Mass., American Secretary. Pp. 466.

This number of the society's Proceedings is mainly occupied by the Report of the Census of Hallucinations taken by a committee of which Prof. Henry Sidgwick was chairman. Seventeen thousand answers were obtained to the question, "Have you ever, when believing yourself to be completely awake, had a vivid impression of seeing or being touched by a living being or inanimate object, or of hearing a voice; which impression, so far as you could discover, was not due to any external physical cause?" About ten persons in a hundred were found to have had such experiences. Accounts of a large number of these occurrences, for the most part written by the percipients, are included in the report. The differences between hallucinations and other phenomena with which they are liable to be confounded are pointed out by the committee and illustrated by cases. Passing from merely subjective hallucinations, the committee discusses those of a veridical character—i. e., such as "can only be accounted for on the hypothesis that impressions or impulses have reached the percipient's mind otherwise than through the recognized channels of sense." A large number of these, and by far the most impressive class, occur at, or within a few hours of, the death of the person whose figure seems to be seen or voice seems to be heard. Another impressive class of cases is those in which the hallucination is experienced at the same moment by two or more persons. The evidence gathered through the census has been carefully sifted, and after rigid requirements have been satisfied there remain enough facts to satisfy the committee that "between deaths and apparitions of the dying person a connection exists which is not due to chance alone." Some other remarkable cases seem to indicate action on the part of the dead, but the committee does not deem them anything like sufficient to establish *post mortem* agency.

Manual of Geology. By James D. Dana. Fourth edition. New York: American Book Company. Pp. 1088.

Prof. Dana's Manual has been an authority for a generation, its first edition having appeared in 1863. It has always been of especial value to American students from the fact that it has treated geology with especial reference to American geological history. In the new edition, for which the work has been wholly rewritten, this feature has been preserved. Historical geology, in fact, occupies about two thirds of the volume, three hundred pages being devoted to the dynamical side of the science, while the physiographic and structural divisions together occupy one hundred. So many new facts and hypotheses have been brought forward in the last fifteen years that the author felt obliged to increase the quantity of matter, both text and illustrations, in the book by fifty per cent. A peculiar interest attaches to this edition from the death of Prof. Dana two months after completing the supervision of its publication. It is fortunate for students of geology that he was able to finish his task.

The Astrophysical Journal. An International Review of Spectroscopy and Astronomical Physics. Vol. I, Nos. 1 and 2, January and February, 1895. George E. Hale and James E. Keeler, Editors. Chicago: University of Chicago Press. Pp. 100. Annual subscription, $4.

The plan of this journal was conceived by Mr. Hale several years ago, but was modified on consultation with Prof. Payne, of the Sidereal Messenger, and a union of forces resulted in the publication, in January, 1892, of the periodical Astronomy and Astrophysics. This periodical was, during three years, a leading organ of astronomical research, and its career was highly creditable to American science. A separation of interests has now taken place, Popular Astronomy being continued as a journal of the character indicated by its title, and Mr. Hale returning to his original plan of conducting a journal of Astronomical Physics. In preparation for this undertaking the co-operation of eminent astronomers the world over has been secured, and besides those of its editors in chief the Astrophysical Journal bears the names as assistant editors of J. S. Ames, of Johns Hopkins; W. W. Campbell, of the Lick Observatory; Henry Crew, of the Northwestern University; E. B. Frost, of Dartmouth College; and F. L. O. Wadsworth, of the University of Chicago; and as associate editors, of ten eminent working astronomers in Europe and America. The scope of the journal includes all investigations of radiant energy, whether conducted in the observatory or in the laboratory—especially photographic and visual observations of the heavenly bodies, spectroscopic, photometric, bolometric, and radiometric work of all kinds; descriptions of instruments and apparatus used in such investigations; and theoretical papers bearing on any of these subjects.

A Text-book of Invertebrate Morphology. By J. Playfair McMurrich, M. A., Ph. D. New York: Henry Holt & Co. Pp. 661. Price, $4.

A student of the invertebrates will welcome this new work by Prof. McMurrich. The various subdivisions are fully discussed, and an excellent bibliography follows each group. The illustrations are abundant enough and in the main clear, though one would wish for better drawings, some of which, especially in the Mollusca, are positively bad. In a work of so comprehensive a nature the author would have avoided many minor mistakes if he had submitted each section to a specialist. Under the Brachiopods we are told that the shells are similar to those of the Lamellibranchs, whereas neither in origin, structure, nor position is there the slightest similarity. In stating the composition of the Brachiopod shell as carbonate of lime he overlooks Lingula, in which the composition is phosphate of lime. He says there are no organs of hearing in Brachiopods, while Lingula has very distinct auditory vesicles. He states that the circulation is induced by the contraction of the body wall, whereas circulation is due to the ciliary lining of the lacunæ. A flushing of the lacunæ, so to speak, takes place now and then when the shells open and close.

The author has frankly stated in his preface that the book must necessarily be tinged with his own opinions, and therefore the reviewer can only express disagreement with the position he has assigned to certain groups, notably the Lamellibranchs, Echinoderms, and Amphioxus, and to the use of the word type. Despite the minor errors, which can be corrected in a subsequent edition, we heartily commend the book, and congratulate the author for his fairness in accrediting drawings to their proper source.

Elements of Mineralogy, Crystallography, and Blowpipe Analysis from a Practical Standpoint. By Alfred J. Moses, E. M., Ph. D., and Charles L. Parsons, B. S. New York: D. Van Nostrand Company. Pp. 342.

A thorough and systematic study of mineralogy is the ideal of this book. The part on crystallography is illustrated with one hundred and seventy-one figures; it describes the use of the hand and the reflection goniometers, and contains a chapter on clinographic projection of crystal figures. The symbols of Weiss, Naumann, Dana, and Miller are given with the several forms. The chapters on blowpipe analysis include systematic schemes of operation. More than half of the volume is devoted to descriptive mineralogy, in which, after some account of the physical and chemical characters of minerals, the species are taken up by groups, as the iron minerals, the manganese minerals, zinc and cadmium minerals, etc. As the book is made from a practical standpoint, the chief uses and localities of each mineral are included in its description. This part is also fully illustrated with forms of crystals, bringing the whole number of figures up to three hundred and thirty-six. A series of tables for determinative work and two indexes complete the volume.

A large fund of information about public affairs is crowded into *The Daily News Almanac and Political Register for 1895* (Chicago, 25 cents). It includes rates of the old and new tariffs, statistics of imports and exports, of manufactures, agriculture, mortgages, the liquor trade, pensions, etc., etc.; accounts of the labor disturbances, the Hawaii affair, and other matters; a register of the national Government, the army, navy, and diplomatic service, important legislation by Congress, election returns, events of the year, including sporting events, and many other things that it is often convenient to refer to.

The Aëronautical Annual for 1895, edited by *James Means* (W. B. Clarke & Co., Boston, $1), is made up largely of historic matter. Some account of Leonardo da Vinci is given, with reproductions of his mechanical drawings and extracts from his Treatise upon the Flight of Birds. This is followed by essays on aërial navigation, by Sir George Cayley, Bart., published in 1809 and 1810, by Thomas Walker in 1810, by F. H. Wenham in 1866; Benjamin Franklin's aëronautical correspondence, 1783 to 1786; and some minor fragments. There are also a bibliography of aëronautics, an essay on The Problem of Manflight, by the editor, 1894, and an editorial article on the prospects of aëronautics. The volume is illustrated with reproductions of many quaint engravings.

The *Smithsonian Geographical Tables*, prepared by *R. S. Woodward*, is an outgrowth and further development of the idea embodied in the meteorological tables prepared by Dr. Arnold Guyot, at the request of Prof. Henry, and published in 1852 in the Smithsonian Miscellaneous Collections. This work passed through four editions, the last having been published in 1884. This edition was exhausted in a few years, and a recasting, rather than a revision, of the work was called for; and it was decided by Prof. Langley to publish the new work in three parts—Meteorological Tables, Geographical Tables, and Physical Tables—each representative of the latest knowledge in its field, and independent of the others. The Meteorological Tables were published in 1893. The present is the second work in the contemplated series. It includes an introductory part and tables. The introductory part is divided into seven sections under the heads Useful Formulas, Mensuration, Units, Geology, Astronomy, Theory of Errors, and Explanation of Source and Use of Tables. The forty-two tables, involving various factors of geodetical and astronomical measurement, occupy one hundred and seventy pages.

The Catholic University Bulletin is a new quarterly publication, conducted by professors of the Catholic University of America, Washington, similar in scope to the reviews and other periodicals which it is now becoming customary for American institutions of learning to issue. Its object is to convey to those who are interested in the university a knowledge of what is being done by its professors and its students; and it will make known the work of the administration so far as it is of public interest; its material progress, benefactions, gifts, etc.; facts relative to the system of teaching and results obtained; descriptions of the special schools and their operation, and the progress made by professors and students in the sciences for which the schools were opened; methods of teaching, educational discussions, and comparative notices of the work of other institutions; articles on higher pedagogics; public official documents concerning the university; literary and biographical notices, necrologies of men of learning deceased, accounts of learned congresses, etc.

A *History of Higher Education in Rhode Island*, prepared by *William Howe Tolman*, Ph. D., is number eighteen of Herbert B. Adams's series of contributions in the Bureau of Education to American Educational History. The educational history of this State is of particular interest because it raises the question whether religious freedom reacted favorably on the establishment of a system of education in the early days of the New England colonies—and helps answer it. The first part of the essay gives an account of colonial and later education. The second part tells the story of the academies and preparatory schools, of which seven are described. The third part is devoted to the institutions for the education of women. The story of Brown University—the only university in the State—occupies the main part of the history, and is told for the most part in connection with the work of the institution's eight presidents. Lastly, the College of Agriculture and Mechanic Arts is represented; and two pages are given to a bibliography.

In the handsome *Geological Map of Alabama*, by the State Geologist, *Eugene A. Smith*, the formations are clearly shown in distinct coloring, which is also harmonious and agreeable to the eye. In the accompanying description and explanatory chart, which corresponds with the map in size and form, the formations, names, synonyms, classification, and common fossils; thickness, lithological and topographical characters, area and distribution; useful products, soils, characteristic timber growth and agricultural features; and the reports in which these features are described, are conveniently shown for ready reference in parallel columns. Mr. Smith's reports, of which we have had many, all bear the marks of good work.

The thirteenth volume of the *Bulletin of the United States Fish Commission*, 1893, contains the proceedings of the World's Fisheries Congress, which was held in Chicago in October, 1893, and the papers that were read there. These papers, represented by forty-nine in the volume, touched various fishery topics, and in many cases called out considerable debate. The same subject gave rise to the expression of divergent opinions, especially on some phases of the commercial fisheries, which demonstrated that a fair conclusion on any of the subjects discussed can be reached only after a careful consideration of all the views presented. The papers given in the volume, being the views of representative men upon the subjects treated, are necessarily of great practical worth, and are published by the Fish Commission with the idea of furnishing the general public with valuable information concerning the fishery industry, and not with any view of approving or disapproving the opinions expressed. Some of the papers are handsomely illustrated, particularly that of Mr. G. F. Kunz, on pearls.

With 1895 the *Journal of the American Public Health Association* takes the place of the annual volume of the association's Transactions. It is issued quarterly from Concord, N. H., at $5 a year. The number for January contains the addresses delivered and part of the papers read at the meeting of 1894, in Montreal. Most of the papers in this number deal with water supplies; two others treat of diphtheria epidemics; and there is one, in French, on the general subject of preventive inoculation.

A plan for teaching science in public schools drawn up by Dr. *William T. Harris* for his report as Superintendent of the St. Louis Schools, in 1871, was afterward published in book form under the title *How to teach Natural Science*, and now appears in a second edition (Bardeen, 50 cents). It would undoubtedly give very practical help to a teacher confronted with the problem of adding science to the subjects usually taught in common schools, but if Dr. Harris were to rewrite it at the present day, in the light of the advances in science teaching made during the past quarter century, he would probably modify it somewhat. He would not omit to mention the peculiar mental discipline that the study of science affords as a reason for including it in a course of study; he would hardly say that science should "afford relief from the other studies, and not be placed in the same rank with them"; and while in this plan he insists that the teacher rather than a text-book should be the pupil's source of information, he would now probably go further and say that the pupils should get their knowledge of natural objects mainly from the objects themselves.

In the mathematical series of text-books by *John H. Walsh*, noticed several months ago, the *Elementary Arithmetic* includes notation, numeration, and the "four rules," the latter being applied in denominate as well as abstract numbers although no tables are given. The arithmetical processes dealt with are exemplified in a great variety of ways, including the use of many practical problems suited to the understanding of young pupils. (Heath, 40 cents.)

The first edition of *Joint-metallism*, by *Anson Phelps Stokes*, noticed in our January number, has been followed by a second and this by a third edition, each being an extension of its predecessor (Putnams, $1). Of the new matter, Part II consists of further arguments for joint-metallism and against bimetallism and monometallism. Part III is historical, giving views of writers on the science of money, beginning with Oresme, who wrote about 1366. In Part IV too great reliance on credit is deprecated and objections to the author's plan are answered.

The eleventh edition of the *Advertiser's Handy Guide* (1895) has been received (L. D. Morse Advertising Agency, New York, $2). It contains the names of the important journals of all the States and Territories of the United States, also those of the Dominion of Canada, in alphabetical order under each State or province. The circulation, politics, and frequency of issue of each paper are given, also the population of the city or town and county in which it is published. In addition to the general list there are separate lists of agricultural, medical, religious, etc., journals and other information valuable to advertisers. The volume contains seven hundred and eighty-six pages and is of handy size—about four by seven inches.

An Introduction to English Literature (Henry Holt & Co., New York), by *Henry S. Pancoast*, is based upon the author's previously published Representative English Literature, enlarged in some directions and curtailed in others, in order to adapt it to somewhat different requirements. It is intended to meet the needs of teachers who may wish to use the historical and critical portions of a book like that one, without being restricted to the prescribed selections which it gives as representing the successive literary epochs. To this end about two hundred pages of new matter have been added, and the notes and selections in the former work omitted. It is still the author's object to send the student directly to the literature itself, which is done here by suggesting in reading lists the selected works, giving them in some instances with general hints for study.

Volume IX of the Contributions to North American Ethnology published by the United States Geological Survey is the *Dakota Grammar Texts and Ethnography*, prepared by *Stephen Return Riggs*, and edited after the author's death with the copy not revised, by J. Owen Dorsey. Mr. Dorsey contributes a preface embodying interesting information concerning the structure, etc., of the language. The texts include eight Dakota myths, Dakota and English interlined, with translations following, the Parable of the Prodigal Son, The Lord's Prayer, and the Fourth Commandment. In the Ethnography are chapters on the Tribes, the Migrations, the Dakota Gens and Phratry, Unwritten Dakota Laws, The Superhuman, Armor and Eagle's Feathers, and Dakota Dances.

The *First Latin Readings*, selected and compiled by *Robert Arrowsmith* and *George*

M. Whicher (American Book Company, $1.25), is an attempt to respond to the call for variety in the Latin authors read in American preparatory schools. It aims, in introducing the student to the literature of the Romans, by presenting attractive and varied material, to arouse the desire for further acquaintance with that literature; to cultivate in him an appreciation of the beauties of language and instruction; and to help him gain, besides a mastery of the mechanism of the language, an insight into the thought and life of the people. The selections have been carefully made with reference to their difficulty, their interest as literature, and, in great part, their relation to Roman life and customs. Eutropius, Cornelius Nepos, Cæsar, Aulus Gellius, Cicero, and Livy are represented.

Roderick Hume; the Story of a New York Teacher, has been written by Mr. *C. W. Bardeen* to depict certain phases of the modern union school. The author says that he has no hobby to ride and no grievance to redress, but has merely described what he has seen, trusting his fancy just far enough to weave into one web characters and incidents that were real but disconnected. (Syracuse, N. Y.: C. W. Bardeen, 50 cents.)

A little book on *Varied Occupations in Weaving* has been prepared by *Louisa Walker*, head mistress of Fleet Road Board School, Hampstead (Infants' Department), for kindergartens. The work described in it has been systematically taught in the author's own school for the past twenty years. The ways and means employed in constructing the articles illustrated have been adapted to meet the exigencies of each case, and simplify matters for little workers. The illustrations are from actual work produced in the school. The entire weaving was done by infants of from five to seven years of age, and the material was afterward manipulated into useful articles by the teachers. (Published by Macmillan & Co., $1.)

The National Geographic Society has arranged for a series of geographical monographs on the physical features of the earth's surface, to be published monthly during the school year, at 20 cents each, or $1.50 for the ten. The first two of these monographs are by Major *J. W. Powell*. The first describes *Physiographic Processes*, treating the atmosphere, waters, and rock formations as envelopes of the earth continually in motion and pointing out the processes by which, through the action of the forces generated, the principal features of the earth's surface are produced. The second is on the *Physiographic Features* of the earth, and is an attempt to characterize these mainly as they are dependent on the three great physiographic processes, and to show how fire, earthquake, and flood have been involved in fashioning the land and the sea.

The *Annales de la Oficine Meteorologica Argentina* (Argentine Weather Office), of which *Walter G. Davis* is director, at Rosario, South America, embodies the results of observations made three times a day at thirty regular stations, and voluntary rain observations made by station agents at sixty-nine stations on the four principal railroads of the republic. The observations, recorded in tabular form, fill a large volume.

The *Geological Atlas* of the United States, now being published in parts called folios, consists of topographical and geological maps. The complete atlas will consist of several thousand folios, each of which contains a topographical and a geological map of a small section of country, and will be named after some well-known town or natural feature within the limits of the district named. The topographical maps will show the reliefs, drainage, and cultures of the districts, indicated by the usual or definite conventional marks. The geological maps will show on distinct sheets the areal geology, or the areas occupied by the various rocks of the district; the economical geology, or the distribution of useful minerals; the occurrence of artesian water, and other facts of economical interest, showing their relations to the features of topography and to geological formations; the sheet of structure sections will exhibit the relations existing beneath the surface among the formations the distribution of which on the surface is represented in the map of areal geology; and the sheet of columnar sections will contain a concise description of the rock formations which constitute the local record of geological history. To each of these maps is attached a legend fully explaining all the conventional signs, marks, and colors used in it; and each folio contains a descriptive letterpress. Of these folios, each containing the six sheets, we have received No. 1, Livingston, Mon.; No. 2, Ringgold, Georgia and Tennessee; No. 3, Placerville, Cal.; No. 6, Chattanooga, Tenn.; and No. 7, Pike's Peak, Col., to be supplemented by a special detailed map of the Cripple Creek district. Each folio is provided with stiff paper covers and cloth backs.

In a little book by *Florence Bass*, in the Nature Stories for Young Readers, entitled *Animal Life*, the subjects are mainly such insects or other animals as the children may observe for themselves. The lessons aim to give illustrations of some of the varied means of self-protection employed by animals; their methods of home building and of caring for their young; the transformations they undergo; the adaptability to their surroundings and coverings; and the "tools" with which the various animals are provided. It is intended to interest children in the animals, and to make them averse to giving them pain and to killing them. (Published by D. C. Heath & Co., 35 cents.)

Regents' Bulletin (of the University of the State of New York), No. 25, contains the secretary's report, with special papers on University Institutions, certain special topics, department reports, and notices of higher educational meetings; No. 28 contains the proceedings of the Thirty-second University Convocation, held July 5 to 7, 1894. Nos. 24, 27, and 29 are specially numbered as Extension Bulletins Nos. 6, 7, and 8. The first comprises the report of the Extension Department for 1893, with the circulars issued and other items of information; No. 27 is a record of the progress of extension teaching; and No. 29 embodies accounts of summer schools in 1892–'93; in New York; other American schools; and foreign schools. The whole number of schools represented is a hundred and five.

Three plates of Enlargements of Lunar Photographs (*Agrandissements de Photographies lunaires*) published by *W. Prinz*, of the Belgian Royal Observatory at Uccle, are phototypic reductions, without retouching, of some of the enlargements which were presented by the author to the Belgian Academy of Sciences in April, 1892. They represent photographs taken with the great refractor of Lick Observatory, enlarged from ten to a hundred times, and among other things they illustrate the richness in details of the views taken with that instrument. They are of special value as permitting a closer study of the details of lunar relief—a study which, it is hoped, may cast some light respecting the origin of terrestrial reliefs. A question of priority is connected with this publication, which is made partly to enforce M. Prinz's claims and partly as a specimen of a proposed atlas. The photographs represent the circle Copernicus, the crater Bullialdus, Mare Humorum, and Mare Imbrium. Sent gratis to astronomers and observatories.

Nos. 14, 15, 16, and 17 of the Contributions to American Educational History, published by the Bureau of Education, under the editorial direction of Herbert B. Adams, present the *History of Education in Connecticut*, by *Bernard C. Steiner; Delaware*, by *Lyman P. Powell; Higher Education in Tennessee*, by *L. S. Merriam;* and *Maryland*, by *B. C. Steiner*. The histories are constructed in general on a common plan, beginning with the first establishment of schools in the State, tracing their development in the colonial or territorial period and under the State government; describing the more important academies and the colleges, and then the principal special and technical schools. The story of education in Connecticut is of peculiar interest; for that State was a pioneer in the establishment of public schools, which are almost coeval with its existence, and is still behind none.

In the Delaware history a logical rather than a chronological order is followed. The beginning of educational enterprise is traced to the middle of the seventeenth century, under the Swedish, Dutch, and English settlers; education in the towns is considered; next the colleges; then public education from its origin in 1796; and the education of the negro.

The history of higher education in Tennessee is in the main the history of private initiative and activity which has been characterized by broad liberality and farsightedness. By these means the State has become the seat of an exceedingly interesting and creditable group of academies and colleges of all kinds, and Nashville an important educational center. Of these institutions, not the least in importance and fame are the schools for negroes.

Maryland has not obtained wide renown until recent years for its higher institutions of learning, yet the number and importance of them have been too great to justify such neglect as they have received. Though the early conditions of life in the colony were not such as to favor schools or colleges, a plan for a college was brought forward as early as 1791—the fourth attempt for a college in the United States—but no college proved successful till Maryland became a State.

It is claimed by Director Powell, in presenting the *Twelfth Annual Report of the Bureau of Ethnology*, covering the year 1890–'91, as a noteworthy feature of the plan under which the work of research is conducted, that the ethnologists who, as authors, prepare the publications of the bureau, personally gather the material for them in the field, supplementing this material by a study of all the connected literature and by a subsequent comparison of all ascertained facts. The continuance of the work for a number of years by the same zealous observers and students, who freely interchange their information and opinions, has resulted in their training with the acuteness of specialists, corrected and generalized by the knowledge obtained from other authorities on the same or related specialties. The present report is an excellent example of the application of this method of work. The substance of it, after the routine matter is disposed of—otherwise the "accompanying paper"—is a Report on Mound Explorations, by Dr. Cyrus Thomas, a veteran laborer in this field, who brings to the task of reviewing the whole subject all the advantages that long experience in field and study work can bestow. The explorations reviewed cover eighteen States in the Mississippi Valley, Atlantic coast, lake, and eastern central regions, supplemented by papers on archæological areas and distribution of types, the mound-builders and comparison of their works with those of the Indians, and evidences of contact with modern European civilization found in the mounds, with 344 illustrations.

In *Le Centre de l'Afrique, autour du Tchad* (The Center of Africa, around Lake Chad), the story of the journeyings of the Maistre French expedition to the region in question is told by M. *P. Brunache*. The object of the expedition, departing from the Congo, was to reach the Chari River and form relations with the Mussulmans of the Chad Valley. The expedition did more than this, for, having reached Palem beyond the Chad, through a country which no European had ever penetrated, it continued on through a region equally virgin to European exploration to Guéroua, and thence diverting from the Binerée to strike it again at Ibi, down that river and the Niger. It made several geographical discoveries of interest; corrected some errors; made treaties with numerous fetich chiefs; and collected anthropological data and material. Published by Félix Alcan, Paris, in the Bibliothèque Scientifique Internationale.

Les Aurores Polaires (Polar Auroras), of M. *Alfred Angot*, has been developed by revision and expansion from a series of articles published in the periodical *La Lumière Electrique* in 1882. All is brought up to date. The history of auroral observations is told, and the theory of the lights is discussed with the clearness of style and facility in explanation that have given the author an eminent position in scientific literature. Numerous carefully executed engravings illustrate some of the most remarkable observations of auroras. A list is appended of auroras observed from 1700 till 1890, in Europe, south of latitude 55°. The work is published by Félix Alcan, in the French edition of the International Scientific Series.

We have already spoken twice of the *Dictionary of Birds*, prepared by *Alfred Newton* and *Hans Gadow*, with the assistance of eminent English naturalists, and Dr. R. W. Shufeldt as American contributor, published by the Blacks in London, and Macmillan & Co., New York. The work is continued in Part III, from Moa to Sheathbill. The matter is arranged alphabetically; is presented in brief, clear statements and descriptions; and the whole is appropriately and well illustrated. Price, $2.60.

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POPULAR MISCELLANY.

Meeting of the American Association.—The forty-fourth meeting of the American Association for the Advancement of Science will be held in Springfield, Mass., August 28th to September 7th. Ample provisions have been made by the local committee for the accommodation of the association and its sections and for the entertainment of those who will attend. The meetings will be held in the Young Men's Christian Association building, where the offices will be and the general meetings will be held; the Art Museum, the high-school building, Christ Church Parish House, Unity Church Chapel, State Street Baptist Church lecture rooms, South Church Chapel, and Evangelist Hall. A large list of excursions has been arranged, to places in the vicinity of Springfield and some longer ones, adapted to almost every taste, a large proportion of them being to factories or laboratories where manufacturing processes and scientific methods are practically illustrated, and a considerable number to interesting geological fields. Meetings of affiliated societies will be held as follows: Geological Society of America, August 27th and 28th; Society for Promotion of Agricultural Science, August 26th; Association of Economic Entomologists, date not given; Association of State Weather Service, date not given; American Chemical Society, August 27th and 28th; American Forestry Association, September 3d; Botanical and Entomological Club of America, during the week. The president for the year is E. W. Morley, of Cleveland, O.; permanent secretary, F. W. Putnam, Cambridge, Mass.; general secretary, James Lewis Howe, Lexington, Va.; treasurer, R. S. Woodward, New York.

Lu Chu Islands Politics.—The history of the Lu Chu Islands for several centuries has consisted, according to Prof. Basil Hall Chamberlain, of "an attempt to sit on both sides of the fence." With China on the one hand and Japan on the other, "the kinglet of Lu Chu was driven into being a sort of Mr. Facing-both-ways; and the whole nation more or less, or at any rate the higher official class, came to have a double set of manners—one for use *vis-à-vis* the first of its inconveniently big neighbors, the other *vis-à-vis* the second. Thus the Japanese copper 'cash,' with which of late some of the commercial transactions of life had been carried on in the absence of any native money, were always carefully kept out of sight when the Chinese officials were by to see. On the other hand, the Chinese year names commonly current in Lu Chu were ignored as far as possible in diplomatic intercourse with Japan. Even in matters of food the poor little Lu Chuans tried to make themselves all things to all men." Of the two patrons China was the favorite, notwithstanding that Japan was more nearly allied by race. The Chinese overlordship was rather nominal than real, and the tribute-ships dispatched annually to Fu Chau did such good strokes of business under the rose that the Lu Chuans actually requested to be allowed to send more tribute to China than the amount originally stipulated.

Undisturbed Nature.—M. de Conferon relates in La Nature that a fox, which had established itself on his place, made nightly excursions for several months into his garden and yard. He was rather pleased with the visits than otherwise, being a lover of animals, and interested in the study of the habits of this one. The marks the fox left behind him indicated that, while he might be fond of grapes, he could eat a great number of rats and mice, and of beetles and other insects too. The many little excavations found everywhere pointed likewise to fondness for crickets and worms. It seems from his observations that foxes are not so mischievous as they are reported to be, and that while they may have their faults, these are to a large extent compensated for by services they render. Yet they are fond of fowls and hares and rabbits; but M. de Conferon remarks that there are not so many hares in the whole region around as in the neighborhood of his estate. Squirrels, jays, magpies, and the like, which are regarded as before everything else destructive, are allowed to build their nests and eat nuts at will on his premises, but he has never found that they prevented his having an abundance of little birds of all sorts, and his shrubbery is filled with the nests of singing birds that are scarce in other places. He ascribes his blessing to the fact that no guns are ever fired on his place. Birds are not destroyed there, or frighteued or disturbed, and the children never take a nest. Nature is allowed to take its course without interference, and there is no trouble. That is the secret of the whole matter.

Electricity and Plant-growing.—Experiments in the application of electricity to plant-growing are recorded by Prof. L. H. Bailey in the Transactions of the Massachusetts Horticultural Society. Deherain had found that the electric light contained rays harmful to vegetation, and that the greater part of the injurious rays were modified by a transparent glass. Exposing different kinds of plants to the light, Prof. Bailey found that they were differently affected. He then tried the effect of the light screened with glass and also of the naked light running half the night. The influence of the naked light upon the productiveness and color of flowers was found to vary with the different species, and different colors within the same species. Tulips were of deeper and richer color, but the colors lost their intensity after four or five days. Petunias were much taller and more slender in the light. But all flowers, of whatever species, which stood within five or six feet of the naked arc were injured. It was apparent, in general, that the light hastened blooming and caused the production of larger stems; but this effect was much obscured by the injuries resulting from the unscreened arc. It was afterward found that the use of a globe or pane of glass will avert the injuries to flowers as well as to foliage, and the long stems and open inflorescence, together with the increase in earliness in some cases, may be obtained without fear of injury. But Prof. Bailey is not ready to recommend the electric arc lamp for the growing of flowers. Lettuce, however, was greatly benefited by the electric light, and filled its heads much earlier than under normal conditions. The injury done to the plants by exposure to the naked light was found to be due to the fact that their vital activity was so hastened by it that the plant could not supply material quickly enough, and it was forced to death; but by removing it to greater distances from the lamp a point will be found where water can be supplied with sufficient rapidity to meet the demands of the quickened activities, and the plant will grow more rapidly, or at least mature earlier, than in normal conditions. The application of electric currents to plant-growing may be made to the plant directly, to the soil, or to the atmosphere. Concerning the first condition, little of an exact nature can be said. A mild electrical discharge will often seriously injure plants; but application to germinating seeds and ripening fruits sometimes hastens the processes. The results in application to the soil are various, and it so far promises little in the way of commercial returns. The effect of atmospheric electricity has been studied by several observers, with the general results, from which only Naudin dissents, that normal atmospheric electricity is in some way beneficial to vegetation. Lemström has suggested that the modifications produced by it are not the direct results of the electrification of the plants or the atmosphere, but rather follow some change in the atmosphere which is engendered by the current—and this, Prof. Bailey thinks, is highly probable.

The Vision of Spiders.—Uncertainty seems to exist among arachnidists concerning the extent and quality of the spider's visionary power, and methodical experiments have been made by Mr. and Mrs. Peckham to determine the fact. Twenty species of *Attidæ* and others of other families were studied. The authors find that "the power of expression through different attitudes and movements is of great assistance in determining not only how far the spider can see, but how much it recognizes of what it sees—or, in other words, its power of distinct vision—since it acts in one way when it catches sight of its prey, in another at the appearance of a male of its own species, and in still another when it sees a female. Dr. McCook says 'their rapid and marked change of manner when prey is sighted, the mode of approach, like the action of a cat creeping upon a bird, the peculiar behavior displayed when the final spring is made, are not to be accounted for on any theory other than a keen sense of sight.'" Among many incidents very much alike related by the authors we cite the case in which eight gnats and four small flies were put into a box containing one of the spiders. "They all settled and became quiet. The spider, neglecting several gnats and flies which were close to him, fixed his eyes upon a gnat five inches away, and, approaching it by short jerks from in front, pounced upon it, holding it tightly a moment and then letting it go. One of its legs was broken. It fluttered off to a distance of seven inches. After a moment the spider followed it and caught it again, still paying no attention to several nearer ones. This he repeated six times, letting it go each time. He then began to catch other gnats and flies at distances of from one to four inches. He made in all twenty-five captures, jumping always when about an inch away. His actions were exactly like those of a cat playing with a mouse. It seems remarkable that he could see clearly enough to follow the gnat which he had at first singled out among a number of others which were almost identical in appearance." Experiments on *Attidæ* at their mating season prove that spiders can see at a considerable distance. A male was put into a box containing a female of the same species. The female was standing motionless twelve inches away, and three inches and a half higher than the male. "He perceived her at once, lifting his head with an alert and excited expression, and went bounding toward her. This he would not have done if he had not recognized her as a spider of his own species. When four inches and a half from her he began the regular display of the species, which consists of a peculiar dance. This he would not have done had he not recognized her sex. A male of this species on the floor of the box caught sight of a motionless female on the glass nine inches away and four inches and a half above him. He raised his body almost vertically, and gazed alternately at her and at a male which was five inches away in another direction. At other times the males recognized the females at eight, nine, and eleven inches, and the females recognized the males at six, seven, nine and a half, and eleven inches." A spider can not recognize its egg sac by sight, because in its natural position it never sees it, and therefore does not know how it looks. Experiments on the color sense of spiders were not conclusive.

British New Guinea.—The colony now called British New Guinea has been formally annexed to the British Empire. The natives, who probably number between 300,000 and 400,000, are described by Sir William Macgregor, administrator, as mostly of a rich, dark bronze color, varying from a brown that might be called black to a yellowish brown. In temper they are cheerful, lively, and full of fun, and are generally very contented; not quarrelsome or violently passionate. Suicide is comparatively rare among them; when it does take place, it is, as a rule, the outcome of affection, one of the strongest and best characteristics of the race. Occasionally a woman would climb a tall cocoanut tree and kill herself by jumping down, because she had become convinced that she could never meet again among men with a husband so good as the one she had lost. This family affection is so strong as to be often an impediment to the employment of men away from their own districts. It is not often that a man cares to remain longer than one year in the constabulary, because he is separated there from his family and friends. The London Missionary Society finds it difficult, for the same reason, to get wives of native teachers to live in strange villages. Yet the strong feeling of affection that the Papuan has for his relatives and neighbors does not prevent him from doing to others what appear terribly cruel things.

It must be recollected, however, that cruel murder is, according to their code of ethics, a conspicuous virtue, a moral duty. They all apparently believe that man is compounded of a body and spirit. The spirit leaves its tenement during sleep, and at death does not return. Hence, in waking up a sleeper, they proceed to rouse him by degrees, so that the spirit may have time to return and take its place.

Korean Marriages.—Korean girls, according to Mr. H. S. Saunderson, after enjoying freedom till they are eight years old, are consigned to the women's quarters, where they live in seclusion till they are married, at sixteen or seventeen years. After marriage the woman is allowed to see no man but her husband. The boys, on the other hand, are taught that it is undignified for them to enter the women's part of the house. They never see their brides till the wedding day, all having been arranged for them, often when both bride and groom are infants. The marriage ceremony is very simple. The bride and bridegroom invite their most intimate friends to assist them in dressing their hair in the manner befitting their new estate. Then the bridegroom mounts a white pony, which is led by two servants, while two others on either side support the rider in his saddle. Thus he proceeds to the bride's house, accompanied by his relatives. At their destination they find a pavilion erected in the courtyard of the house, in which the bride and her relatives are awaiting their arrival. A goose (the Korean symbol of fidelity), which the bridegroom brings with him, is then produced. The bride (who has to cover her face with her long sleeves) and the bridegroom then bow to each other until their heads almost touch the ground. This they do three or four times, and are then man and wife. A loving-cup is passed round, and then the bride is taken off to the woman's apartments of her husband's home, where she is looked after by her mother and mother-in-law, while the groom entertains his friends. Fidelity is imposed on the wife, but the husband is under no such obligation. He can marry but one wife, it is true, but he is allowed as many concubines as he can afford. These, however, never inhabit the same house as his principal wife. The husband is forced to maintain his wife properly and treat her with respect. Marriage is the great event in a Korean's life, for he then attains man's estate. Before marriage, no matter how old he may be, he is treated as a boy, and has to maintain a deferential attitude toward the married men, even though they be only half his age.

Rapid Transmission of Earthquake Motion.—Attention is called by Prof. John Milne to the apparently high velocity with which motion is transmitted from an earthquake center to places far distant from it—a quarter of the earth's circumference—and to the importance of instituting an extended systematic observation of these movements. During the last few years European observers have recorded earth movements that had their origin in Japan or in other distant countries. Beyond a radius of a few hundred miles from their origin these disturbances are often too feeble to be sensible or to be recorded by ordinary seismographs. Their presence is, however, made known by the use of specially contrived nearly horizontal pendulums, and it is found that they have a duration of from ten to thirty minutes, and sometimes last for one or two hours. Observations made at Tokyo of the earthquake of March 22, 1894, the distance from the epicentrum being about six hundred miles, indicated that the rate of propagation of the motion of the waves was from 2·3 kilometres per second for the more pronounced superficial waves, to 11·5 kilometres per second for the lighter shocks, and they passed to Italy at the rate of nine or ten kilometres per second. An investigation is especially wanted of the velocities of propagation of the elastic movements which apparently go from Japan to Europe in fifteen or twenty minutes. Prof. Milne has devised some delicate instruments expressly to be used in these investigations.

American Nickel Mines.—The nickel mine at Lancaster Gap, Pa., belongs to the class of ores described by Prof. J. H. L. Vogt, of Christiania, Norway, as typical deposits of nickeliferous sulphides, formed by a process of magnetic differentiation in basic igneous rocks. It is situated about three miles south of the main line of the Pennsylvania Railroad, a little more than fifty miles west of

Philadelphia, and fifteen miles north of the Maryland border. It lies in the midst of mica schists, presumably Archæan, in what was called the middle gneissic belt by H. D. Rogers, and the Georgetown series by Persifor Frazer. This formation is quite narrow in the vicinity of the mine, and pinches out to the westward, from the coming in of the limestone on the north and south sides. The dark, basic rock with which the ore is associated forms a lenticular mass of rock, which consists most largely of green secondary hornblende, and often shows almost nothing else than this mineral. It is called hornblende at the mine, and is best described by the word amphibolite as a rock name. The pyrrhotite lens on Anthony's Nose, near Peekskill, on the Hudson, is quite different in its geological relations from the Gap mine. It is situated on the northern side of the mountain, about seven hundred feet above tide water, and three miles from Highlands Station. The general geology consists of the usual gneisses of these old formations. Several well-known iron mines lie about twenty miles northeast. The ore bed was opened shortly after the war, when it was known as the Phillips Mine, and was operated for ten or fifteen years, but for sulphur fumes, and not for its metallic contents, which proved too low for profit. Other minor nickel-bearing beds have been noticed along the Hudson. Openings for nickel in gneiss have also been made at Litchfield, Conn.; at Dracut, near Lowell, Mass.; and perhaps at other points. The geological relations seem to be practically the same as those along the Hudson. These ores and the formations in which they occur have been fully described in a paper of the Geological Department of Columbia College, by J. F. Kemp, in the light of Prof. Vogt's views of the igneous origin of the ores.

The Former Antillean Continent.—The theory of a former kind of continental extension—the Antillean continent—which united the West Indies to the mainland, excluding the Atlantic waters and admitting the Pacific waters into the Mexican Gulf and the Caribbean Sea, has been examined in the light of the geographical and geological evidences by J. W. Spencer, who has attempted to restore the topography of the submerged continent and to set forth the geomorphic evidence that the drowned valleys of the Atlantic coasts are the valleys of former lands now depressed beneath the sea. These valleys or fiords are very numerous, and many of them are traceable to depths of more than two miles along the Atlantic, Gulf, and Caribbean coasts. The measurements of them give data for calculating the late elevation of the region. From the application of the continental movements it becomes apparent that the mainland stood as high as the fiords are deep, less some correction for unequal subsidence of the continental region. Accordingly, it is concluded that the Antillean bridge stood at from one and a half to two and a half miles above the present altitudes of the plains that now form the islands, with their mountains relatively somewhat lower than at present. The formations out of which the valleys are excavated belong mostly to the more recent geological periods, and are generally but little disturbed. From the determination of their age and that of the materials filling the buried valleys, it has been found that there were two epochs of great elevation, namely, in the Pleiocence and in the Pleistocene periods. Between these there was a subsidence of such depth as to drown the continental coastal plains, and reduce the West Indian region to very small islands, with (probably) a shallow connection between the Atlantic and Pacific coasts.

The Gothenburg System.—What is called the Gothenburg system of regulating the sale of intoxicating liquors is undergoing fierce criticism in England, where its adoption is favored by the Public-House Reform Association, founded by the Bishop of Chester. Under this system the traffic is made a concern of the community, and is carried on in its behalf by a company to which it is committed under conditions. The principles of the theory of popular control of the liquor traffic are summarized by the Rev. F. S. McC. Bennett, Honorary Secretary of the Public-House Reform Association, as being that licenses, though they have been granted for years to private persons and have been renewed with such regularity as to give them a marketable value, are essentially local public property, and the community, while bound to recognize the equitable claims of those whom it has allowed to hold them, is entitled to deal with its own in whatever way seems best calculated to promote the public weal; that those communities which, though unprepared to veto the liquor traffic, desire to reduce the consumption of alcohol, should be granted the option of local management. The "company" feature of the Gothenburg system is sharply attacked by W. S. Caine, M. P., who, while admitting that there has been a sweeping reduction in the intemperance of Scandinavia, in consequence of the Swedish law of 1855, asserts that this is not in consequence but in spite of the company system, "the ingrafting of which upon the law of 1855 has been followed by an increase of drunkenness in every large city in which it has been adopted. Undoubtedly," Mr. Caine continues, "the drunkenness of Norway and Sweden is very greatly reduced from that prevailing thirty years ago; but it is due entirely to other causes than the company system, was realized before the company system came into operation at all, and has reverted to a steady increase since the company system prevailed." The most important evidence adduced in favor of this proposition is derived from the statistics of convictions for drunkenness, which appear to have increased since the company system went into operation. Mr. Bennett replies that the small increase remarked in the number of convictions indicates increased vigilance, activity, and efficiency in enforcing the law quite as much as increased violation of it, and he quotes strong counter-evidence against other allegations that drunkenness has increased.

Flowers and their Unwelcome Visitors.—Having, in a lecture on the pollenization of flowers, considered the means by which the plants secure the aid of insects in that work, Prof. L. H. Pammel mentions a few of the methods by which flowers are protected from the invasions of unwelcome insects. Aquatic plants are protected by their isolation in water. Land plants have occasionally secured the same advantages for themselves by certain leaves forming cups around the stem; some have a leaf-cup at each joint; in others there is a single basin formed of the rosette of leaves at the base, in which rain and dew collect, and are retained for a considerable time. Some plants have slippery leaves, with often a curved surface, over which it is impossible for ants to climb; others are covered with hairs and spines, especially in the parts near the corolla, which often point downward. Some plants are distinguished by viscid and gelatinous secretions. Kerner believes that the milky juices of such plants as lettuce, asclepias, euphorbia, apocynum, chelidonium, etc., serve to keep ants away. Relative to hybridization, Prof. Pammel finds that hybrids between widely separated species are usually tender, especially in their early life, so that it is hard to grow such seedlings. Hybrids of species of closer relationship on crosses of races are usually strong and productive. Such plants are characterized by their greater size, rapid growth, early maturation of the flowers, longer life, greater productiveness, and unusual size of the separate organs.

Abrasive Substances.—The growing importance of abrasives is such as to suggest inquiry concerning our future supply, and that is one of the topics considered by T. Dunkin-Paret in his paper on Emery and other Abrasives. At present we depend for the larger part on Turkey and Greece. Emery occurs also in Sweden, Spain, Saxony, and Greenland, but the lands named are apparently the only foreign countries that afford a commercial supply. Our supply of native emery has come thus far from New York and Massachusetts, while the corundum has come from Pennsylvania, North Carolina, and Georgia. While small specimens of corundum, in the form of imperfect sapphires, have come from Montana, where the existence of this mineral has long been known, no other locality has yielded corundum except the belt which reaches from Massachusetts to Georgia, and seems to have its center in the corner where North and South Carolina, Georgia, and Tennessee come together. In this belt the localities where the mineral occurs are innumerable, but its prevalence is a poor indication of its quality. Corundum occurs in pockets, seams, sand veins, narrow streaks, and detached crystals, seldom in large mass. Chester County, Pennsylvania, is apparently the only locality where large, solid masses have been found. The largest annual product of American corundum was six hundred and forty-five tons. Unlike corundum, emery consolidates in large masses. It does not, indeed, form continuous beds of great extent, but its discontinuous masses and veins sometimes contain hundreds of tons. The emery-bearing locality in Westchester County, New York, is a strip from one half to three fourths of a mile in width and from five to six miles in length. The place in which the largest openings have been made, and which has excited the most interest, is on a part of a summit about three miles from Peekskill and seven hundred or eight hundred feet above tide level. It overlooks, on the one side, the valley of the Croton, whose stream is invisible, and, on the other side, the Hudson. On the north and northeast of the emery belt are outcrops of granite. South of it lies the common marble of Sing Sing; still farther south, at Spuyten Duyvil, occur the oldest of the Laurentian gneisses; and still farther south, on Manhattan Island, the mica schist. The emery is, however, all immediately associated with a hornblende rock. Large masses of emery are seen projecting above the surface. These are delusive, and those which hold out a large promise are sometimes found to extend only one or two feet underground and to yield only from five to twenty tons. Such masses are usually surrounded by soft, reddish earth.

Substitutes for White Lead.—Only two substances at present manufactured are regarded by Mr. A. P. Laurie as satisfactory substitutes for white lead in painting—sulphate of lead and oxide of zinc. Sulphate of barium has hardly any covering power, and sulphide of zinc, though remarkable for covering power, has not proved, as at present manufactured, a durable pigment. Oxide of zinc, though deficient in covering power, is remarkably white, and preserves its color in impure air. Sulphate of lead is in the market in two forms—sublimed sulphate, which is prepared directly from galena; and precipitated sulphate, ground by Freeman's patent with oxide of zinc, and sold as Freeman's white. Sulphate of lead prepared by sublimation has much more covering power and is much denser than precipitated sulphate. Another pigment sold as a harmless white lead is prepared in a similar way by grinding together oxide of zinc and sulphate of barium. In quantity of oil required the substitutes named compare well with white lead, some taking a little more and some a little less, except oxide of zinc, which takes a very large quantity. In the matter of susceptibility to impure air, they all have a distinct advantage over white lead. Zinc oxide is not at all affected, and the sulphate is very slightly affected unless the gas is in very large quantities and the paint is wet. In durability under outdoor exposure they are not better than white lead, except that oxide of zinc remains white. In their appearance in oil they differ considerably from white lead, being thin and stringy instead of stiff and firm, and this is against them. But Mr. Laurie does not find that when thinned down they seem to differ appreciably from lead carbonate in ease of working. In their effects on health, oxide of zinc is harmless. Sulphate of lead is not absolutely insoluble in very weak hydrochloric acid, and may therefore be slightly soluble in the stomach and to some extent poisonous; but the author does not believe that under ordinary conditions of manufacture or use it would produce lead poisoning.

The Dangerous Proportion of Carbonic Acid.—Of the power of carbonic acid to smother, Prof. F. Clowes, of Nottingham, England, ascertained that the flames of candles, oil, paraffin, and alcohol are extinguished by air containing from thirteen to sixteen per cent of carbonic acid. The flame of coal gas requires the presence of at least thirty-three per cent of the extinguishing gas, while the flame of hydrogen requires fifty-eight per cent. Concerning the proportion of carbonic acid mixed with water that can be breathed with impunity, the statements of different observers are conflicting. Prof. Clowes finds ten per cent more than is required to extinguish a candle flame respirable, while Dr. Haldane, of Oxford, estimates that air containing twenty per cent of carbonic acid can not be breathed, even for a minute, without serious consequences; even five per cent, he claims, caused serious distress of body and mind, while any proportion higher than ten per cent produced distinct poisonous effects.

The vitality of the hydrogen flame in foul air, Prof. Clowes points out, makes it useful for maintaining the flame of a miner's safety lamp in an impure atmosphere. The author's testing lamp, which burns either oil or hydrogen, or both together, can be carried into foul air with both substances burning. The oil flame is extinguished as soon as the proportion of carbonic acid reaches a certain limit, while the hydrogen continues to burn. As soon as the miner goes back into a somewhat purer atmosphere, the still burning hydrogen relights the oil flame, and the miner is not left in complete darkness, as he otherwise would be.

The Earth's School of Enterprise.—In his study of the Relation of the Earth to the Industries of Mankind, Prof. O. T. Mason infers that the earth was in the beginning and is now the teacher of the activities through which commodities are conducted through the progress of industries. "There were quarriers, miners, lumberers, gleaners, and some say planters; there were fishermen, fowlers, trappers, and hunters before there was a *genus homo*. There were also manufacturers in clay, in textiles, and in animal substances before there were potters, weavers, and furriers; there were all sorts of moving material and carrying passengers and engineering of the simplest sort. It might be presumption to hint that there existed a sort of barter, but the exchange of care and food for the honeyed secretions of the body going on between the ants and the *Aphidæ* looks very much like it. The world is so full of technological processes brought about among her lower kingdoms that I should weary you in enumerating them. Stone-breaking, flaking, clipping, boring, and abrading have been going on always, by sand-blast, by water, by fire, by frost, by gravitation. Archæologists tell us that savages are very shrewd in selecting bowlders and other pieces of stone that have been blocked out and nearly finished by Nature for their axes, hammers, and other tools. In tropical regions of both hemispheres where scanty clothing is needed, certain species of trees weave their inner bark into an excellent cloth, the climax of which is the celebrated tapa of Polynesia. Furthermore, the fruits of vines and trees offer their hard outer shells for vessels and for other domestic purposes, and as motives in art and handicraft. Among the animals there is hardly one that has not obtruded itself into the imaginations of men and stimulated the inventive faculty. The bears were the first cave dwellers; the beavers are old-time lumberers; the foxes excavated earth before there were men; the squirrels hid away food for the future, and so did many birds; and these were also excellent architects and nest-builders; the hawks taught men to catch fish; the spiders and caterpillars to spin; the hornet to make paper, and the crayfish to work in clay."

A Generation of French Science.—The Revue Scientifique, of Paris, last November entered upon its thirty-third year. Noticing the event, it recalled the fact that when it was begun, in 1863, the Darwinian theory was only timidly sustained by a few, while it was contested by most men of science—in France at least. The Revue fought actively for it from the first, and for ten years gave it the most prominent place among subjects discussed. After that it gave other questions, including the new ones as they sprang up, a larger share of attention. The purpose which the Revue has constantly pursued has been to keep scientific readers acquainted with the work accomplished by other students in related or neighboring fields, and thereby serve as a kind of bond of connection between the scattered members of the scientific body. The collected volumes, according to the Revue's own expression, constitute a kind of gigantic scientific encyclopædia, in which may be found the traces of great scientific contests mingled with dogmatic expositions of the most glorious contemporary discoveries.

Sewer-fed Oysters.—Concerning the possible contamination of oysters by sewage, which seems to be demonstrated by experiences at Middletown, Conn., Nature says: "It has been alleged, on the evidence of certain recent bacteriological investigations as regards the contents of London sewers, that the organism producing typhoid fever can not live and multiply in sewers. But the organism has been found in sewers; it also lives in sea-water; and the fact remains that sewage bathes our oysters during cultivation to an extent that is essentially disagreeable and that ought not to take place; and also that typhoid fever follows the use of oysters so cultivated. It may also be alleged, as is done by certain oyster-growers, that sewage is fatal to the oyster itself. In answer to this we can only say that such evidence as we have obtained as to some of our oyster beds is absolutely opposed to this statement; and not only so, but we know of more than one instance where the oysters are deliberately brought from the beds to fatten in still nearer proximity to outfall sewers for a week or more preliminary to their sale. In brief, if sewage and noxious micro-organisms can be retained in the beard and other portions of the oyster, or in the 'juice,' which is so much relished, everything seems contrived to secure such retention of filth at some of our oyster fisheries."

Japanese Bronze Casting.—The casting of bronze has been carried on in Japan from very early times, reaching nearly, if not quite, back to the settlement of the country by its present inhabitants, seven or eight centuries before Christ. It appears to have been developed since then with the course of the centuries, each successive period having its peculiar styles and being distinguished by its more remarkable works. Among the great works of the bronze founders of the early seventeenth century were a colossal figure of the Buddhist divinity Rochana in Kioto, built to replace the wooden image that was destroyed by an earthquake in the previous century, and a huge bell for the temple. The image was nearly sixty feet high, and was cast where it stood, in segments, the mold being built upon the parts already finished. It was completed in 1614, but was destroyed forty-eight years afterward by an earthquake. The bell is the largest in Japan, and is about fourteen feet high, nine feet in external diameter at the mouth, and ten and three quarters inches thick at the rim, which is swelled internally so as to constrict the mouth. It is this constriction that causes the gentle rising and falling tones that characterize the boom of all Japanese bells. Two other similar bells were cast during the first half of the seventeenth century. Mr. W. Gowland, late of the Japanese Imperial Mint, says that the casting of a large bell in old times in Japan was an important event, and was accompanied by religious ceremonies and popular rejoicings. On the day appointed for running the metal into the mold a grand festival was held, which people of all ranks came from far and near to attend, with contributions, many with offerings of mirrors, hairpins, and metal ornaments, to be added to the bronze. On one occasion the Shogun himself was present and took part in the direction of operations.

Revival of Ramie Cultivation.—The cultivation and treatment of the ramie plant as an industrial product are again attracting attention as a field for the profitable employment of capital. It was apprehended at one time that the returns from cultivation had so far fallen short of expectation as to discourage further effort with it. The plant has, however, been closely studied in all its phases for three or four years past, and the processes of decorticating and degumming the stalks have been established upon a scientific basis. As the ramie gives an exceedingly small quantity of raw fiber—about three and a half to three per cent of the weight of the green stalks—the only way of making it a commercial success has been to treat it in enormous quantities at the lowest possible limit of cost. This necessitated the designing of machines upon the simplest lines. Many of the machines have recently been greatly improved, and their mechanism has been simplified to the apparent limit. Hence the ramie problem seems to have been definitely solved.

Overhead Wires and Lightning.—Concerning the influence of overhead electric wires in reference to safety from lightning, it is to be remembered, the Lancet says, that an overhead telephone wire becomes in point of fact a lightning conductor, and in this capacity may act in two ways: by equalizing differences of potential it may prevent the occurrence of the disruptive discharge; or, by receiving a lightning charge, it may carry the current to the earth. There can be little doubt that overhead conductors if connected with the earth play an important part in the distribution of atmospheric electricity. Lord Kelvin, in a recent paper, said that the difference of potential he obtained between the earth and an insulated burning match placed nine feet above the ground was from two hundred to four thousand volts. What, then, is the result of permanently connecting by a good conductor the earth and the atmosphere directly above it, a condition that exists in the case of single-wire circuits? Such an arrangement must tend to equalize potential and prevent the accumulation of those charged masses which no doubt form the nucleus of the storm cloud. This equalization will continue to take place in all conditions of weather. But when a storm occurs it is obvious that if struck by lightning the wire carries the current to the point of greatest range—viz., to the instrument and to any one in its vicinity. Therefore, unless the strictest structural precautions be taken, such a wire becomes a source of danger rather than of safety. To obviate this danger, every post or support for overhead wires ought to be fitted with a lightning guard, and every instrument, whether using the earth as a return or not, should be furnished with a lightning arrester.

Conditions of Sleep.—Some interesting experiments on sleep have been made by Prof. I. Tarchanoff, of St. Petersburg, upon puppies from three weeks to three months old. The animals at this age have a strong disposition to sleep, and are not awakened even when physiological experiments are made upon them—a few minutes' stroking of the head and back assuring the persistence of their slumbers or their return to sleep if they are aroused. Adult dogs will not sleep under such circumstances, except with the aid of a narcotic. Position of the body exerts a distinct influence on the sleeping. Puppies lightly strapped were placed, some in a horizontal and others in a vertical position, and of the latter some were held with the head downward and others with the tail down. Stroking and caressing failed to induce sleep only when the head was kept down. Other experiments demonstrated that the arterial pressure falls during sleep, and that when the animal wakes it returns to its former height. These facts agree with the statements and observations of Mr. Darben that the brain is anæmic during sleep. Further experiments were made by Prof. Tarchanoff on animals in which the spinal cord had been divided between the dorsal and lumbar regions, and the animals had recovered from the immediate effects of the injury. The result was expressed in the observation that the spinal cord never sleeps. The author thinks, further, that the brain is not during sleep inactive in all its parts, but is a source of depressed action propagating itself to all parts of the cord which are in perfect continuity with the brain.

Physiological Influence of Music.—In the investigation of the influence of music on man and animals, Prof. Tarchanoff, of St. Petersburg, used the ergograph of Mosso, and found that, if the fingers were completely fatigued, music had the power of making the fatigue disappear. It appeared that music of a sad and lugubrious character had the opposite effect, and could check or inhibit the contractions. The author is inclined to suppose that the voluntary muscles, being furnished with excito-motor and depressant fibers, act in reference to the music similarly to the heart—that is, that joyful music resounds along the excito-motor fibers and sad music along the depressant or inhibitory fibers. Experiments on dogs showed that music was capable of increasing the elimination of carbonic acid by 16·7 per cent, and of increasing the consumption of oxygen by 20·1 per cent. It was also found that music increases the functional activity of the skin. The author claims as the result of his experiments that music may fairly be regarded as a serious therapeutic agent, and that it exercises a genuine and considerable influence over the functions of the body.

NOTES.

A timely protest is made in the Pharmaceutische Rundschau against the proposition of some pharmaceutical schools to confer the degree of Doctor of Pharmacy. A forcible objection to the use of the term doctor in this connection was uttered in 1874 by the Board of the Philadelphia College of Pharmacy, which deprecated the use of that title because the practices of pharmacy and medicine were so closely connected with each other that it would tend to confusion. A dispensing druggist possessing it would be supposed to have the right to prescribe, and danger of conflict would arise. President Gilman, of Johns Hopkins University, writes to the editor of the Rundschau that by expediency, usage, and justice, "the ancient and honorable title of a doctor should not be bestowed or accepted in any unjustified way," and that the proposed application of it is likely to mislead the public. Other confusion may arise, too, from the use of the initials Ph. D., which are those of Doctor of Philosophy, a degree that implies the successful pursuit of some special study. The title of Master of Pharmacy, already in use, is appropriate and significant, and should be held sufficient.

A curious theory of the channels on Mars is propounded by Mr. Törnebohm, of Stockholm, which is worth citing for its ingenuity. With a drier atmosphere and less mountainous relief than the earth, Mars must have large desert tracts. Across these its enterprising inhabitants have constructed trade roads, which they have furnished with artesian wells and possibly with canals, for the convenience and facilitation of traffic. This irrigation has promoted the growth of vegetation for a considerable distance back of the roads on either side, and the dark marks it makes are what we call the channels.

Objections to the use of wood in warships arise out of its combustibility and its liability to splinter. A board of experts commissioned by the United States Navy Department to consider the subject of dispensing with it and of finding a substitute for it, has decided that the substitute sought should be light, or not heavier than wood, nonconducting, noncombustible, and, when struck by shot, should not fly into splinters. It suggests, as a direction in which the search for a substitute should be made, to select something in the nature of cheap wood or vegetable fiber and fine sawdust; treat them chemically with some insoluble fireproof substance, not too heavy; then press and roll into boards, more or less dense, according to the use for which the material is desired.

An international and representative committee of one hundred and eighty men of science has been formed for the erection of a monument to the late Prof. von Helmholtz. The Emperor of Germany has promised ten thousand marks and a free site for the purpose.

Thoreau records in his journal how he witnessed the formation of a ravine in the course of a February thaw. "Much melted snow and rain being collected on the top of the hill, some apparently found its way through the ground frozen a foot thick, a few feet from the edge of the bank, and began, with a small rill, washing down the slope the unfrozen sand beneath. As the water continued to flow, the sand on each side continued to fall into it and be carried off, leaving the frozen crust above quite firm, making a bridge five or six feet wide over this cavern. Now, since the thaw, this bridge, I see, has melted and fallen in, leaving a ravine some ten feet wide and much longer, which now may go on increasing from year to year without limit. I was there just after it began."

A number of explosions of gas have recently occurred in London, which are supposed to have been connected with the electric-lighting conduits, though the connection was not in every case traced, so that Major Cardew, who has investigated them, has sought for other possible causes. As shown by his report, the most striking features about the accident of four explosions on Southwark Bridge were the distance to which a series of explosions may travel along the electric mains; the proof the event affords of the insufficiency of any ordinary ventilation of the pipes and street boxes, if gas can find an easy access to them; and the necessity for exercising great care to make and keep the street boxes impervious to gas.

A section of Anthropology was organized in connection with the Academy of Natural Sciences of Philadelphia on the 3d of April last, under the chairmanship of Harrison Allen, M. D. The purpose of the section is the presentation of original papers, the statement of interesting facts, the exhibition of illustrative objects, and the discussion of the methods included under the term anthropology. The meetings of the section will be held at the academy on the evenings of the second Friday in each month, from September to May. Communications should be addressed to Charles Morris, Academy of Natural Sciences, or 2223 Spring Garden Street.

The fourth summer session of the School of Applied Ethics, at Plymouth, Mass., will continue from July 7th to August 9th. The school will embrace four departments: Economics, Prof. H. C. Adams, director; Ethics, Dr. Felix Adler, director; Education, S. T. Dutton, of Brooklyn, R. G Huling, Cambridge, Mass., and Paul H. Hanus, of Harvard University, committee in charge; and History of Religions, Prof. C. H. Toy, director. A large variety of subjects will be discussed in these departments, with teachers and specialists of high repute leading; and in most of their relations to social questions those relating to labor will be held prominent.

Prizes have been awarded by the adjudicators on behalf of the Leprosy Fund in England for five papers on leprosy—relating to the decline and extinction of the disease as endemic in the British Islands; its prevalence and decline in Iceland; its increase at the Cape and prevalence in South Africa; its extent and probable causes in Australia; and the conditions under which it prevails in China, Cochin China, Batavia, and the

Malay Peninsula. On some of the subjects for which prizes were offered no essays were sent in, and some of the essays sent in were held not to meet the terms of the competition.

A committee of the British House of Commons appointed to consider the advisability of adopting the metrical system of weights and measures has found many considerations in favor of the movement. An engineering firm has used the system for several years, having adopted it on account of the advantage of working interchangeably with engineers on the Continent. Their workmen were agreed that the entire system was easier to deal with than the English measures, and was much less liable to error. Dr. Gladstone insisted upon the superior facility of teaching the metric system. As the children have to learn decimals, very little more time would be needed by them for learning the metric system.

OBITUARY NOTES.

Prof. Julius Lothar Meyer, one of the greatest of chemists, died "suddenly, gently, and painlessly," at Tübingen, Germany, April 12th, in the sixty-fifth year of his age. He was born in 1830; studied at Zurich, Würzburg, Heidelberg, and Königsberg, medicine, chemistry, and mathematical physics; was graduated doctor of medicine from Würzburg in 1854; received leave to teach chemistry and physics in 1859; and was successively engaged in the Physiological Institute at Breslau, the Royal Prussian Forstakademie at Eberswalde, the Polytechnikum at Carlsruhe, and the University of Tübingen, where he was professor of chemistry for nearly twenty years, and where he died. His reputation as a philosophical chemist was based upon a work on Modern Theories in Chemistry, which he published in 1864, and which has appeared in a fifth edition and in an English translation. He was preparing a sixth edition at the time of his death. In 1883 he with Prof. Seubert recalculated the atomic weights of the elements from the original data, and published a book embodying their results. He was one of the earliest investigators of the relations between the properties and the atomic weights of the elements, and published a memoir on that subject in 1869, in which he arranged the elements in the order of atomic weights, in a single table, and indicated the periodic character of the dependence of properties on atomic weights. On this subject a question of priority arose between him and Mendeleeff. The case appears to be one of those of which the history of science offers many illustrations, in which two investigators reached similar results about the same time independently. In experimental chemistry, Lothar Meyer published memoirs in almost every branch, including those on the atomic weight of beryllium, on determinations of vapor densities, on the combustion of carbon monoxide, on the preparation of hydriodic acid, on the transpiration of gases, and on various organic compounds, etc.

Prof. Karl Ludwig, the eminent German physiologist, died in Leipsic, April 25th. He was born at Welzenhausen, in 1816, and took the degree of doctor in 1839. He became a *privat docent* at Marburg in 1842; extraordinary professor at Zurich in 1849; ordinary professor in the Academy for Army Surgeons at Vienna; and for the last thirty years was professor of physiology at the University of Leipsic. His first published work was on the Mechanism of the Secretion of Urine. He improved physiological methods by the introduction of apparatus for the graphic recording of results; was the author of important researches on the circulation of the blood, on the influence of respiration on the circulation, and on the action of the medulla oblongata on the circulation; and he made very valuable researches on the part played by the nervous system in glandular secretion.

Prof. Carl Vogt, an eminent naturalist and original investigator on his own lines, from whom the Monthly has published several charming as well as instructive articles, died in Geneva, Switzerland, May 5th. He was born at Giessen, in 1817, and was particularly industrious in the study of fresh-water mollusks. In 1845 he published, with Prof. Agassiz, a memoir on the anatomy of fishes of the family *Salmonidæ*, in preparation for which he had specially studied the different phases of the development of these fishes. This was the beginning of the investigation of the embryology of fishes. He gained much fame by the researches which he carried on, under the direction of Agassiz, on the formation and movement of glaciers, establishing a station, which was named the Hotel of the Neufchatelais, on the lower glacier of the Aar. In his later years he published, in conjunction with M. Jung, a treatise on zoölogy.

Daniel Kirkwood, late Professor of Mathematics in Indiana State University, and a distinguished astronomer, died in Riverside, Cal., June 11th. He was born in Bladensburg, Md., in 1814; studied in the academy at York, Pa., where he became first assistant and mathematical instructor; was appointed Principal of the High School at Lancaster, Pa., in 1843; Professor of Mathematics in Delaware College in 1851, and president of the institution three years later; and served thirty years, from 1856 till 1886, as Professor of Mathematics in Indiana University. He was a frequent contributor on astronomical subjects to scientific journals, and published a book upon the asteroids, or minor planets between Mars and Jupiter.

CHARLES UPHAM SHEPARD

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PROFESSIONAL INSTITUTIONS.

IV.—ORATOR AND POET, ACTOR AND DRAMATIST.

By HERBERT SPENCER.

THINGS which during evolution become distinct were of course originally mingled: the process of evolution implies this. Already we have seen that in the triumphal reception of the conqueror, originally spontaneous and rude but in course of time becoming an established ceremonial elaborated into definite forms, there were germs of various arts and the professors of them. With the beginnings of dancing and music just described, were joined the beginnings of oratory, poetry, acting and the drama; here, for convenience, to be treated of separately. All of them manifestations of exalted emotion, at first miscellaneous and confused in their display, they only after many repetitions became regularized and parted out among different persons.

With the shouts of applause greeting David and Saul, came, from the mouths of some, proclamations of their great deeds; as, by Miriam, there had been proclamation of Yahveh's victory over the Egyptians. Such proclamations, at first brief and simple, admit of development into long and laudatory speeches; and, with utterance of these, begins the orator. Then among orators occasionally arises one more fluent and emotional than ordinary, whose oration, abounding in picturesque phrases and figures of speech, grows from time to time rhythmical, and hence the poet. The laudations, comparatively simple in presence of the living ruler, and afterward elaborated in the supposed presence of the apotheosized ruler, are, in the last case, sometimes accompanied by mimetic representations of his achievements. Among children, everywhere much given to dramatizing the doings of adults, we may see that some one of a group, assuming the character of a personage heard about or read about, imitates his actions, especially of a destructive kind; and naturally therefore, in days when feelings were less restrained than now, adults fell into the same habit of representing the deeds of the hero they celebrated. The orator or poet joined with his speech or song the appropriate actions, or else these were simultaneously given by some other celebrant. And then, when further developments brought representations of more complex incidents, in which the victories of the hero and his companions over enemies were shown, the leading actor, having to direct the doings of subordinates, became a dramatist.

From this sketch of incipient stages based on established facts, but partly hypothetical, let us pass to the justifying evidence, supplied by uncivilized races and by early civilized races.

If we take first the usages of peoples among whom the musical faculty is not much developed we meet with the lauding official in his simplest form—the orator. Says Erskine of the Fijians, each tribe has its "orator, to make orations on occasions of ceremony, or to assist the priest and chief in exciting the courage of the people before going to battle": the encouragement being doubtless in large measure eulogy of the chief's past deeds and assertions of his coming prowess. So is it among the New Caledonians.

> In Tanna "every village has its orators. In public harangues these men chant their speeches, and walk about in peripatetic fashion, from the circumference into the center of the marum [forum], laying off their sentences at the same time with the flourish of a club": [a dramatic accompaniment.]

And, according to Ellis, the Tahitians furnish like facts. Of their "orators of battle" he says—

> "The principal object of these Rautis was, to animate the troops by recounting the deeds of their forefathers, the fame of their tribe or island, the martial powers of their favoring gods," etc.

The Negro races have commonly large endowments of musical faculty. Among them, as we have seen, laudatory orations assume a musical form; and, in doing so, necessarily become measured. For while spoken utterances may be, and usually are, irregular utterances which, being musical, include the element of time, are thereby in some degree regularized. On reading that among the Marutse, those who "screech out the king's praises" do so to a muffled accompaniment of their instruments," we must infer that, as the sounds of their instruments must have some rhythmical order, so too must their words. Similarly the Monbutto ballad-singers, whose function it is to glorify the king, must fall into versified expression of their eulogies. The "troop of laureates or bards" kept at the Dahoman court, can not utter their praises in chorus without having these praises rhythmically arranged. So, too, in Ashanti and among the Mandingos, the laudations shouted before their chief men, having assumed the form of songs, must have verged into speech more measured than usual. Other uncivilized peoples show us the official orator and poet giving to his applause a musical form which must, by implication, be rhythmical. Atkinson says:—

> "The Sultan ordered his poet to sing for us. The man obeyed, and chanted forth songs, describing the prowess and successful plundering expeditions of my host and his ancestors, which called forth thunders of applause from the tribe."

Among these African peoples, however, and the nomadic peoples of Asia just named, eulogies of the living ruler, whether or not with rhythmical words and musical utterance, are but little, or not at all, accompanied by eulogies of the apotheosized ruler, having a kindred form but with priests in place of courtiers. Why is this? There appear to be two reasons, of which perhaps one is primary and the other secondary. We have seen that among the Negro peoples in general, ideas about life after death, where they exist, are undeveloped. The notion is that the double of the dead man does not long remain extant: when there are no longer any dreams about him he is supposed to have perished finally. Consequently, propitiation of his ghost does not grow into a cult, as where there has arisen the notion that he is immortal. And, then, possibly because of this, African kingdoms are but temporary. It is remarked that from time to time there arises some powerful chief who conquers and consolidates neighboring tribes and so forms a kingdom; but that after a generation or two this ordinarily dissolves again. We have seen how powerful an aid to consolidation and permanence is the supposed supernatural power of a deceased ruler; and hence it appears not improbable that the lack of this belief in an immortal god, and consequent lack of the established worship of one, is a chief cause of the transitory nature of the African monarchies.

This supposition harmonizes with the facts presented to us by ancient civilized societies, in which, along with praises of the living ruler, there went more elaborate praises of the dead and deified ruler.

Egypt furnishes instances of poetic laudations of both. Preceding a eulogy of Seti I, it is written:—

> "The priests, the great ones, and the most distinguished men of South and North Egypt have arrived to praise the divine benefactor on his return from the land of Ruthen." Then follows a song "in praise of the king and in glorification of his fame."

So too Rameses II is glorified in "the heroic poem of the priest Pentaur." In the eighteenth dynasty we see the two functions united.

"An unknown poet, out of the number of the holy fathers, felt himself inspired to sing in measured words the glory of the king [Thutmes III], and the might and grandeur of the god Amon."

And then we have the acts, wholly priestly, of—

"the nobleman who bore the dignity of 'prophet of the Pyramid of Pharaoh.' This officer's duty was to praise the memory of the deceased king, and to devote the god-like image of the sovereign to enduring remembrance."

Still better and more abundant evidence is furnished by accounts of the early Greeks. The incipient poet, as eulogizer of the god, is priestly in his character and at first is an official priest. Concerning the Greeks of rude times Muir writes—"Hence, in their traditions, the character of poet is usually found to combine those of musician, priest, prophet, and sage;" and he adds that—

The mythical poet Olen "ranks as the earliest and most illustrious priest and poet of the Delian Apollo . . . Bœo, a celebrated priestess of that sanctuary [the Delphic], pronounces him . . . to be, not only the most antient of Apollo's prophets, but of all poets."

We are told by Mahaffy that "the poems attributed to these men [poets prior to Homer] . . . were all strictly religious."

"The hexameter verse was commonly attributed to the Delphic priests, who were said to have invented and used it in oracles. In other words, it was early used in religious poetry . . . There is no doubt that the priests did compose such works [long poems] for the purpose of teaching the attributes and adventures of the gods. Thus epic poetry [was at first] purely religious . . . Homer and Hesiod represent the *close* of a long epoch."

And that their poetry arose by differentiation from sacred poetry, is implied in his further remark that in Homer's time, "the wars and adventures, and passions of men, had become the center of interest among the poets." This partially secularized poetry at a later date became further secularized, while it became further differentiated from music. The hymn of the primitive priest-poet was uttered to the accompaniment of his four-stringed lyre, in a voice more sonorous than ordinary speech—not in song, as we understand it, but in recitative; and, as Dr. Monro argues, a vague recitative—a recitative akin to the intoning of the liturgy by our own priests, and to the exalted utterance spontaneously fallen into under religious excitement.* But in course of time, this quasi-

* In his learned work, *The Modes of Ancient Greek Music*, he writes:—"Several indications combine to make it probable that singing and speaking were not so widely separated from each other in Greek as in the modern languages with which we are most familiar." (p. 113) . . .

. . . "For if the language even in its colloquial form had qualities of rhythm and intonation which gave it this peculiar half-musical character, so that singing and speaking were musical utterance of hexameters was dropped by a certain derived secular class, the Rhapsodists. These, who recited at courts "the books [of Homer] separately, some one, some the other, at the feasts or public solemnities of the Greek cities," and who themselves sometimes composed "dedicatory prologues or epilogues in honor of the deities with whose festivals such public performances were connected," and became in so far themselves poets, were distinguished from the early poets by their non-musical speech.

"While the latter sang, solely or chiefly, his own compositions to the accompaniment of his lyre, the rhapsodist, bearing a laurel branch or wand as his badge of office, rehearsed, without musical accompaniment, the poems of others:" [sometimes, as above said, joined with his own].

Thus there simultaneously arose a class of secular poets and a divergence of poetry from song.

A parallel genesis occurred among the Romans. Though its sequences were broken, its beginning was the same. Says Grimm—

. . . "Poetry borders so closely on divination, the Roman vates is alike songster and soothsayer, and soothsaying was certainly a priestly function."

Congruous with this is the statement that—

"Roman religion was a ceremonial for the priests, not for the people; and its poetry was merely formulæ in verse, and soared no higher than the semi-barbarous ejaculations of the Salian priests or the Arvolian brotherhood."

The more elaborated forms of religious ceremony appear to have been imported from subjugated countries—the sacred games from Etruria, and other observances from Greece. Hence the Romans being the conquerors, it seems to have resulted that the arts, and among others the art of poetry, brought with them by the captives, were for a long period lightly thought of by their captors. Having no commission from the gods, the professors of it were treated with contempt and their function entirely secularized. So that, as Mommsen writes:—

"The poet or, as he was at this time called, the "writer," the actor and the composer, not only belonged still, as formerly, to the despised class of laborers for hire, but were still, as formerly, placed in the most marked way under the ban of public opinion, and subjected to police maltreatment."

With like implications in a later chapter he adds:—

"None of those who in this age appeared as poets before the public, as we have already said, can be shown to have been noble, and not only so, but none can be shown to have been natives of Latium proper."

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more closely akin than they ever are in our experience, we may expect to find that music was influenced in some measure by this state of things." (p. 119).

Thus it is clear that the primitive priest-poet of the Greeks was simply an emotionally-excited orator, whose speech diverged from the common speech by becoming more measured and more intoned.

More coherent evidence concerning the differentiation of the poet from the priest is hardly to be expected where, instead of a continuous evolution of one society, we have an agglomeration of societies, in which the conquering society from the beginning incorporated other ideas and usages with its own.

When, from Southern Europe of early days, we turn to Northern Europe, we meet, in Scandinavia, with evidence of a connection between the primitive poet and the medicine-man. Speaking of the "diviners, both male and female, honored with the name of prophets," who were believed to have power to force the ghosts of the "dead to tell them what would happen," Mallet says that "poetry was often employed for the like absurd purposes:" these same skalds or bards were supposed to achieve this end "by force of certain songs which they knew how to compose." At the same time that these poets and musicians of the ancient northern nations invoked the spirits of the departed in verses which most likely lauded them, they "were considered as necessary appendages to royalty, and even the inferior chieftains had their poets." The Celts had kindred functionaries, whose actions were evidently similar to those of the Greek priest-poets. Says Pelloutier, basing his statement on Strabo, Lucan, and others:—

"Les Bardes, qui faisoient [des] Hymnes, etoient Poëtes et Musiciens; ils composoient les paroles, et l'air sur lequel on les chantoit."

The use of the word "hymnes" apparently implying that their songs had something of a sacred character. That the connection between poet and priest survived, or was re-established, after paganism had been replaced by Christianity, there is good evidence. In the words of Mills—

"Every page of early European history attests the sacred consideration of the minstrel;" his peculiar dress "was fashioned like a sacerdotal robe."

And Fauriel asserts that—

"Almost all the most celebrated troubadours died in the cloister and under the monk's habit."

But it seems a probable inference that after Christianity had subjugated paganism, the priest-poet of the pagans, who originally lauded now the living chief and now the deified chief, gradually ceased to have the latter function and became eventually the ruler's laureate. We read that—

"A joculator, or bard, was an officer belonging to the court of William the Conqueror."

"A poet seems to have been a stated officer in the royal retinue when the king went to war."

And among ourselves such official laureateship still survives, or is but just dying.

While the eulogizer of the visible ruler thus became a court-functionary, the eulogizers of the invisible ruler—no longer an indigenous deity, but one of foreign origin—came to be his priests; and in that capacity praised him, sometimes in poetical, sometimes in oratorical, form. Throughout Christendom from early times down to ours, religious services have emphasized in various proportions the different attributes of the deity—now chiefly his anger and revenge, now chiefly his goodness, love, and mercy; but they have united in ceaseless exaltation of his power; and the varieties of oral admiration, of invocation, of devotion, have been partly in prose and partly in verse. All along the Church-service has had for its subject-matter this or that part of the divine story, and all along it has embodied its ideas and feelings in a semi-rhythmical liturgy, in hymns, in the orations which we call sermons: each of them having in one way or other the laudatory character. So that the Christian priest has throughout stood in substantially the same relation to the being worshiped, as did the pagan priest, and has perpetually used kindred vehicles of expression.

While the Christian priest has been officially one who repeated the laudations already elaborated and established, he has also been to a considerable extent an originator, alike of orations and poems. Limiting ourselves to our own country, and passing over the ancient bards, such as Taliesin and Merlin, whose verses were in praise of living and dead pagan heroes, and coming to the poets of the new religion, we see that the first of them Cædmon, a convert who became inmate of a monastery, rendered in metrical form the story of creation and sundry other sacred stories—a variously elaborated eulogy of the deity. The next poet named is Aldhelm, a monk. The clerical Bede again, known mainly by other achievements, was a poet, too; as was likewise bishop Cynewulf. For a long time after, the men mentioned as writers of verse were ecclesiastics; as was Henry of Huntingdon, a prior; Geraldus Cambrensis, archdeacon; Layamon, priest; and Nicholas of Guildford. Not until Edward III's reign do we find mention of a secular song-writer—Minot; and then we come to our first great poet, Chaucer, who, whether or not "of Cambridge, clerk," as is suspected, became court-poet and occupied himself mainly with secular poetry. After this the differentiation of the secular verse-writer from the sacred verse-writer became more marked, as we see in the case of Gower; but still, while the subject-matter of the poems became more secularized, as with Langland and with Barbour, the ecclesiastical connection remained dominant. Lydgate was priest, orator and poet; Occleve, poet and civil servant; William of Massington, proctor and poet; Juliana Berners, prioress and secular poetess; Henryson, schoolmaster and poet; Skelton, priest and poet laureate; Dunbar, prior and secular poet; Douglas, rector and court-poet; Barclay, priest and poet; Hawes, priest and poet; and so on. It should be added that one of the functions of the clergyman has been the writing of laudatory hymns—hymns composed now by ordained ecclesiastics, now by dissenting ministers. These facts, joined with facts of recent times, make it clear that as in pagan societies, so in Christian societies, the priest-poet, appointed eulogizer of the deity he serves, is the first poet; and that the poets we distinguish as secular have gradually arisen by differentiation from him.

Along with the divergence of secular poets from sacred poets there have arisen divergences within the assemblage of secular poets themselves. There have come the mainly epic, as Milton; the didactic, as Pope; the satiric, as Butler; the descriptive, as Wordsworth; the comic, as Hood.

From those official praisers of the hero or god whose laudations take the form of speech, non-rhythmical or rhythmical, we pass to those whose laudations take the form of mimetic actions—who express the triumphs of the deified ruler by imitations of his deeds. United as the two originally were, they diverge and develop along their respective lines.

Existing savages yield illustrations of the primitive union of vocal laudation and mimetic laudation. Concerning the Point Barrow Eskimo we read:—

"The most important festivals are apparently semi-religious in character and partake strongly of the nature of dramatic representations. . . . All festivals are accompanied by singing, drumming, and dancing."

More detailed evidence is supplied by an official account of the Navajo Indians, from which here are relevant passages:—

"Hasjelti Dailjis, in the Navajo tongue, signifies the dance of Hasjelti, who is the chief or rather the most important and conspicuous of the gods. The word dance does not well designate the ceremonies, as they are in general more histrionic than saltatory. . . . The personation of the various gods and their attendants and the acted drama of their mythical adventures and displayed powers exhibit features of peculiar interest. . . . Yet, from what is known of isolated and fragmentary parts of the dramatized myths, it is to be inferred that every one of the strictly regulated and prescribed actions has or has had a special significance, and it is obvious that they are all maintained with strict religious scrupulosity."

And it is added that each of these observances "clearly offers a bribe or proposes the terms of a bargain to the divinities."

Noting next the evidence furnished by Ancient India, we are led to infer that there, as elsewhere, the triumphal reception of a conqueror was the observance from which sprang the dramatic art, along with the arts we have thus far contemplated. Weber writes—

"Next to the epic, as the second phase in the development of Sanskrit poetry, comes the Drama. The name for it is *Nátaka*, and the player is styled *Nata*, literally 'dancer.' Etymology thus points to the fact that the drama has developed out of dancing, which was probably accompanied, at first with music and song only, but in course of time also with pantomimic representations, processions, and dialogue."

And though himself offering another interpretation, he quotes Lassen to the effect that—

"The Indian drama, after having acquitted itself brilliantly in the most varied fields—notably too as a drama of civil life—finally reverted in its closing phases to essentially the same class of subjects with which it had started—to representations from the story of the gods."

Greek history yields various facts of like meaning. In Sparta—

"The singing chorus danced around it ['the sacrifice . . . burning on the altar'] in the customary ring; while others represented the subject of the song by mimic gesture."

That the drama had a religious origin is shown by the fact that it continued always to have a religious character. Says Moulton—"the performance of every drama was regarded by the ancients as an act of worship to Dionysus." And to like effect is the statement of Mahaffy that—"the old Greek went to the theater to honor and serve his god." The dramatic element of religious ceremonies was at first mingled with the other elements, as is implied by Grote, who speaks of the importance of the united religious celebrants—

"in the 'ancient' world, and especially in the earlier periods of its career—the bards and rhapsodes for the epic, the singers for the lyric, the actors and singers jointly with the dancers for the chorus and drama. The lyric and dramatic poets taught with their own lips the delivery of their compositions."

The process of differentiation by which the drama arose is well shown by the following extracts from Moulton:—

"Only one of these Ballad-Dances was destined to develop into drama. This was the Dithyramb, the dance used in the festival worship of the god Dionysus.

" . . . the 'mysteries' of ancient religion were mystic dramas in which the divine story was conveyed."

"The chorus started from the altar in the center of the orchestra, and their evolutions took them to the right. This would constitute a Strophe, whereupon (as the word 'Strophe' implies) they turned round and in the Antistrophe worked their way back to the altar again."

In lyric tragedy "the Chorus appears as Satyrs in honor of Dionysus, to whose glory the legend is a tribute; they maintain throughout the combination of chant, music, and dance."

"The work of Thespis was to introduce an 'actor,' separate altogether from the chorus."

That along with differentiation of the drama from other social products there went differentiation of the dramatist and the actor from other persons and from one another, may fairly be inferred, however little able we may be to trace the process. Already, by the above extract from Grote, we are shown that a leading actor gave oral directions to subordinate actors; and in doing this he assumed to some extent the character of dramatist. Before the rise of a written literature no greater distinction could be made; but after written literature arose, the dramatist proper became possible. Still, it is to be observed that in the productions of the great dramatic writers of Greece, the original relations continued to be shown. As Moulton remarks:—

"Tragedy never ceased to be a solemn religious and national festival, celebrated in a building which was regarded as the temple of Dionysus, whose altar was the most prominent object in the orchestra."

And the subject-matter continued in late days as in early days to be, in chief measure, the doings of the gods. An illustration is furnished by Mahaffy, who says:—

"We hear in the days of the Ptolemies about 250 B. C., of a regular symphony at a Delphic feast, in which the contest of Apollo and the Python was represented in five movements with the aid of flutes (or rather clarinettes, *αὐλοί*), harps, and fifes without singing or libretto."

Clearly this incident, which while mainly showing the development of instrumental music, shows also the kind of theme chosen. But when we come to the comedies of Aristophanes we see a complete secularization.

Partly because, as pointed out above in following the genesis of the poet, so much of Roman civilization was not indigenous but foreign, and partly because Roman life, entirely militant, led to a contempt for all non-militant occupations (as happens everywhere); the rise of the dramatist in Rome is indefinite. Still we find indications akin to the foregoing. Duruy, in agreement with Guhl and Koner, writes that—

In 364 during a pestilence the Romans applied to the Etruscans who "replied that the gods would be satisfied if they were honored by scenic games, and, that the Romans might be able to celebrate these games, they sent them at the same time actors, who executed religious dances to the sound of the flute . . . the pestilence then ended."

And he goes on to say that—

"Young Romans learnt the dances introduced from Etruria, and marked the rhythm of them by songs, often improvised, which ended by being accompanied with action. Roman comedy was discovered."

In Rome as in Greece an idea of sacredness long attached to the drama. "'Varo,' says St. Augustine, 'ranks theatrical things with things divine.'" This conception of sacredness, however, was congruous with their conceptions of the gods, and widely different from sacredness as understood by us.

"The subjects of the pantomime were taken from the myths of gods and heroes, the actor having to represent male and female characters by turns, while a choir, accompanied by flute-players, sang the corresponding canticum."

"Sometimes mythological scenes were performed in the arena with cruel accuracy. Condemned criminals had to mount the pyre like Hercules, or to give their hand to the flames like Mucius Scævola, or to be crucified like Laureolus the robber; others were torn by bears, in imitation of the fate of Orpheus."

Having usually been an alien and possessing no odor of sanctity derived from his traditional religious function,—

The actor "was ranked with slaves and barbarians . . . he generally was a slave or freedman, or a native of some country where his profession was more esteemed, such as the Greek colonies and the East generally."

Little as one might have expected it, we find that the pagan genesis of the drama was paralleled by the Christian regenesis of it in mediæval Europe. It commenced, as in India, Greece, and Rome, with representations of sacred subjects by priestly actors. Incidents in the life of the god were dramatically repeated in edifices devoted to his worship.

"The circumstance that the ritual was carried on in Latin naturally led to its being supplemented on particular occasions with sacred scenes or lessons acted to the ignorant."

"Thus the *raison d'être* of the mysteries and miracle plays was to act stories from Scripture or the lives of Saints, or embodying central doctrines such as the incarnation, for the benefit of a populace unable to read for themselves."

But there are confused evidences and conflicting opinions respecting dramatic representations in early Christian days—secular and sacred origins appearing to be mingled. We read that "sometimes when a sufficient number of clerical actors were not to be procured, the churchwardens . . . caused the plays to be acted by secular players." And in the same work we also read that "complaint [to Richard II] is made against the secular actors, because they took upon themselves to act plays composed from scripture history, to the great prejudice of the clergy." But in another passage the writer, Strutt, says that these acted mysteries "differed greatly from the secular plays and interludes which were acted by strolling companies, composed of minstrels, jugglers, tumblers, dancers, bourdours or jesters . . . these pastimes are of higher antiquity than the ecclesiastical plays." Not improbably such companies may have survived from pagan times, in which their representations formed part of the pagan worship: losing their original meanings, as did the songs of the minstrels. This view seems congruous with the opinion that the secular drama did not arise by direct descent from the mystery-plays, but that, influenced by the familiarity of its writers both with them and with the popular exhibitions, it took its definite form mainly by suggestion of the classic drama: a supposition favored by the fact that in various Elizabethan plays a chorus is introduced. Be this as it may, however, the general implication remains the same. There arose in Christendom, as in Greece, a sacred drama performed by priests and representing incidents in the sacred story; and if our secular drama did not directly descend from this Christian religious drama, then it indirectly descended from the original pagan religious drama.

Along with the rise of the secular drama have arisen minor differentiations. The separation between actor and dramatist, though still not complete, has become greater; most dramatic authors are not actors. And then the dramatic authors are now distinguished into those known as producers chiefly of tragedy, comedy, melodrama, farce, burlesque.

We meet here with no exception to the general law that segregation and consolidation are parts of the evolutionary process. Beginning with Greece we trace the tendency even among the poets. Curtius remarks that "poetry like the other arts was first cultivated in circles limited after the fashion of guilds." And the religious character of these guilds is shown by the further statement that "schools of poets came to form themselves which were . . . intimately connected with the sanctuary."

Naturally the process readily took place with those occupied in combined representations; for they, as a matter of necessity, existed as companies. But there early arose more definite unions among them. Mahaffy says, concerning the Greeks, that—

> "Inscriptions reveal to us the existence of guilds of professionals who went about Greece to these local feasts, and performed for very high pay."

And he further states that—

> The actors' "corporation included a priest (of Dionysus) at the head, who still remained a performer; a treasurer; dramatic poets of new tragedies and comedies and odes; principal actors of both tragedy and comedy . . . and musicians of various kinds."

From Rome, for reasons already indicated, we do not get much evidence. Still there is some.

> The authorities . . . out of regard for the Greek Andronikos "conceded to the guild of poets and actors a place for their common worship in the temple of Minerva."

Nor do modern days fail to furnish a few, though not many, illustrations of the integrating tendency. A slight organization is given by the Actors' Benevolent Fund. The dramatic writers have an agency for collecting the amounts due to them for the performance of their pieces, and are to that extent combined. And then we have a special newspaper, *The Era*, which forms a medium for communication, by advertisements, between all kinds of stage-performers and those who wish to engage them, as well as an organ for representing the interests of the stage and the semi-dramatic music-hall.

[After the above chapter was written my attention was drawn to a passage in the late Prof. Henry Morley's work, *A First Sketch of English Literature* (p. 209), which in short space yields verification for the various leading propositions contained in it and in the preceding chapter:—

"Our English ballads are akin to those which also among the Scandinavians became a familiar social amusement of the people. They were recited by one of a company with animation and with varying expression, while the rest kept time, often with joined hands forming a circle, advancing, retiring, balancing, sometimes remaining still, and, by various movements and gestures, followed changes of emotion in the story. Not only in Spain did the people keep time by dance movement to the measure of the ballad, for even to this day one may see, in the Faroe Islands, how winter evenings of the North were cheered with ballad recitations, during which, according to the old northern fashion, gestures and movements of the listeners expressed emotions of the story as the people danced to their old ballads and songs."

Here, then, as in the Hebrew triumphal reception of the living hero, and the Greek worship of the apotheosized hero, we see a union of music and the dance, and with them a union of rhythmical speech with some dramatic representation of the incidents described, and of the emotions caused by the description. We see that everywhere there has tended to bud out afresh the combined manifestations of exalted feeling from which these various arts originate. Another fact is forced upon our attention. We are shown that in all cases, while there arises some one of a group who becomes singer or reciter, the rest assume the character of chorus. This segregation, which characterized the religious worship of the Greeks and characterized also their dramatic representations, is not only displayed in later times by the cathedral choir, which shares the service with the solo-singers, and by the operatic chorus which does the like on the stage, but is also displayed by the choral accompanists described in the above passage, and even now survives among us as the chorus which habitually winds up the successive verses of a convivial song in a public house.]

Describing a lecture by Dean Buckland on Kent's Cavern, Sir Henry Ackland says that the lecturer "paced like a Franciscan preacher up and down behind a long show-case, up two steps, in a room in the old Clarendon (at Oxford). He had in his hands a huge hyena's skull. He suddenly dashed down the steps, rushed, skull in hand, at the first undergraduate on the front bench, and shouted, 'What rules the world?' The youth, terrified, threw himself against the next back seat, and answered not a word. He rushed then on me, pointing the hyena full in my face: 'What rules the world?' 'Haven't an idea,' I said. 'The stomach, sir,' he said (again mounting his rostrum), 'rules the world. The great ones eat the less, and the less the lesser still.'"

NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XX.—FROM THE DIVINE ORACLES TO THE HIGHER CRITICISM.

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III. THE CONTINUED GROWTH OF SCIENTIFIC INTERPRETATION.

THE science of biblical criticism was, as we have seen, first developed mainly in Germany and Holland. Many considerations there, as elsewhere, combined to deter men from opening new paths to truth: not even in those countries were these the paths to preferment; but there at least the sturdy Teutonic love of truth for truth's sake found no such obstacles as in other parts of Europe. Fair investigation of biblical subjects had not there been extirpated, as in Italy and Spain; nor had it been forced into channels which led nowhither, as in France and southern Germany; nor were men who might otherwise have pursued it dazzled and drawn away from it by the multitude of splendid prizes for plausibility, for sophistry, or for silence displayed before the ecclesiastical vision in England. In the frugal homes of North German and Dutch professors and pastors high thinking on these great subjects went steadily on, and the "liberty of teaching," which is the glory of the northern Continental universities, while it did not secure honest thinkers against vexations, did at least protect them against the persecutions which, in other countries, would have thwarted their studies, and starved their families.

In England the admission of the new current of thought was apparently impossible. The traditional system of biblical interpretation seemed established on British soil forever. It was knit into the whole fabric of thought and observance; it was protected by the most justly esteemed hierarchy the world has ever seen; it was intrenched behind the bishops' palaces, the cathedral stalls, the professors' chairs, the country parsonages—all these, as a rule, the seats of high endeavor and beautiful culture. The older thought held a controlling voice in the senate of the nation, it was dear to the hearts of all classes, it was superbly endowed, every strong thinker seemed to hold a brief for it, or to be in receipt of its retaining fee.

While there was inevitably much alloy of worldly wisdom in the opposition to the new current, no just thinker can deny far higher motives to many, perhaps to most, of the ecclesiastics who were resolute against it. The evangelical movement incarnate in the Wesleys had not spent its strength; the movement initiated by Pusey, Newman, Keble, and their compeers was in full force.

The æsthetic reaction, represented on the Continent by Chateaubriand, Manzoni, and Victor Hugo, and in England by Walter Scott, Pugin, Ruskin, and, above all, by Wordsworth, came in to give strength to this barrier. Under the magic of the men who led in this reaction, cathedrals and churches, which in the previous century had been regarded by men of culture as mere barbaric masses of stone and mortar, to be masked without by classic colonnades and within by rococo work in stucco and *papier maché*, became even more beloved than in the thirteenth century. Even men who were repelled by theological disputations were fascinated and made devoted reactionists by the newly revealed beauties of mediæval architecture and ritual.*

The center and fortress of this vast system, and of the reaction against the philosophy of the eighteenth century, was the University of Oxford. Orthodoxy was its vaunt, and a special exponent of its spirit and object of its admiration was its member of Parliament, Mr. William Ewart Gladstone, who, having begun his political career by a labored plea for the union of church and state, ended it by giving that union what is likely to be a deathblow. The mob at the circus of Constantinople in the days of the Byzantine emperors was not more wildly orthodox than the mob of students at this foremost seat of learning of the Anglo-Saxon race during the middle decades of the nineteenth century. A curious proof of this had been displayed just before the end of that period. The minister of the United States at the Court of St. James was then Edward Everett. He was undoubtedly the most accomplished scholar and one of the foremost statesmen that America had produced; his eloquence in early life had made him perhaps the most admired of American preachers; his classical learning had at a later period made him Professor of Greek at Harvard; he had successfully edited the leading American review, and had taken a high place in American literature; he had been ten years a member of Congress; he had been again and again elected Governor of Massachusetts; and in all these posts he had

* A very curious example of this insensibility of persons of really high culture is to be found in American literature toward the end of the eighteenth century. Mrs. Adams, wife of John Adams, afterward President of the United States, but at that time Minister to England, one of the most gifted women of her time, speaking, in her very interesting letters from England, of her journey to the seashore, refers to Canterbury Cathedral, seen from her carriage windows, and which she evidently did not take the trouble to enter, as "looking like a vast prison." So, too, about the same time, Thomas Jefferson, the American plenipotentiary in France, a devoted lover of classical and Renaissance architecture, giving an account of his journey from Strasburg to Paris, never refers to any of the beautiful cathedrals or churches upon his route.

For the alloy of interested motives among English church dignitaries, see the pungent criticism of Bishop Hampden by Canon Liddon, in his Life of Pusey, vol. i, p. 363.

shown amply those qualities which afterward made him President of Harvard, Secretary of State of the United States, and a United States Senator. His character and attainments were of the highest, and, as he was then occupying the foremost place in the diplomatic service of his country, he was invited to receive an appropriate honorary degree at Oxford. But on his presentation for it in the Sheldonian Theater there came a revelation to the people he represented, and indeed to all Christendom: a riot having been carefully prepared beforehand by sundry zealots, he was most grossly and ingeniously insulted by the mob of undergraduates and bachelors of arts in the galleries and masters of arts on the floor; and the reason for this was that, though by no means radical in his religious opinions, he was thought to have been in his early life, and to be possibly at that time, below what was then the Oxford fashion in belief, or rather feeling, regarding the mystery of the Trinity.

At the center of biblical teaching at Oxford sat Pusey, Regius Professor of Hebrew, a scholar who had himself remained for a time at a German university, and who early in life had embodied so much of the German spirit as to expose himself to suspicion and even to attack. One charge against him at that time shows curiously what was then expected of a man perfectly sound in the older Anglican theology. He had ventured to defend Holy Writ with the argument that there were fishes actually existing which could have swallowed the prophet Jonah. The argument proved unfortunate. He was attacked on the scriptural ground that the fish which swallowed Jonah was created for that express purpose. He, like others, fell back under the charm of the old system: his ideas gave force to the reaction: in the quiet of his study, which, especially after the death of his son, became a hermitage, he relapsed into patristic and mediæval conceptions of Christianity, enforcing them from the pulpit and in his published works. He now virtually accepted the famous dictum of St. Hilary of Poictiers—that one is first to find what is to be believed, and then to search the Scriptures for proofs of it. His devotion to the main features of the older interpretation was seen at its strongest in his utterances regarding the book of Daniel. Just as Cardinal Bellarmine had insisted that the doctrine of the Incarnation depends upon the retention of the Ptolemaic astronomy; just as Wesley had insisted that the truth of the Bible depends on the reality of witchcraft; just as Peter Martyr had made everything sacred depend on the literal acceptance of Genesis; just as Bishop Warburton had insisted that Christianity absolutely depends upon a right interpretation of the prophecies regarding Antichrist—so did Pusey now virtually insist that the whole claim of Christianity upon the world depends upon the early date of the book of Daniel. Happily, though the Ptolemaic astronomy and witchcraft, and the Genesis legends of Creation, and the prophecies regarding Antichrist, and the early date of the book of Daniel have now been relegated to the limbo of delusions, Christianity has but come forth the stronger.

Nothing seemed less likely than that such a vast intrenched camp as that of which Oxford was the center could be carried by an effort proceeding from a few isolated German and Dutch scholars. Yet it was the unexpected which occurred; and it is instructive to note that, even at the period when the champions of the older thought were to all appearance impregnably intrenched in England, a way had been opened into their citadel, and that the most effective agents in preparing it were really the very men in the universities and cathedral chapters who had most distinguished themselves by uncompromising and intolerant orthodoxy.

A rapid survey of the history of general literary criticism at that epoch will reveal this fact fully. During the last decade of the seventeenth century there had taken place the famous controversy over the Letters of Phalaris, in which, against Charles Boyle and his supporters at Oxford, was pitted Richard Bentley at Cambridge, who insisted that the letters were spurious. In the series of battles royal which followed, although Boyle, aided by Atterbury, afterward so noted for his mingled ecclesiastical and political intrigues, had gained a temporary triumph by wit and humor, Bentley's final attack had proved irresistible. Drawing from the stores of his wonderfully wide and minute knowledge, he showed that the letters could not have been written in the time of Phalaris—proving this by an exhibition of their style, which could not then have been in use, of their reference to events which had not then taken place, and of a mass of considerations which no one but a scholar almost miraculously gifted could have marshaled so fully. The controversy had attracted attention not only in England but throughout Europe. With Bentley's reply it had ended. In spite of public applause at Atterbury's wit, scholars throughout the world acknowledged Bentley's victory: he was recognized as the foremost classical scholar of his time; the mastership of Trinity, which he accepted, and the Bristol bishopric, which he rejected, were his formal reward.

Although in his new position as head of the greatest college in England, he went to extreme lengths on the orthodox side in biblical theology, consenting even to support the doctrine that the Hebrew punctuation was divinely inspired, this was as nothing compared with the influence of the system of criticism which he introduced into English studies of classical literature in preparing the way for the application of a similar system to all literature, whether called sacred or profane.

Up to that period there had really been no adequate criticism of ancient literature. Whatever name had been attached to any ancient writings was usually accepted as the name of the author; whatever text was imputed to an author was settled generally on authority. But with Bentley began a new epoch. His acute intellect and exquisite touch revealed clearly to English scholars the new science of criticism and familiarized the minds of thinking men generally with the idea that the texts of ancient literature must be submitted to this science. Henceforward a new spirit reigned among the best classical scholars, prophetic of more and more light in the greater field of sacred literature. Scholars, of whom Porson was chief, followed out this method, and though at times, as in Porson's own case, they were warned off, with much loss and damage, from the application of it to the sacred text, they kept alive the better tradition.

A hundred years after Bentley's main efforts appeared in Germany another epoch-making book—Wolf's Introduction to Homer. In this was broached the theory that the Iliad and Odyssey are not the works of a single great poet, but are made up of ballad literature wrought into unity by more or less skillful editing. In spite of various changes and phases of opinion on this subject since Wolf's day, he dealt a killing blow at the idea that classical works are necessarily to be taken at what may be termed their face value.

More and more clearly it was seen that the ideas of early copyists and even of early possessors of masterpieces in ancient literature were entirely different from those to which the modern world is accustomed. It was seen that manipulations and interpolations in the text by copyists and possessors had long been considered not merely venial sins, but matters of right, and that even the issuing of whole books under assumed names had been practiced freely.

In 1811 a light akin to that thrown by Bentley and Wolf upon ancient literature was thrown by Niebuhr upon ancient history. In his History of Rome the application of scientific principles to the examination of historical sources was for the first time exhibited largely and brilliantly. Up to that period the time-honored utterances of ancient authorities had been, as a rule, accepted as final: no breaking away, even from the most absurd of them, was looked upon with favor, and any one presuming to go behind them was regarded as troublesome and even as dangerous.

Through this sacred conventionalism Niebuhr broke fearlessly, and, though at times overcritical, he struck from the early history of Rome a vast mass of accretions, and gave to the world a residue infinitely more valuable than the original amalgam of myth, legend, and chronicle.

His methods were especially brought to bear on English history by one of the truest men and noblest scholars that the English race has produced—Arnold of Rugby—and, in spite of the inevitable heavy conservatism, were allowed to do their work in the field of ancient history as well as in that of ancient classical literature.

The place of myth in history thus became more and more understood, and historical foundations, at least so far as *secular* history was concerned, were henceforth dealt with in a scientific spirit. The extension of this new treatment to *all* ancient literature and history was now simply a matter of time.

Such an extension had already begun, for in 1829 had appeared Milman's History of the Jews. In this work came a further evolution of the truths and methods suggested by Bentley, Wolf, and Niebuhr, and their application to sacred history was made strikingly evident. Milman, though a clergyman, treated the history of the chosen people in the light of modern knowledge of Oriental and especially of Semitic peoples. He exhibited sundry great biblical personages of the wandering days of Israel as sheiks or emirs or Bedouin chieftains, and the tribes of Israel as obedient then to the same general laws, customs, and ideas as govern wandering tribes in the same region now. He dealt with conflicting sources somewhat in the spirit of Bentley, and with the mythical, legendary, and miraculous somewhat in the spirit of Niebuhr. This treatment of the history of the Jews, simply as the development of an Oriental tribe, raised great opposition. Such champions of orthodoxy as Bishop Mant and Dr. Faussett straightway took the field, and with such effect that the Family Library, a very valuable series in which Milman's history appeared, was put under the ban and its further publication stopped. For years Milman, though a man of exquisite literary and lofty historical gifts, as well as of most honorable character, was debarred from preferment and outstripped by ecclesiastics vastly inferior to him in everything save worldly wisdom; for years he was passed in the race for honors by divines who were content either to hold briefs for all the contemporary unreason which happened to be popular or to keep their mouths shut altogether. This opposition to him extended to his works. For many years they were sneered at, decried, and kept from the public as far as possible.

Fortunately, the progress of events lifted him, before the closing years of his life, above all this opposition. As Dean of St. Paul's he really outranked the contemporary archbishops; he lived to see his main ideas accepted, and his History of Latin

Christianity received as certainly one of the most valuable, and no less certainly the most attractive, of all church histories ever written.

The two great English histories of Greece—that by Thirlwall, which was finished, and that by Grote, which was begun, in the middle years of the nineteenth century—came in to strengthen this new development. By application of the critical method to historical sources, by pointing out more and more fully the inevitable part played by myth and legend in early chronicles, by displaying more and more clearly the ease with which interpolations of texts, falsifications of statements, and attributions to pretended authors were made, they paved the way still further toward a just and fruitful study of sacred literature.*

Down to the middle of the nineteenth century the traditionally orthodox side of English scholarship, while it had not been able to maintain any effective quarantine against Continental criticism of classical literature, had been able to keep up barriers fairly strong against Continental discussions of sacred literature. But in the second half of the nineteenth century these barriers were broken at many points, and, the stream of German thought being united with the current of devotion to truth in England, there appeared early in 1860 a modest volume entitled Essays and Reviews. This work discussed various subjects in which the older theological positions had been rendered untenable by modern research, and brought to bear upon them the views of the newer school of biblical interpretation. The authors were, as a rule, scholars in the prime of life, holding influential positions in the universities and public schools. They were seven—the first being Dr. Temple, a successor of Arnold at Rugby; and the others, the Rev. Dr. Rowland Williams, Prof. Baden Powell, the Rev. H.

* For Mr. Gladstone's earlier opinion, see his Church and State and Macaulay's review of it. For Pusey, see Mozley, Ward, Newman's Apologia, Dean Church, etc., and especially his Life by Liddon. Very characteristic touches are given in vol. i, showing the origin of many of his opinions (see letter on p. 184). For the scandalous treatment of Mr. Everett by the clerical mob at Oxford, see a rather jaunty account of the preparations and of the whole performance in a letter written at the time from Oxford by the late Dean Church in The Life and Letters of Dean Church, London, 1894, pp. 40, 41. For a succinct and brilliant history of the Bentley-Boyle controversy, see Macaulay's article on Bentley in the Encyclopædia Britannica; also Beard's Hibbert Lectures for 1893, pp. 344, 345; also Dissertation in Bentley's works, edited by Dyce, London, 1836, vol. i, especially the preface. For Wolf, see his Prolegomena ad Homerum, Halle, 1795; for its effects, see the admirable brief statement in Beard, as above, p. 345. For Niebuhr, see his Roman History, translated by Hare and Thirlwall, London, 1828; also Beard, as above. For Milman's view, see, as a specimen, his History of the Jews, last edition, especially pp. 15-27. For a noble tribute to his character, see the preface to Lecky's History of European Morals. For Thirlwall, see his History of Greece, *passim;* also his letters; also his Charge of the Bishop of St. David's, 1863.

B. Wilson, Mr. C. W. Goodwin, the Rev. Mark Pattison, and the Rev. Prof. Jowett—the only one of the seven not in holy orders being Goodwin. All the articles were important, though the first, by Temple, on The Education of the World, and the last, by Jowett, on The Interpretation of Scripture, being the most moderate, served most effectually as entering wedges into the old tradition.

At first no great attention was paid the book, the only notice being the usual attempts in sundry clerical newspapers to pooh-pooh it. But in October, 1860, appeared in the Westminster Review an article exulting in the work as an evidence that the new critical method had at last penetrated the Church of England. The opportunity for defending the Church was at once seized by no less a personage than Bishop Wilberforce, of Oxford, the same who a few months before had secured a fame more lasting than enviable by his attacks on Darwin and the evolutionary theory. His first onslaught was made in a charge to his clergy. This he followed up with an article, in the Quarterly Review, very explosive in its rhetoric, much like that which he had devoted in the same periodical to Darwin. The bishop declared that the work tended "toward infidelity, if not to atheism"; that the writers had been "guilty of criminal levity"; that, with the exception of the essay by Dr. Temple, their writings were "full of sophistries and skepticisms." He was especially bitter against Prof. Jowett's dictum, "Interpret the Scripture like any other book"; he insisted that Mr. Goodwin's treatment of the Mosaic account of the Origin of Man "sweeps away the whole basis of inspiration and leaves no place for the Incarnation"; and through the article were scattered such rhetorical adornments as the words "infidel," "atheistic," "false," "wanton," and the like. It at once attracted wide attention, but its most immediate effect was to make the fortune of Essays and Reviews, which was straightway demanded on every hand, went through edition after edition, and became a power in the land. At this a panic began, and with the usual results of panic—much folly and some cruelty. Addresses from clergy and laity, many of them frantic with rage and fear, poured in upon the bishops, begging them to save Christianity and the Church; a storm of abuse arose; the seven essayists were stigmatized as "the seven extinguishers of the seven lamps of the Apocalypse," "the seven champions *not* of Christendom." As a result of all this pressure, Sumner, Archbishop of Canterbury, one of the last of the old, kindly, bewigged pluralists of the Georgian period, headed a declaration, which was signed by the Archbishop of York and a long list of bishops, expressing pain at the appearance of the book, but doubts as to the possibility of any effective dealing with it. This letter only made matters worse.

The orthodox decried it as timid and the liberals denounced it as irregular. The same influences were exerted in the sister island, and the Protestant archbishops in Ireland issued a joint letter warning the faithful against the "disingenuousness" of the book. Everything seemed to increase the ferment. A meeting of clergy and laity having been held at Oxford in the matter of electing a Professor of Sanskrit, the older orthodox party having made every effort to defeat the eminent scholar Max Müller, and all in vain, found relief after their defeat in new denunciations of Essays and Reviews.

Of the two prelates who might have been expected to breast the storm, Tait, Bishop of London, afterward Archbishop of Canterbury, bent to it for a period, though he soon recovered himself and did good service; the other, Thirlwall, Bishop of St. David's, bided his time, and, when the proper moment came, struck most effective blows for truth and justice.

Tait, large-minded and shrewd, one of the most statesmanlike of prelates, at first endeavored to detach Temple and Jowett from their associates, but though Temple was broken down with a load of care, and especially by the fact that he had upon his shoulders the school at Rugby, whose patrons had become alarmed at his connection with the book, he showed a most refreshing courage and manliness. A passage from his letters to the Bishop of London runs as follows: "With regard to my own conduct I can only say that nothing on earth will induce me to do what you propose. I do not judge for others, but in me it would be base and untrue." On another occasion Dr. Temple, when pressed in the interest of the great institution of learning under his care to detach himself from his associates in writing the book, declared to a meeting of the masters of the school that if any statements were made to the effect that he disapproved of the other writers in the volume, he should probably find it his duty to contradict them. Another of these letters to the Bishop of London contains sundry passages of great force. One is as follows: "Many years ago you urged us from the university pulpit to undertake the critical study of the Bible. You said that it was a dangerous study, but indispensable. You described its difficulties, and those who listened must have felt a confidence (as I assuredly did, for I was there) that if they took your advice and entered on the task, you, at any rate, would never join in treating them unjustly if their study had brought with it the difficulties you described. Such a study, so full of difficulties, imperatively demands freedom for its condition. To tell a man to study, and yet bid him under heavy penalties to come to the same conclusions with those who have not studied, is to mock him. If the conclusions are prescribed, the study is precluded." And again, what, as coming from a man who has since held two of the most important bishoprics in the English Church, is of great importance: "What can be a grosser superstition than the theory of literal inspiration? But because that has a regular footing, it is to be treated as a good man's mistake; while the courage to speak the truth about the first chapter of Genesis is a wanton piece of wickedness."

The storm howled on. In the Convocation of Canterbury it was especially violent. In the Lower House Archdeacon Denison insisted on the greatest severity, as he said, "for the sake of the young who are tainted, and corrupted, and thrust almost to hell by the action of this book." At another time the same eminent churchman declared: "Of all books in any language which I ever laid my hands on, this is incomparably the worst; it contains all the poison which is to be found in Tom Paine's Age of Reason, while it has the additional disadvantage of having been written by clergymen."

Hysterical as all this was, the Upper House was little more self-contained. Both Tait and Thirlwall, trying to make some headway against the swelling tide, were for a time beaten back by Wilberforce, who insisted on the duty of the Church to clear itself publicly from complicity with men who, as he said, "gave up God's word, creation, redemption, and the work of the Holy Ghost."

But the matter was brought to a curious issue by two prosecutions—one against the Rev. Dr. Williams by the Bishop of Salisbury; the other against the Rev. Mr. Wilson by one of his clerical brethren. The first result was that both these authors were sentenced to suspension from their offices for a year. At this the two condemned clergymen appealed to the Queen in Council. Upon the Judicial Committee to try the case in last resort sat the Lord Chancellor, the two Archbishops, and the Bishop of London. One occurrence now brought into especial relief the power of the older theological reasoning and ecclesiastical zeal to close the minds of the best of men to the simplest principles of right and justice. Among the men of his time most deservedly honored for lofty character, thorough scholarship, and keen perception of right and justice was Dr. Pusey. No one doubted then, and no one doubts now, that he would have gone to the stake sooner than knowingly countenance wrong or injustice; and yet we find him at this time writing a series of long and earnest letters to the Bishop of London, who, as a judge, was hearing this case, which involved the livelihood and even the good name of the men on trial, pointing out to the bishop the evil consequences which must follow should the authors of Essays and Reviews be acquitted, and virtually beseeching the judges, on grounds of expediency, to convict them. Happily, Bishop Tait was too just a man to be thrown off his bearings by appeals such as this.

The decision of the court, as finally rendered by the Lord Chancellor, virtually declared it to be no part of the duty of the tribunal to pronounce any opinion upon the book; that the court only had to do with certain extracts which had been presented. Among these was one adduced in support of a charge against Mr. Wilson—that he denied the doctrine of eternal punishment. On this the court decided that it did "not find in the formularies of the English Church any such distinct declaration upon the subject as to require it to punish the expression of a hope by a clergyman that even the ultimate pardon of the wicked who are condemned in the day of judgment may be consistent with the will of Almighty God." While the Archbishops dissented from this judgment, Bishop Tait united in it with the Lord Chancellor and the lay judges.

And now the panic broke out more severely than ever. Confusion became worse confounded. The earnest-minded insisted that the tribunal had virtually approved Essays and Reviews; the cynical remarked that it had "dismissed hell with costs." An alliance was made at once between the more zealous High and Low Church men, and Oxford became its headquarters; Dr. Pusey and Archdeacon Denison were among the leaders, and an impassioned declaration was posted to every clergyman in England and Ireland, with a letter begging him "for the love of God" to sign it. Thus it was that in a very short time eleven thousand signatures were obtained. Besides this, deputations claiming to represent one hundred and thirty-seven thousand laymen waited on the Archbishops to thank them for dissenting from the judgment. The Convocation of Canterbury also plunged into the fray, Bishop Wilberforce being the champion of the older orthodoxy, and Bishop Tait of the new. Caustic was the speech made by Bishop Thirlwall, in which he declared that he considered the eleven thousand names, headed by that of Pusey, attached to the Oxford declaration "in the light of a row of figures preceded by a decimal point, so that, however far the series may be advanced, it never can rise to the value of a single unit."

In spite of all that could be done, the act of condemnation was carried in Convocation.

The last main echo of this whole struggle against the newer mode of interpretation was seen when the Chancellor, referring to the matter in the House of Lords, characterized the ecclesiastical act as "simply a series of well-lubricated terms—a sentence so oily and saponaceous that no one can grasp it; like an eel, it slips through your fingers, and is simply nothing."

The word "saponaceous" necessarily elicited a bitter retort from Bishop Wilberforce; but perhaps the most valuable judgment on the whole matter was rendered by Bishop Tait, who declared, "These things have so effectually frightened the clergy that I think there is scarcely a Bishop on the bench, unless it be the Bishop of St. David's (Thirlwall), that is not useless for the purpose of preventing the widespread alienation of intelligent men."

During the whole controversy, and for some time afterward, the press was burdened with replies, ponderous and pithy, vitriolic and unctuous, but in the main bearing the inevitable characteristics of pleas for inherited opinions stimulated by ample endowments.

The authors of the book seemed for a time likely to be swept out of the Church. One of the least daring but most eminent, finding himself apparently forsaken, seemed, though a man of very tough fiber, about to die of a broken heart; but sturdy English sense at last prevailed. The storm passed, and afterward came the still, small voice. Really sound thinkers throughout England, especially those who held no briefs for conventional orthodoxy, recognized the service rendered by the book. It was found that, after all, there existed even among churchmen a great mass of public opinion in favor of giving a full hearing to the reverent expression of honest thought, and inclined to distrust any cause which subjected fair play to zeal.

The authors of the work not only remained in the Church of England, but some of them have since represented the broader views, though not always with their early courage, in the highest and most influential positions in the Anglican Church.*

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* For the origin of Essays and Reviews, see Edinburgh Review, April, 1861, p. 463. For the reception of the book, see the Westminster Review, October, 1860. For the attack on it by Bishop Wilberforce, see his article in the Quarterly Review, January, 1861; for additional facts, Edinburgh Review, April, 1861, pp. 461 *et seq.* For action on the book by Convocation, see Dublin Review, May, 1861, citing Jelf *et al.*; also, Davidson's Life of Archbishop Tait, vol. i, chap. xii. For the Archiepiscopal Letter, see Dublin Review, as above; also, Life of Bishop Wilberforce by his son, London, 1882, vol. iii, pp. 4, 5. It is there stated that Wilberforce drew up the letter. For curious inside views of the Essays and Reviews controversy, including the course of Bishop Hampden, Tait, *et al.*, see Life of Bishop Wilberforce, by his son, as above, pp. 3–11; also 141–149. For the denunciation of the present Bishop of London (Temple) as a "leper," etc., see ibid., pp. 319, 320. For general treatment of Temple, see Fraser's Magazine, December, 1869. For very interesting correspondence, see Davidson's Life of Archbishop Tait, as above. For Archdeacon Denison's speeches, see ibid., vol. i, p. 302. For Dr. Pusey's letter to Bishop Tait, urging conviction of the Essayists and Reviewers, ibid., p. 314. For the striking letters of Dr. Temple, ibid., pp. 290 *et seq.*; also, The Life and Letters of Dean Stanley. For replies, see Charge of the Bishop of Oxford, 1863; also, Replies to Essays and Reviews, Parker, London, with preface by Wilberforce; also, Aids to Faith, edited by the Bishop of Gloucester, London, 1861; also, those by Jelf, Burgon, *et al.* For the legal proceedings, see Quarterly Review, April, 1864; also Davidson, as above. For Bishop Thirlwall's speech, see Chronicles of Convocation, quoted in Life of Tait, vol. i, p. 320. For Tait's tribute to Thirlwall, see Life of Tait, vol. i, p. 325. For a remarkably able review, and in most charming form, of

ART AND EYESIGHT.

By LUCIEN HOWE, M. D.,
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THERE was perhaps no more interesting object at the Columbian Exposition, as an example of a developing appreciation, than the typical Illinois farmer as he stood surprised and bewildered before some of the works of the modern school of painters. His verdict in many instances was doubtless like that of the small boy upon the decorative attempts of an artistic aunt when he said, "It do look awful." Apparently the effect upon at least one such visitor was even more appalling. Perhaps he had been gazing at the various yearnings of the impressionists, or was lost in the labyrinth of color, but at any rate he accosted a bystander in hot haste with "Mister, can you tell me the handiest way to get out of this 'ere place?" If others were not in equal haste to leave the place, they certainly went away questioning seriously what causes had combined to produce some of the conspicuous phases of modern art. Perhaps an explanation can be offered by science. At least, when we examine into the subject we find that the vision of artists is, as a rule, more imperfect than that of other persons. Where this is a not natural defect, artists find it convenient or necessary in their work to make their vision purposely imperfect, and in consequence do not place on canvas what the eye usually sees. Hence a discrepancy between Nature, as seen by the ordinary observer, and its alleged representation by some artists.

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the ideas of Bishop Wilberforce and Lord Chancellor Westbury, see H. D. Traill, The New Lucian, first dialogue. For the cynical phrase referred to, see Nash, Life of Lord Westbury, vol. ii, p. 78, where the noted epitaph is given, as follows:

"RICHARD BARON WESTBURY,
Lord High Chancellor of England.
He was an eminent Christian,
An energetic and merciful Statesman,
And a still more eminent and merciful Judge.
During his three years' tenure of office
He abolished the ancient method of conveying land,
The time-honored institution of the Insolvents' Court,
And
The Eternity of Punishment.
Toward the close of his earthly career,
In the Judicial Committee of the Privy Council,
He dismissed Hell with costs,
And took away from Orthodox members of the
Church of England
Their last hope of everlasting damnation."

The chief imperfection in the vision to which I refer is astigmatism, although either with that, or independently of it, there is usually with artists excessive contraction of the muscle used in focusing the eye—the so-called ciliary muscle. The majority of people have become somewhat familiar with the term astigmatism and its meaning, but, as it involves a rather complicated principle in optics, it may be well to define it here. Technically it might be described as an asymmetry of the eye in which the radius of curvature in one meridian is greater or less than the radius of curvature in another. This definition may be easily understood by a simple illustration. If the transparent portion in the front part of the eye, known as the cornea, were perfectly regular, like the surface of the ordinary sunglass, the rays of light would all tend to converge to a single point; but if the globe were compressed in any one direction—for example, from above downward—then this transparent portion of the eye would not have a regular curvature, but would be somewhat like the top of a Derby hat, held with the long diameter horizontally and the convex surface forward. Practically this is what usually exists in the human eye. As the globe is compressed above and below by the upper and lower lids, it is to a certain extent flattened. This is the usual form of astigmatism, or astigmatism with the rule, as it is called. Other causes tend to make the axes of these two curvatures oblique to each other, or may change their position in various ways, which need not be considered here.

According to the popular idea, the human eye is a perfect instrument, but this, in the vast majority of cases, is not the truth. Nearly every one is astigmatic. Many a person whose eyes are quite imperfect would laugh at the idea if this were told him. He has perhaps always prided himself upon having the best of vision. But the fact is that only a very small per cent of eyes are really free from this unequal curvature which we call astigmatism.

One series of observations made by Dr. Roosa of two hundred eyes, whose owners supposed them to be perfect, and which were apparently perfectly normal, showed that only about one per cent were, beyond question, absolutely perfect, and my own investigation in the same direction would fully corroborate this. If, therefore, a variation from the normal type is so frequent, it is but natural to suppose that artists should have at least their share of astigmatism. But the fact is that among artists astigmatism is not only more frequent, but also that it exists, on the average, in a higher degree, probably, than among any other class of persons.

We can understand the reason for this if for a moment we observe an artist at his work. Having arranged on his palette a variety of pigments, he stands before the easel and applies them to the canvas, but at intervals steps back some few feet in order to get the effect of distance, as he says. It should be noticed that almost without exception the artist when doing this partly closes his eyes, pressing the lids together, making "*clingement*" as the French call it, because, as he explains, "better effects" are thus obtained. At the same time he tips his head from one side to the other, the reason for which we will consider later. Now, if the eyes of persons with ordinary occupations are changed, as we have seen, by the pressure of the upper and lower lids upon the globe, it is but natural to infer that the same result would follow even in a greater degree with persons whose occupation from morning until night, year in and year out, is such as to cause them to practice to an unusual degree this habit of *clingement*, or lid pressure upon the cornea. Indeed, this fact has long since attracted the attention of investigators and has been demonstrated and elaborated by Bull, of Paris, and others. Dr. Bull experimented on his own eyes, having them measured exactly by an instrument of wonderful exactness known as the ophthalmometer while he was making this lid pressure. These measurements showed that even this slight momentary contraction of the lids produced a perceptible increase of the unequal curvature of the cornea, and also that a very high degree of astigmatism could with little effort be produced by pressure of the lids.

Very strong *a priori* reasons, therefore, lead us to expect that the eyes of artists are as a rule more imperfect than those of persons with other occupations. I have taken pains, however, to establish this fact by tests and measurements. The first results of that investigation are given in the American Journal of Ophthalmology for October, 1894, and tests have been made at intervals since then of the vision of artists, record being kept of the variety of work done, style preferred, whether the individual practiced lid pressure habitually or not, and other details of a technical nature. Excluding those on the one hand who were too young in the profession to be really classed as "artists," and on the other hand those whose eyes were practically in a diseased condition, the list thus far includes eighty-four artists, or one hundred and sixty-eight eyes.

Among these, not a single eye was found to be without some astigmatism. This is not surprising, but the degree of astigmatism is significant.

In the series of two hundred eyes already referred to as examined by Dr. Roosa, which had every indication of being absolutely perfect, an exact examination showed that there was, on the average, a degree of astigmatism which technically would be written 0·68 of a *dioptre*, this *dioptre* corresponding to a certain weak glass used as the unit of measure.

Among artists, on the other hand, the examination showed that the average was 0·83 of a *dioptre*, thus being decidedly greater than with persons having other occupations.

It would be interesting to study the degree of this fault as related to the style of the artist, but the limits of this paper do not permit such a long digression. Moreover, this number is small, and there is always danger in generalizing from insufficient data, but I think it fair to say that these facts are sufficient to show the comparatively high degree of the astigmatism of artists, and I am confident that corroborative testimony will not be wanting when this subject is studied by others. Nor is this idea by any means a new one. It is true, exact measurements of the vision of so large a number of painters had not been previously made, but long ago the effects of astigmatism were so conspicuous in some well-known pictures as to attract attention.

A quarter of a century ago no oculist was more prominent than Prof. Liebreich, of London, or better able than he to speak on questions relating to optics. Unfortunately for that branch of science, he came into a fortune, and, giving up the labors of professional work, devoted himself to the study of painting, thus doubling his equipment for the investigation of such questions as these. He turned his attention to the pictures of Turner and Mulready, both of whom have prominent places in the National Gallery and at the Kensington Museum, and in the works of these artists Liebreich's trained sight discovered incontrovertible evidences of defective vision. These facts were brought out in 1863 by Liebreich in a communication to the Royal Institution which still lies buried among its archives.

"Till the year 1830," he says, in speaking of Turner, "all is normal. In 1831 a change in the coloring becomes for the first time perceptible, which gives to the works of Turner a peculiar character not found in any other master. Optically this is caused by an increased intensity of the diffused light proceeding from the most illuminated parts of the landscape. . . . From the year 1833 this diffusion of light becomes more and more vertical. It gradually increases during the following years. At first it can only be perceived by a careful examination of the pictures, but from the year 1839 the regular vertical streaks become apparent to every one. . . . It is a generally received opinion that Turner adopted a peculiar manner, that he exaggerated it more and more, and that his last works are the result of a deranged intellect. I am convinced of the incorrectness—I might almost say of the injustice—of this opinion. . . . According to my opinion, his manner is exclusively the result of a change in the eyes, which developed itself during the last twenty years of his life. In consequence of it, the aspect of Nature gradually changed for him, while he con-

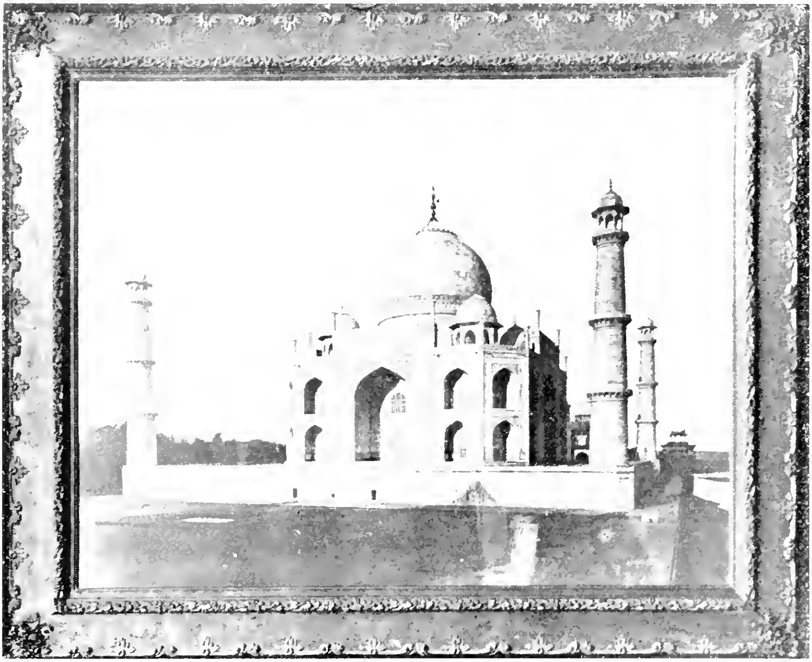


Fig. 1.

tinued in an unconscious, I might almost say in a naïve, manner to reproduce what he saw. . . ."

That astigmatism distorts objects can be easily demonstrated. It is well known that the structure of the human eye is practically the same as that of the photographer's camera. Ordinarily the image which falls on the glass plate of the camera is equally clear in every part, because the lenses in front are ground with spherical surfaces. Such a camera when properly directed at a picture like that of the Taj Mahal, for example, gives us on the glass plate a clear and undistorted image of the building, such as is seen in Fig. 1. If, now, we render the front glass of the camera slightly astigmatic, by placing in front of it a so-called cylindrical glass with the axis horizontal, it produces optically exactly the same effect as that obtained when the globe of the eye is pressed from above downward. Moreover, the degree of this distortion in any eye can be reproduced with perfect exactness by placing in front of the camera a cylindrical glass of proper strength. It will be remembered that the average degree of astigmatism with the artist's examined was found to be

0·83 of a *dioptre*, and for this experiment I have chosen one of the lenses which is very nearly the same strength. Of course, the effect is magnified, as the camera is larger than the eye. But the eye can recognize differences infinitely more minute than those which it is possible to reproduce here, and the physiological distortion is even greater than that which it is possible to represent on the printed page. A picture taken with such a combination of lenses is shown in Fig. 2. In this it will be noticed that while the vertical lines are all clearly marked the horizontal ones are blurred and indistinct. If, now, for any reason the globe of the eye has the same distortion from side to side instead of from above downward, this can be imitated by placing the cylindrical lens before our camera with the axis vertical instead of horizontal. The result is shown in Fig. 3. The effect in this case is to blur the lines which before were clear, and make clear those which were blurred. For example, the horizontal line extending

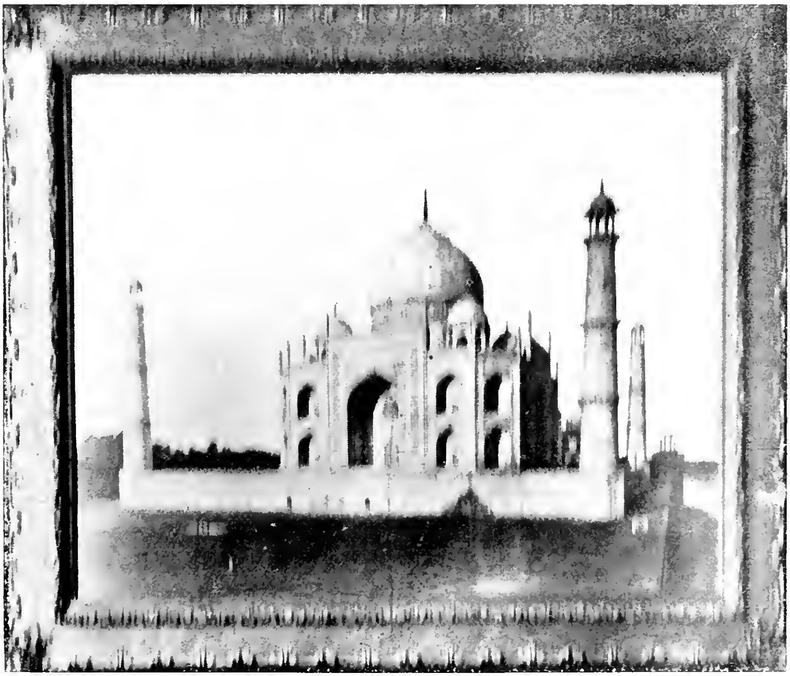


Fig. 2.

along the top of the wall of the terrace, and even some of the strata of the stones, can be distinguished, and the horizontal lines in the building itself are also well defined. On the contrary, the vertical lines are blurred. The pillars at the top of the tower and on the dome itself are all indistinct, while, as a whole, the building is broadened and the arches are apparently wider than is shown in Fig. 2.

In all these pictures the frame also is worthy of notice. In the first it has its true proportions; and in the second, it is distorted at the sides, and in the third, above and below.

There can be no question but that astigmatism even in a slight degree materially affects what the artist sees, and if it is true that he draws what he sees, does this not mean that his drawing tends to be proportionately faulty? Nor does it affect the vision for rectangular objects alone. This distortion is a constant quantity, and it does not take very exact study to see its effect in the draw-

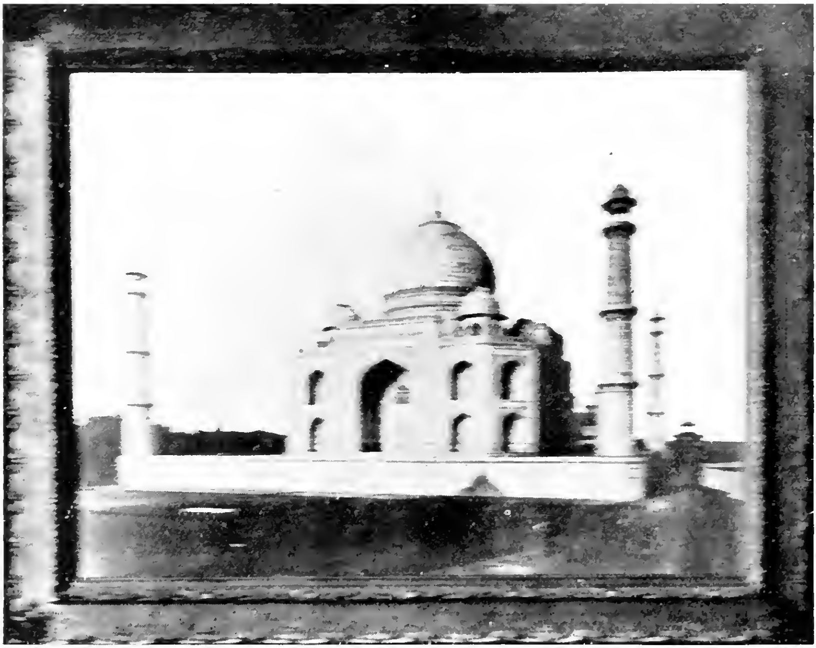


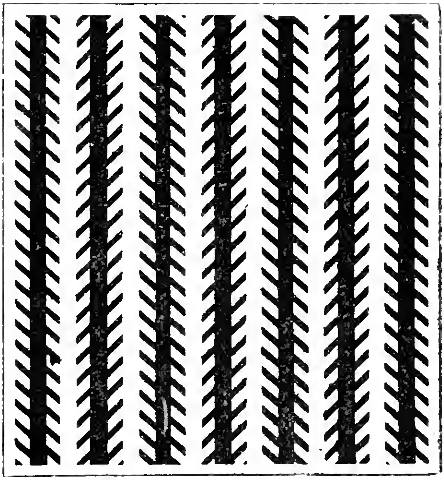
FIG. 3.

ing of the figure. For this reason, often an undue plumpness is given to some portions, while others are rendered emaciated and anæmic to a degree of which the originals were never guilty.

Another disadvantage of astigmatism to the artists is that lines really parallel appear to converge or diverge, when distorted by the blurring which astigmatism can produce. The reason of this would require too great a digression here. The practical fact is that as the blurring is unequal when different parts of the objects are differently illuminated, and as the direction of the apparent blurs depends somewhat upon the form of the object, lines which should be straight have their direction apparently changed.

This is shown in a modified way by the accompanying diagram.

If the page be tilted so as to be held in the line of vision, and if we "sight" along these heavy black lines, they are seen to be really parallel; and yet, when viewed as the page is ordinarily held, they appear inclined more or less to each other. Such an effect is produced only in exceptional cases, where the axis of the astigmatism varies in the two eyes, and this is therefore rather an unfair example. But the fact remains that the blurring of lines in certain directions may cause an artist to misrepresent very greatly the object which he is trying to reproduce.



Before leaving this phase of astigmatism it is worth while to note in passing a significant motion of the artist, already mentioned, in tipping his head from side to side, as he stands off to criticise his work. I am inclined to think he does this instinctively, in order to see better the errors in drawing caused by his own astigmatism.

The imperfect photographs of the Taj Mahal may serve to illustrate this point for some of the readers of this article. If one eye be closed (simply to exclude the correcting vision of the other), and if either of the astigmatic pictures be looked at while the book is rotated from side to side in the plane of the open page, one position can be found by most persons in which the lines are decidedly more distinct than in any other.

But, as the artist can not conveniently tip up the sides of his easel without disturbing also the equilibrium of brushes and paints and bottles, he simply steps back and tips his head.

Moreover, the critic does the same. He, too, instinctively wishes to obtain the clearest lines—for to some these blurred, astigmatic images are confusing, disagreeable, almost painful—and to obviate that, the stranger in the studio, when he comes to see the finished picture, tips the head just as did the artist when he was at his work. The more closely we observe actions called "instinctive," the more frequently do we find they have an underlying cause.

There is another imperfection of vision, more frequently artificial and temporary than due to any structural change. This is imperfect focusing. To understand this, let us for a second time observe the artist before his easel. If he is painting a bunch of flowers, with a white rose near the center, and if he wishes this rose to stand out in strong relief, he focuses his eyes naturally and normally upon it, and reproduces on the canvas the same clearly defined, well-focused flower which he sees. To the other flowers of the cluster he does not care to give the same prominence, and sketches them with less distinctness, or else focuses his eyes purposely for a point in front of the bouquet or behind it, thus blurring the colored flowers and purposely transferring to the canvas an ill-defined image of them. For example, teachers often find fault with their pupils, saying, "The trouble is, you see too much; you should not paint so exactly." An artist, holding an important public position as a teacher of painting in Boston, recently showed me lenses which were used by the students when learning thus to focus the objects imperfectly. Given, then, this fact of imperfect vision on the part of the artist, either in the form of astigmatism or in the form of undue contraction of the focusing muscle, let us consider its effect in relation to three factors—namely, drawing, values, and color.

As to the first, imperfect vision is unquestionably a disadvantage, as we have seen. The draughtsman owes his power to two things—accuracy of eye, which enables him clearly to perceive forms; and dexterity of hand, which enables him to reproduce them. Truth in one is as indispensable as in the other.

Next, as to the question of values. This term, as we know, is used in a certain sense to express perspective, or, more exactly, the relative distance of an object in the foreground as compared with another more or less in the background. In the case of the bouquet, just cited, the white flower in the center, having the highest relative value, is painted exactly in focus. A certain amount of artificial adjustment of focus by the artist is an undoubted advantage for the rest of the bouquet, however, and the habit of focusing the eye for some point in front of the picture or beyond it is, therefore, practically universal among artists, though in most instances they are not conscious of the act. In a similar way the effects called technically "distance" and "atmosphere" are also best secured in this way. The two factors thus far considered relate to representations in black and white as well as to those in color.

We come now to consider the third factor, that of the mixing of colors. We shall find that this involves the blurring or overlapping of images on the retina, which can be caused by astigmatism, if it exists in sufficient degree, or by improper focusing. It is usually produced by both of these together and by another function dependent on the combination and contrasting of colors. All this is done unconsciously by the observer.

To make this point clear, a slight digression is necessary to glance at the growth of painting. It must be remembered that the earlier artists were religious enthusiasts. First, they painted upon the walls of the basilicas and baptisteries; but as the early styles of architecture changed, and more and more of the wall space was encroached upon by windows, canvas came into use, and with opportunities thus increased painters grew more numerous and more proficient. Their methods of procedure were as simple as their faith, and there were but few efforts to produce unusual effects. The pigments were mixed on the palette, and thus mixed were transferred to the canvas. This was the method until recent times, and by that method the great masterpieces have been produced.

It is true that the works of some of the great colorists before which we bow down and worship to-day are not the pictures painted by these artists. The pigments they used have faded, and successive layers of varnish have changed them greatly. But in all, whether well preserved, in a slightly pathological condition, or in an advanced stage of decomposition, the point to be observed is, that the pigments were mixed on the palette just as they were placed on the canvas, and in looking at them no effort at accommodation of the eye or special focusing is required. If the eyes of the observer are opened in a natural manner, he sees just what was intended should be seen. In spite of certain variations from this type, that was the condition of the art of painting until the present generation. But, near the middle of this century a book was published by Chevreul on the Principles of Harmony and Contrasts of Colors, which by popularizing facts already known undoubtedly exerted an important influence on the artistic mind, especially in France. The principle to which I refer consists in this, that the pigments mixed on the palette and transferred to the canvas, as was the habit of earlier artists, do not produce upon the human retina so marked or so true an effect as when the proper pigments are placed unmixed but side by side on the canvas, and then viewed in such a blurred way that the rays from each are superimposed upon the retina. It is not simply a theory that the mixture of colors optically, produces effects quite different from those obtained by the mixture of corresponding pigments, but it is easily demonstrated. If we mix the rays of the spectrum, as can be done by means of a lens or concave mirror, the result is white light; but if the very same pigments, as pure as can be obtained, are mixed on the palette, we obtain not white, but a dark gray—indeed, in certain proportions we have almost a black resulting. Again, the commingling of the yellow and blue of the spectrum produces *white*, as was first shown by Helmholtz, but when these pigments are mixed they produce *green*. Such examples might be multiplied to a considerable extent. The reason why the mixture of colors in the spectrum differs in the results from the mixture of pigments is due to the fact that the pigments are not pure colors. Every red contains some blue or yellow, the yellows contain some blue or red, and the blues contain some red or yellow. Not only does the actual mixture of pigments produce effects differing from those caused by the mixture of the same colors in the eye, but the mere juxtaposition of the two pigments on the canvas influences the color of each, even when they are both properly focused in the eye. Thus, if small spots of pure yellow and blue are placed side by side, we see that the yellow inclines to red and the blue to violet. But if the spots are blurred and blended by making the eye sufficiently astigmatic by improper focusing, then by this or other optical combination it is possible to obtain shades of gray. In a word, the combination is in a "higher key." These and similar facts have been gradually worked out on the one hand in the laboratory by the physicists, and on the other by those who were constantly experimenting with pigments as they were mixed on the palette. Only a few painters know the scientific principles involved, but many had stumbled upon the practical results, and of late a new and almost distinctive class has arisen, whose usual practice it is not to mix the colors on the palette, but, consciously or unconsciously, to so arrange them on the canvas that they blend in the eye when properly viewed. This is one of the distinctive features of the so-called school of impressionists. It is easy to see that unusual care and fine artistic sense must be exercised in attempting any such trick with pigments. A genius may succeed at this, but the result for a mere imitator is disastrous. The effect is that produced when a certain artist by chance sat down on his freshly prepared palette. "Ah!" said his friend, "that is the best picture you ever produced. Cut it out, call it 'An Old-time Garden,' and it will sell for a fortune." In spite of the ridicule which this class of painters has brought upon itself, it must be said in justification that the method has a certain basis of scientific truth, and that good effects, striking effects, if not the best effects, can often be obtained by this mixture of colors, not on the palette, but in the eye. But this method of arranging colors demands as its correlative a certain amount of imperfect vision. In order to see such pictures at their best, it is necessary to view them from a considerable distance, as we have seen the artist do in his studio, or else, approaching the picture, pinch the cornea by means of the lids into a marked degree of astigmatism, or, consciously or unconsciously, contract the ciliary muscle so that the eye is really focused for a point in front of the picture. Under any one of these three conditions there can be produced on the retina an overlapping of the colors, or what is termed in optics circles of diffusion. It may be mentioned in this connection that one of the most distinguished leaders to-day of the school of impressionists in France, a master who has probably done more than any other to bring that style of painting to public attention, has one eye so imperfect as to be practically useless for his painting, and the other eye is distinctly astigmatic, besides having the changes in the hardening of the lens common to advancing years. This was shown by tests which I made less than two years ago. The question might be asked, Has every impressionist a marked degree of imperfect vision from astigmatism or from other causes? While I am convinced that this is the rule, there are, of course, a great many exceptions to it. Certainly the degree of impressionistic tendency shown is by no means in proportion to the astigmatism possessed by a given artist. Various causes in the individual cases combine to influence the results. Imitation of a popular style is undoubtedly a potent factor, and many artists of late have certainly modified their previous methods in the honest desire to get more light into their pictures, as they would say, or to paint in a higher key. While the artistic instinct itself may be unchangeable from age to age, it is not strange that the expression of that instinct in painting should strive for greater perfection, and in doing so make use of any aids which science may offer.

But we must not confuse this optical trick of the impressionist with his mental condition. It is well known that when the pictures of the extremists of this school were first exhibited in the Paris *Salon*, they were called the works of the impressionists, for the reason that they were supposed to represent the impression of the artists at the moment. They were expressions of the lyric mood, as it were, and represented, not Nature, but the mental attitude of the painter. (If purple shadows were given to a rock, and no one else had ever seen such shadows, that was of no consequence—simply, so much the worse for the rock. Real representation was not the aim.) When the original of a portrait complained that there was not the least resemblance to himself in the picture, the impressionist replied: "Of course not. This is not photography; it is art." With some subjects such idealism is convenient. But in the extreme it shows not an astigmatism of the eye, but of the brain. The two should not be confounded.

A few practical conclusions may be drawn from our study of art and eyesight. These are briefly:

1. As far as the artist is concerned, if he wishes to avoid increasing astigmatism, it is necessary for him to abstain from this

habit of making lid-pressure on the cornea, the resulting astigmatism being of no advantage, but always a disadvantage.

2. If he wishes to render himself relatively near-sighted, or, as he would state it, throw the eye out of focus, it is better to wear at his work a pair of convex glasses. The inconvenience of removing and replacing these could be obviated by spectacles made after the plan of the ordinary bifocal glasses, or, still better, by having the upper half cut away entirely, leaving for the lower a convex glass of such a strength as that individual would find most convenient for his special variety of work. In this way he is at least rid of the annoyance of constantly walking back and forward to obtain the effect of distance.

3. It is an undoubted advantage to every artist to ascertain the degree in which his eyes vary from the normal standard. Such a formula could be easily obtained. If the degree of error is but slight, of course it can be disregarded; if decided, and not properly corrected, knowledge of that variation from the normal in the artist's vision, if given in some way to the observer, would, without doubt, often win more favorable criticism for his work.

The logical and imaginative reader will perhaps picture to himself the art catalogue of the future, with a formula for the amount of imperfect vision (ametropia, as the oculists call it) added to each title. Thus:

No. 42. A Summer Morning. Myopic astigmatism, 1·5 *dioptre*, vertical meridian.

No. 44. He Cometh Not. Cylindrical, minus 0·5 *dioptre*, with spherical, minus 1·5, axis forty-five degrees.

This may seem rather like the "schedule of emotions," as it was once called, which was printed on the weekly programme in the earlier days of the Boston Symphony Orchestra, but none the less some such cataloguing of pictures would probably assist the critics and give the artist the satisfaction of more praise.

4. As the corollary of the last proposition it should be said that the observer, in order to see a picture to the best advantage, must adjust his vision to that of the artist who produced it. Most of us do this instinctively. Not only do we select the best point of view from which to observe a picture, but we recede from the painting until the lights and colors blend in just the right degree. In addition to that, many instinctively pinch the eyes together, producing thus a momentary astigmatism, such as the artist had produced in his own eye, and find the picture thus apparently improved. A most useful appliance for viewing pictures is the so-called stenopaic slit. This is merely a slit one or two millimetres in width in a card or thin plate of brass. Simple as this device is, but few persons are aware of how much it adds to the effect in viewing paintings, as it allows the rays of light in only

one meridian to pass through the cornea of the observer. If he wishes to look at a painting done by an artist whose vision is normal, or nearly so, the observer turns the slit around to correspond with the meridian of his own best vision. If, however, he looks at a picture in which it is desirable to have overlapping of the retinal images—at one, where the colors must be mixed in the eye, for example—it is necessary to rotate the slit to another position, usually at right angles to the first, and with this a canvas which before showed too clearly the blotches of color now becomes blended into a much more perfect whole. I would recommend this simple device to any one who has not already experimented with it. Thus, by adjusting our own personal equation of eyesight to that of the artist, we literally obtain his point of view. The colors are heightened, the daubs blend, and new beauties appear. Instead of seeking, like our friend mentioned at first, for "the handiest way to get out of this 'ere place," we are glad to stay longer to study and to enjoy. Here, as everywhere, it is art and science together that yield the richest result. If science is allowed to be the interpreter, we may gain a heightened enjoyment of art, and the artist a comforting increase of appreciation.

THE PHYSICAL ELEMENT IN EDUCATION.

By EUGENE L. RICHARDS,
PROFESSOR OF MATHEMATICS IN YALE UNIVERSITY.

IT would be as unwise as it is impossible to expect that every person engaged in education should be able to survey the whole field. Each educator takes a part, and is very apt to think that his or her part is the most important. Education, until quite recently, has been so widely regarded as brain culture that the whole trend of education is to develop the mind as one organ of the body, as if mind resided in the brain alone. And even those who know and admit that the mind is something more than brain, disregard the fact in their systems of education, following almost unconsciously the old ruts. Thus Bain says in one place: "The organ of mind is not the brain by itself; it is the brain, nerves, muscles, organs of sense, and viscera." And yet, in Education as a Science, he says: "Now, when we inquire into the meaning of physical education, we find it to be the rearing of a healthy human being by all the arts and devices of nursing, feeding, clothing, and general regimen. Mill includes this subject in his article, and Mr. Herbert Spencer devotes a very interesting chapter to it in his work on Education. It seems to me, however, that this department may be kept quite separate, important though it be. It does not at all depend upon the principles and considerations that the educator, properly so called, has in view in the carrying on of his work. The discussion of this subject does not in any way help us in educational matters, as most commonly understood, nor does it derive any illumination from being placed side by side with the arts of the recognized teacher." And we have seen a Committee of Ten of the "recognized" teachers of our own land blocking out the time of the secondary schools without a single word of reference to the important matter of physical education.

The Committee of Fifteen, which lately met at Cleveland, Ohio, in their voluminous report on Education, did devote one short paragraph to physical culture. But they did not seem to grasp the vital connection between the growth of the mind and the development of the body; for they remark that "systematic physical training has for its object rather the will training than recreation"; and again: "Systematic physical exercise has its sufficient reason in its aid to a graceful use of the limbs, its development of muscles that are left unused or rudimentary unless called forth by special training, and for the help it gives to the teacher in the way of school discipline." The report makes physical culture subsidiary to other kinds of education; not as it should be considered—a *fundamental* and *necessary* part of education.

I have therefore thought that a few remarks on the physical element in education would be timely.

It is a suggestive fact that the ratio, by weight, of the brain to the body of a new-born infant is one to ten, while the ratio of the brain to the body of the average European adult man is one to forty-six. Does not this fact at the very outset of life point the way to a correct education? The body needs development till it attains maturity, if it is to have its appropriate growth. The brain needs care rather than special culture while the body is developing rapidly. Its appropriate culture for the years of growth is to be found in its supervision, direction, and control of the body.

If I were asked what should be the prime essential result of a man's education, I should say power, vigor. And by that I mean that a rightly educated man should have force in himself, of which he is master. And I do not hesitate to say that any education, however well it stores the mind with ideas or fills it with knowledge, and yet fails to cultivate this force, is so far a failure. I would extend my remarks so as to include similar statements about the education of woman. Her power may be of a different kind, but power she needs for the battle of life just as much as man needs his force. And until we educate our men rightly, and our women also to be in this respect real helpmeets to men, we shall not have on this continent a race which is to remain. What Dr. Clark says, in the Building of a Brain, may well be quoted here: "On this continent races have been born and lived and disappeared. Mounds at the west, vestiges in Florida, and traces elsewhere proclaim at least two extinct races. The causes of their disappearance are undiscovered. We only know they are gone. The Indian, whom our ancestors confronted, was losing his hold on the continent when the Mayflower anchored in Plymouth Bay, and is now also rapidly disappearing. It remains to be seen if the Anglo-Saxon race, which has ventured upon a continent that has proved the tomb of antecedent races, can be more fortunate than they in maintaining a permanent grasp upon this western world."

How shall we develop this power? Regarding the new-born child as a bundle of latent forces, how shall we draw out these forces so that they shall be active, and yet be directed and controlled by an enlightened will? Only general suggestions can be offered. The order of development is important. The earliest attention should necessarily be given to the physical powers. Nutrition is of the first importance. Next comes motion, the exercise of muscles, and through these a certain development of mind and will. And these phenomena of motion on the part of children are so common, and, when we wish them to be quiet, so exasperating to us, that we miss their great importance in development. How can children grow without continual motion? Consider how large a part of our physical economy is dependent on motion. We pour food into the stomach, but the stomach is a muscular organ and does a great part of its work through muscular motion. It is to a certain extent dependent for its tone on the vigor of the muscular system. After the food is converted into chyle and sent drop by drop into the blood and is then passed through the oxygenizing process in the lungs, what is it that pumps it along the arteries but another muscular organ, the heart? And how much help this flow of nutritious blood to the very extremities of the system, into every nook and cranny of every organ of the body, derives from the action of the voluntary muscular system, we can hardly estimate. But we know the life current is quickened by exercise and slackened by the cessation of exercise. There is another way in which we know the influence of the voluntary muscular system. When more exercise is taken, more food is required to repair the waste, and there is better circulation of the blood.

Again, consider the senses, those avenues of knowledge to the knowing mind. Take the eye. It is not only a combination of lenses with a retina behind them sensitive to impressions. The lenses are furnished with adjusting muscles. And the ball itself is fitted with other muscles to roll it in the socket and to direct it on objects which the will commands it to see. Then, too, there is the sense of touch, which, with sight, gives us knowledge of the outside world. How could it give us such complete information of our environment were it not supplemented by the muscles of the outstretched arm and the feeling hand? Our hearing is better because we have muscles to enable us to turn the head that we may listen. Smell and taste are more efficient because they are supplemented by muscles appropriate to their functions.

Then, if we take our social life, how large a part of it is dependent on speech! And speech itself would be impossible without the muscular power of taking and expelling breath and the movement of the muscles of the larynx. Without muscles the hand of the writer could not produce our books any more than the cunning hand of the artificer could work out the inventions of this inventive age. Knowledge itself, then, is dependent on muscles and the power of muscles on motion.

It is, therefore, a wise provision of Nature which implants in children a desire for play. By their very instincts they seek motion, and the exercise and growth of their bodies through motion.

But does the good effect of exercise end in the body? Is that simply larger and stronger? The mind, too, has its share of good. In the first place, the brain and nervous system are supplied with blood and more of it. The repair of the waste is more completely made. This of itself is one great gain. But in all use of the voluntary muscles there is, as the term implies, a necessary putting forth of will. The mind is exercised while the body works. And this is especially true in all exercises which require skill, in which the mind has an object to gain through the skillful use of the body. This mental element comes in very early in a child's life—as, for instance, in learning to walk, to swim, or to write. All through the years of childhood it accompanies motions in games, most mind being required in those games which require most skill. So those gymnastic exercises which call for combinations of muscles in action, and need quickness and exactness, are more useful for the majority of children and men than those requiring the use of strength alone. For, to attain success in games or exercises of skill, not only quickness of body is needed, but an alertness of mind, and often, too, quickness of the senses of sight and hearing. This mental element in certain athletic games explains, in a measure, their fascination. They furnish an exercise not for the body alone, but for the whole man—every part of his being, including his mind, his social nature, and even his moral nature, coming into play. This is particularly the case in games in which a number of players are involved, so that individual skill must be subordinated to the good of the whole body of players. The individual must repress and control self and observe law. Children have the same discipline in their play when they engage in games requiring the observance of rules.

This mental element in games assigns to them the first place in any rational system of physical culture. The grind of the gymnasium is so distasteful to the generality of people that gymnastic exercise, whether free or with apparatus, is only sought as a last resort. But gymnasium work can be made interesting by variety and by competitions. By being made also a preparatory training for athletic sports, gymnastic exercises can be given an interest and a power which they would fail to possess if taken only from a sense of duty.

The more complete the exercise is for the whole system, the more complete is this development of the mind through the body. Therefore all supervision of the exercise of children should be in the line of removing obstacles to the free exercise of every muscle of the body. Care should be used to guard against the compression of any part of the body by tight clothing. Badly fitting, uncomfortable shoes often make the movements of the feet and lower limbs a torture, affecting, unfortunately, the carriage of the whole person, and producing ungraceful habits of walking.

The connection between the body and mind is so close that the working of every (even the smallest) muscle of the body must leave some trace in the mind. The education of the mind through the body is defective to the extent of every unused muscle. We see this plainly, according to Dr. Luys, quoted by Dr. Faries in his paper read last April: "When a limb has lost its function there is atrophy of certain parts of the gray matter of the brain, due to defective action of the motor cells." So that muscular exercise, besides conducing to the strength of the body, is necessary to the storing of force in the brain and nervous system. But this is not all. The brain has a great deal of its development in consequence of directing and controlling the use of the body through the muscular system. The more extensive this use of the muscles, the more complete the education. Interfere with this education by directing the will too early in life to conscious cerebration by means of books, and you not only check the development of the brain, but you deprive it also of a growth more important than knowledge can give it, and one which no subsequent effort can supply.

In support of this theory of the growth of mind and true brain power during the period of immaturity through the muscular system, I quote from Dr. Ladd's work on Psychology: "All our study hitherto has led us to emphasize greatly the influence upon mental development of the constitution and functions of the muscular system. The condition and action of the muscles stand in reciprocal relation to the senses and to the feelings which form the necessary effective accompaniment of the senses. Furthermore, the striated (or so-called voluntary) muscles are organs of the will. In the complicated sensory motor apparatus all the most primary foundations of the intellectual life are laid."

This quotation is right in line with the fact that the first development of will comes through exercise of the muscles; for the first development of will, like all succeeding development of will, consists in overcoming resistance; and the first resistance to be overcome is physical. The child with flabby muscles has generally a defective will power. Men of strong physique have strong will power. Of course this will power to be effective must be educated and directed like any other power. But its foundation is laid in bodily power.

Another confirmation of the necessary connection between strength of body and power of mind is to be found in the history of the dominant races. The Greeks afforded the finest types of body of their times or of any succeeding times. They showed also that their intellectual activity was as remarkable as their physical development. They have produced a literature that will never die. The Roman supremacy, which lasted longer than the Greek, was founded on physical prowess. It also has left a law and a literature which are imperishable. The northern races of Europe, overcoming the Roman arms by sheer physical force, and appropriating what was best in the Roman polity, became the masters of the world. From those races—one more virile than the rest—the Saxon (now become the Anglo-Saxon) is through its descendants almost master of the present world. Moreover, all those races which declined, went down before races of stronger physical power. The corruption of the body by sloth and effeminate luxury was followed by a mental decline, just as softness and weakness of mind and will have always gone hand in hand with enervated, enfeebled bodies.

But I should be misunderstood if I leave the impression that muscular force is the only one to be considered. Even of the bodily forces, or of the agents which go to make these forces, it is only one, though one of the most important. Nutrition must be attended to. Without perfect nutrition the best muscular force is impossible. If nutrition is faulty, muscular exercise if long continued does harm rather than good. Next in importance to nutrition is a fresh supply of oxygen to make good, pure blood. Exercise should be taken in the open air, or at least in the purest air possible. The skin should not be neglected. In fact, all the laws of hygiene should be observed. Tests and measurements should be made of every person, to determine the best kind of exercise for that particular person. And these examinations ought to be made by a thoroughly educated physician. It will not do to trust such an important agent in education as physical culture to a man or woman who has only a smattering of knowledge.

Systems of exercise are not half as important as the person who exercises. Systems are only important in what they can do for that person. The systems studied apart from the individual may be perfect. Applied without judgment to particular individuals they may prove disastrous failures. The persons exercising must be studied first, last, and all the time; next, their environment; and then the kinds of exercise suited to their condition and needs.

APPARATUS FOR EXTINGUISHING FIRES.

By JOHN G. MORSE.

DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS. XIX.

A PECULIARITY common to all nations is the fact that not until the industries of peace and the armaments of war had been well developed was attention paid to procuring safeguards against conflagrations; and when it was at last realized that means for the extinguishing of fire were necessary, so little was attempted that the results were entirely inadequate. Even in the United States, noted the world over for advanced methods of fire-fighting, the marked improvements have been so long in coming that half the men alive to-day can remember the time when the most marked changes were made.

It is believed that the first hose used for the extinguishing of fire was made from the gut of an ox. This was attached to a bag filled with water, which, being pressed, would force out a jet. Charles F. T. Young, C. E., the author of Fires, Fire Engines, and Fire Brigades, considers it probable that some mechanical devices capable of squirting water existed in Nineveh, Tyre, Babylon, etc. Ctesibius, of Alexandria, who flourished in the second century B. C. during the time of Ptolemy, is said to have invented a fire engine. Philadelphus and Euergetes are also said to have worked in the same direction.

Certain it is that Hero in 150 B. C. invented and had made a fire engine that was provided with an air chamber, and therefore played a continuous stream. During the darkness of the middle ages fire engines seem to have been forgotten, and it is doubtful if syringes were kept in use. The Chronicles of Augsburg, 1518, speak of "water syringes useful at fires," and from that time onward mention is made of fire engines in Denmark, Germany, Holland, France, and Great Britain. From the work above referred to it is stated that Decaus, in his Forcible Movements, published in 1615, describes a German engine of that period in the following quaint language:

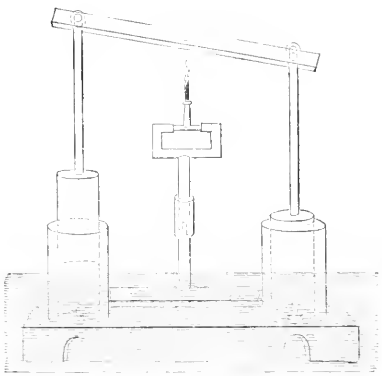


FIG. 1.—HERO'S FIRE ENGINE, 150 B. C. (From Knight's Mechanical Dictionary, by permission of the publishers.)

"A rare and necessary engin, by which you may give a greate reliefe to houses that are on fire. This engin is much practiced in Germany, and it hath been seen what great and ready help it may bring: for although the fire be 40 foot high, the said engin shall there cast its water by help of four or five men lifting up and putting down a long handle, in form of a lever, where the handle of the pump is fastened. The said pump is easily understood: there are two suckers (valves) within it, one below to open when the handle is lifted up, and to shut when it is put down, and another to open to let out the water; and at the end of the said engin there is a man which holds the copper pipe, turning it to and again to the place where the fire shall be."

In 1632 there was a patent granted in England to one Thomas Grant for a fire engine. Caspar Schott, of Nuremberg, manufactured one in 1657 that, when worked by twenty-eight men, would play a stream eighty feet in length. In 1663 John Van der Hayden, of Amsterdam, patented another, and to him is given the credit of bringing the machine to the modern form of hand engine. Several other early engines are mentioned in different works on the subject; among them the "*pompe portative*," patented in France by Duperrier in 1699. To this Perrault added the air chamber.

Although many different engines had been invented, buckets and syringes were in use in England and on the Continent until far into the seventeenth century. The largest of the hand syringes were of brass, and held no more than a gallon. Two men were required with each, one to hold the syringe and the other to direct the stream. In the sixteenth century larger ones were made and placed on wheels. These were capable of holding about a barrel of water and had no hose. The direction of the stream, or, more properly speaking, of the series of squirts, could be changed up and down, as the syringe rested on pivots. To change the direction from side to side, the entire machine, wheels and all, had to be moved.

Barring the gut of an ox mentioned at the beginning of this article, hose was not known until 1672. Mr. C. R. Robinson, in an address before the National Association of Fire Engineers, states that fire hose was invented by John and Nicholas Van-der-Heide (spelled by some Heyden) in 1672. These brothers were the inspectors of fire apparatus in the city of Amsterdam, and were probably led to make the invention by their experience in these matters. The hose was made of leather, of sail cloth, or of seamless fabric, in fifty-foot lengths, and coupled together with brass screws. This contradicts the popular impression that canvas hose was an exclusively modern invention. Although the leather hose made at that time was very defective, being sewed like a boot leg, it soon supplanted the sail-cloth and woven hose that became worn out so quickly, and up to a very recent date leather has been the only substance used in making hose.

The early settlers in America paid no attention toward protecting themselves against fire, and the different colonies had grown into fair-sized communities with several industries well established before any steps were taken in that direction. About the earliest mention of a definite method of fire protection was made at Salem, Mass., in 1644, when each inhabitant was ordered to be supplied with a ladder under penalty of a fine of five shillings. These ladders were undoubtedly made in Salem or in the immediate vicinity, and one might rightly say that here began an American industry that is now carried on so extensively in many places and under a multitude of different forms. In 1648 four fire wardens were appointed in New York city. These men passed a law to fine every one whose chimney became foul or whose house was burned by his own carelessness. The money so obtained was to be used in the purchase of ladders, hooks, and buckets. These were not provided, however, until some years later.

Boston also took steps in this direction, and on the first day of the twelfth month of 1653, or, by the modern method of computation, on February 1, 1654, the following entry is found in the town records:

"The select men have power and liberty hereby to agree with Joseph Jynks for Ingins to Carry water in Case of fire, if they see Cause soe to doe." Mr. James R. Newhall, in his history of Lynn, Mass., gives the following facts about this maker of fire engines: Joseph Jenks, or Jynks, came from Hammersmith, England, to Lynn as an operative in the iron works. He soon made himself known to the community and to the country at large by his ingenious inventions. In regard to the order found in the town records of Boston, Mr. Newhall makes the following comment:

"This order, it will be observed, is permissive rather than imperative; and there has been a question whether they did contract for an engine, or, if they did, whether the contract was ever fulfilled, for it is asserted that Boston had no engine till after the great fire in November, 1676, at which time some forty-six dwellings were destroyed, besides shops, warehouses, and 'a meeting house of considerable bigness.' An opportune rain is mentioned as having done much toward arresting the flames, and some buildings were blown up. But nothing is said about an engine being there. Pemberton seems to have thought that as late as 1711 Boston had no fire engine. Yet on the 9th of March, 1702, the town voted that the selectmen should 'procure two water engines suitable for the extinguishing of fire, either by sending for them to England, or otherwise to provide them.' This must have been in addition to one before had, for it was on the same day voted that 'the Selectmen are desired to get the Water Engine for the quenching of fire repaired, as also the house for keeping the same in.' Now, might not the one referred to as needing repairs in 1702 have been manufactured by Mr. Jenks, on the order of 1654? It would have been an old 'machine,' to be sure, but was, no doubt, constructed in a thorough manner, and not very frequently called into use."

Mr. Caleb H. Snow, in his history of Boston, published in 1828, doubts if the engine ordered in 1654 was ever made. He states, however, that in 1679 a fire engine is mentioned as having lately come from England. If this be true, there is a bare possibility that this is the engine referred to as needing repairs in 1702.

It seems extremely doubtful whether a fire engine was manufactured for Boston as early as 1654. The town was then but twenty-four years old, and what money was not used in keeping the wolf from the door was probably fully expended in the meager village improvements and in paying men to repel the continually obnoxious Indians. The inhabitants would hardly have cared to go to the expense of buying a doubtful invention for the extinguishment of the then rarely occurring fires. Nevertheless, Mr. Jenks, from what we know of his mechanical genius, was probably fully capable of making a successful fire engine, had any of the towns in the widely separated and struggling colonies cared to buy one. Had this engine been built, it would not only have been the first made in this country, but it would have been the first one *used* here, many English engines being introduced later. But, as will be seen later, without taking this engine into consideration, Boston holds priority in the ownership of a fire engine. Besides authorizing the purchase of an engine in this first order of 1654, it was ordered that every house be provided with a ladder and a twelve-foot pole to reach the ridge-pole. Six good and long ladders were to be furnished by the selectmen.

In 1657 New York had made some ladders and hooks. It was also decided to order two hundred and fifty leather buckets from Holland. Thinking it would take too long to have the order filled, it was decided to have one hundred and fifty buckets made in this country. Remout Remoutzen was ordered to make one hundred and Adrian Van Lair to make fifty. These were to cost six guilders two stuyners each (about two dollars and a half). The buckets were finished in 1659, and properly distributed.

Undoubtedly the first fire company organized in this country was formed in New York in 1658. It was called the Prowlers, and was composed of eight men with two hundred and fifty buckets, hooks, and small ladders. Where the buckets were obtained, and whether or not they were in addition to those owned by the town, the records fail to state. In 1679 Salem purchased two or three dozen cedar buckets, besides hooks and other implements; also, the selectmen and two others were authorized to take command at fires, and to blow up and pull down buildings when such action was necessary. This practice appears to have been much more common before the use of engines than afterward. Boston, on September 9, 1679, ordered that every quarter of the town should be provided with twenty swobes, two scoopes, and six axes. The swobes, or swabs as they are now called, were long-handled mops that could be used to put out roof fires. The general use of swabs has long since disappeared, but when a slight blaze is beyond the reach of a pail of water and more improved apparatus is not at hand, a long-handled mop is to-day the most efficient article to be used. In Japan these swabs may be seen on many roof tops.

In 1690 New York ordered that five ladders and also hooks be made. In Philadelphia no mention is made of public precaution against fire until 1696, when a law was passed forbidding the firing of chimneys or allowing the same to become foul. Each house was to have a swab, bucket, or pail. Another act was passed in 1700, ordering every household to have two leather buckets. In the following year six or eight hooks for the purpose of tearing down houses were ordered to be made.

As has been stated above, Boston bought two engines in England in 1702, and therefore, if the engines of 1754 and 1679 never existed, Boston was yet the first town to be the proud owner of a fire engine. Philadelphia came next, in 1618. On December 8th of that year the Council agreed with one Abraham Bickley for "his ffire Engine At ye sum of £50." This engine had been imported from London by the said Bickley.

With the exception of the buckets made in New York in 1657–'59 by Remout Remoutzen and Adrian Van Lair, no mention is made of the makers of the different equipments provided. In 1729 Salem again took steps toward protection from fire by ordering buckets, hooks, poles and ladders to be kept in the Town

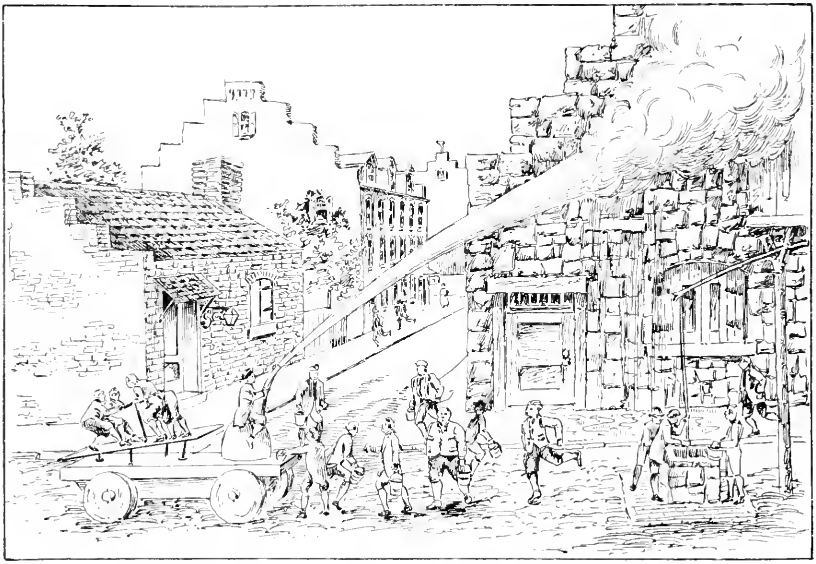


Fig. 2.—Early Fire Fighting. (From an old print.)

House, but the records fail to state where and by whom the buckets, etc., were made. It is most probable, however, that the ladders, hooks, poles, and swabs were made by artisans in the different towns, but many of the buckets were undoubtedly manufactured in Europe. Later records are more specific. In 1730, Philadelphia, besides buying some buckets in England, made a bargain with a townsman, Thomas Oldman, for one hundred leather buckets.

New York had no fire engine until 1731, when two were bought of Mr. Newsham, the celebrated London maker. These engines were box affairs, with small wheels and axles solidly set. They could not turn corners, but had to be lifted bodily around. The first engine of home manufacture was built in New York in 1737. In the New York Gazette, of May 9th of that year, the following advertisement appeared:

"A Fire-engine that will deliver two hogsheads of water in a minute, in a continual stream, is to be sold by William Lindsay, the maker thereof. Enquire at Fighting Cocks, next door to the Exchange Coffee-house, New York."

Whether or not this engine was successful is unknown, but it is tolerably certain that it was never used. Bartholomew Weldern also made two engines, neither of which would work. In the same year, however, Thomas Lote made an engine that was more successful. It was used in the New York department, and known as number three. Considering the length of time between 1654 and 1737, in which no mention is made of home-made engines, it seems still more doubtful if Mr. Jenks, of Lynn, did make the first machine in this country, and undoubtedly priority should be given to one of the several New-Yorkers just mentioned.

Benjamin Franklin states in his autobiography that his reading a paper on fire protection before a Philadelphia society gave rise to the forming of "a company for the ready extinguishing of fires, and mutual assistance in removing and securing of goods when in danger." Besides the usual buckets, each member carried a bag made of four yards of osnaburgs or wider linen, with a running cord at the neck. These bags were used in safely transporting valuables and small articles from burning buildings, and

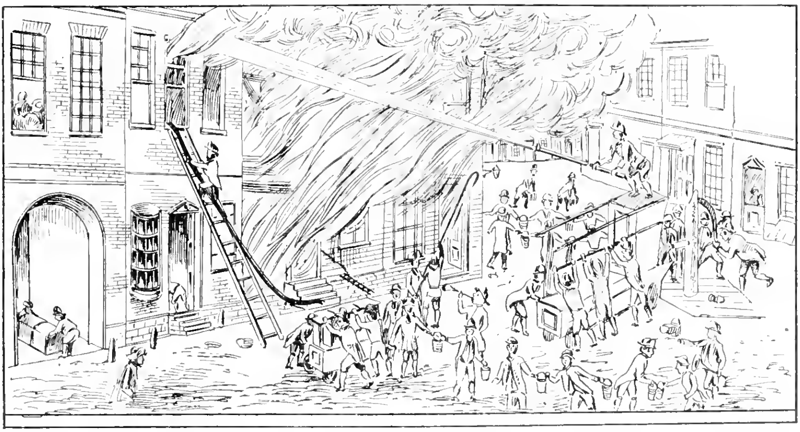


Fig. 3.—Early Fire Fighting. (From a certificate issued to Seth Kneeland, New York Volunteer Fire Department, November 13, 1789.)

formed a primitive forerunner of the outfits of the protective patrols of to-day. Franklin was a member of the company thus started.

Jacob Turk, who became the head of the New York department in 1739, introduced the style of leather hat that is worn by firemen at the present day. Despite the countless changes that have taken place in apparatus of all kinds, the fireman's hat remains practically unchanged, and serves, as it always has, for a distinguishing emblem to the profession.

Massachusetts passed a law in 1744 empowering all towns to choose fire wards. The wards were to have for a distinguishing badge of office a staff five feet long, painted red, and headed with a bright brass spire six inches in length. One of the first towns to take advantage of this law was Salem. At the same time a fire club was formed that purchased a fire engine in England in 1749 and another in 1751.

Baltimore first took precautions against fire in 1747, when the housekeepers were ordered to have ladders in readiness. The Annals of Providence tell us that measures in this direction were not taken until 1754, when a law was passed compelling each housekeeper to have two buckets. An engine was also purchased, although the records fail to state where it was manufactured. Another engine was bought in Boston in 1760, undoubtedly a second-hand English machine, as at that time there were no makers in Boston.

It will be noticed that, although engines had been made in this country, foreign machines were preferred, probably on account of

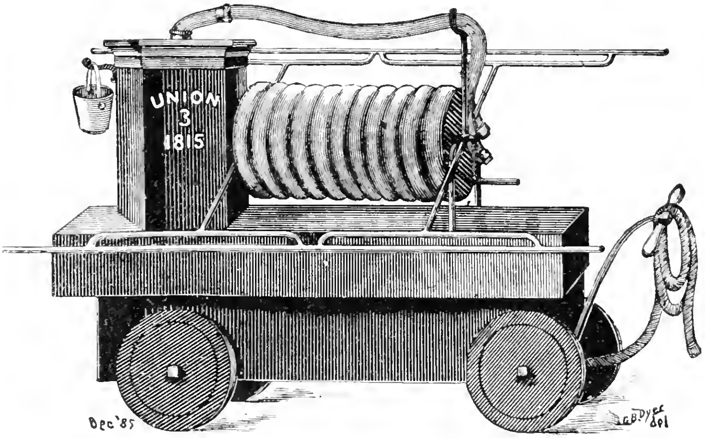


Fig. 4.—Early "Hand Tub." (From a Sketch and Reminiscences of the Providence Fire Department.)

their superior workmanship. The foreign makers, however, were soon to lose their precedence. Mr. A. W. Brayley, in his History of the Boston Fire Department, states that in 1765 David Wheeler, an ex-fireman of Boston Engine Company 8, manufactured the first complete fire engine ever made in that town. Wheeler was a blacksmith established on Washington Street, then called Newbury. He gave notice to the press that he would encourage home industry by making a fire engine. This he did, and on August 21st the same year he had a chance to try his production, which worked to the satisfaction of all present. In 1767 Wheeler asked permission to make another. This was granted, and the same year the importation of engines from abroad was prohibited. An industry was not only started but encouraged by law—one that has increased and spread in all parts of the country, embracing the manufacture of more improved apparatus at a later day, until now it is the greatest industry of its kind in the world.

Although begun in New York and Boston, the making of fire engines was soon established in Philadelphia, where for over a century it flourished to a greater extent than in any other city in the country. From the history of that city by Messrs. Scharf and Westcott, we learn that in 1768 Richard Mason, on Second Street, began the manufacture of fire engines. His quaint advertisement appears in a copy of the Massachusetts Centinel of Saturday, November 7, 1789, published in Boston:

"Fire Engines made on the newest and most approved construction; warranted for seven years, and sold as cheap as they can be procured from Europe. The business is now extensively carried on in all its various branches, by the subscriber, in Union Street, Philadelphia; where Engines of any size may be had; and towns and fire companies supplied therewith on the shortest notice." After mentioning small engines for house, garden, and ship use, the advertisement goes on to state:

"He has several good second-hand engines for sale, at low rates:—and makes fire-buckets of the neatest and best sort, which he supplies, handsomely painted with any device required, at a short notice.

"The strictest attention paid to orders from any part of the continent, or elsewhere; and the utmost punctuality and dispatch may be relied on."

A list is given of the five sizes made, varying from one of eighty gallons, throwing water eighty feet and worked by six men, to one of one hundred and seventy-five gallons, throwing one hundred and seventy-five feet and worked by eighteen men. The prices varied from £40 to £120. The advertisement closes as follows:

"N. B.—The main body of water will not be thrown to the above distances, and a greater number of men may be applied to the large engines if occasions should require."

Mr. Mason was the first one to place the levers upon the ends instead of upon the sides of the engines, and thereafter they were spoken of as the Philadelphia levers.

The first ladder companies possessing trucks on which to carry their ladders and hooks were formed in New York in 1772, and were numbered one and two. There had been two trucks in the New York department previous to this, carrying no name or number. These were probably the first pieces of apparatus of this kind used in the United States, for a careful scrutiny of different records fails to show an earlier one.

In 1774 each engine in Salem—there were then three—was furnished with a framed canvas screen in three or four leaves, eight feet high. The canvas was kept wet by the use of long-handled swabs, and the screens are said to have been of great service in preventing the spread of fire. Screens of this kind were used in Salem and the adjoining towns until a very late day but they were evidently local in their character, for the records of the departments in other parts of the country do not mention anything of like nature.

At the close of the Revolutionary War in 1782 the manufacture of fire engines that had been established in Philadelphia took a decided start, and soon became such a distinctive feature among the industries of that town that it added greatly to its notoriety. Boston also for some time took a prominent part in this industry. In 1792 the firm of Hunneman & Company, manufacturers of hand fire engines, was established. This firm continued to make hand fire engines until the introduction of steamers threatened to ruin its business, and to save itself it embraced the manufacture of steam fire engines. After continuing to bear the name of Hunneman for almost a century it passed into different hands and the firm is still in existence. As far as can be ascertained, this is the oldest concern of the kind in this country and perhaps in the world.

When Hunneman & Company first established their works the New York authorities decided to make their own engines, and did so to some extent, but also continued to buy elsewhere, the records showing that one was purchased from Philadelphia in 1798. The Philadelphia engines traveled farther from home than to New York. In 1797 Salem, having bought several in England during the previous years, ordered one from a Philadelphia maker by the name of Samuel Briggs. The journey to Salem so injured the machine that it was useless on its arrival, and the maker had to send on an agent to superintend its repair.

The history of the Boston Fire Department states that in 1798 a Mr. Fenno, of that town, made some new hose for engine five. This seems to be the first mention of the making of fire hose in this country. Although the Boston authorities had prohibited the importation of foreign engines, they did not put the same restrictions upon hose. In the same year they purchased two hundred feet of hemp hose from Holland, giving as their reason for so doing that the English and American kinds were unsatisfactory.

The New York firemen saw at an early date the need of something more effectual than land engines with which to fight fires on the water front. Somewhere between 1805 and 1810 a large boat, rowed by twenty-four men, and provided with a fire engine, was put in service. It did good work, but in winter the hardships of the men were so great that few would serve, and the boat was abandoned. This was a forerunner of the fire boats with which so many of the larger cities are now provided.

Messrs. A. L. Pennock and James Sellers, of Philadelphia, in 1818 invented and manufactured the first leather copper-riveted hose used in this country. Burr and Shaw, of Providence, established a similar business a few years later.

Boston had no ladder truck until 1820. Having provided many new ladders and hooks, the authorities purchased a rather worn-out express wagon upon which the articles mentioned could be carried to fires more readily. A company was formed to man the same.

During the early part of the century the departments of the larger towns realized that the private pumps and wells did not form a sufficient water supply, and town pumps and cisterns were placed at convenient intervals about the streets. Instead of filling the engines by means of lines of bucket-passers, it was often possible to pump directly into the machine. This led to pumping direct from the stationary pumps into the fire hose when the pumps were in close proximity to the fire, and soon hose companies were formed. A famous company of this kind was formed in Providence. Equipped with a hose carriage and one thousand feet of hose, its members competed for honors with the finest engine companies. This was one of the first hose carriages used. The leading hose of the engines had always been carried on the machines, and this custom was generally continued. Mr. George W. Sheldon, in his history of the New York Volunteer Firemen, states that David J. Hubbs, foreman of one of the companies. introduced the first separate hose carriage in the New York department. It was a very simple device, a reel on the axle between two ordinary wheels. This was known as "Hubbs's Baby." It was either tied behind the engine or pulled by two of the members of the company.

Up to the year 1820 the fire apparatus in use had improved but little. The larger towns only were provided with engines, and, as has been stated, these were box affairs that were filled by lines of bucket-passers or by stationary pumps. The brakes and pumps, it is true, had been greatly improved, and, indeed, besides the piston-pump engines worked by brakes there was a rotary pump in use, driven by a crank and geared to greater speed by cog wheels, but the engines were limited in their usefulness by the unsatisfactory method employed in supplying them with water. Somewhere between 1819 and 1822, although the exact date is in question, a new era was begun in the method of fighting fire.

The Hon. Elisha Dyer, in a paper devoted to the Providence Fire Department, states that the first successful suction engine made in the United States was manufactured by Sellers & Pennock, of Philadelphia, in 1822, for the town of Providence. It was named Hydraulion No. 1. At about this date all the engines of the New York department were provided with suctions. Proba-

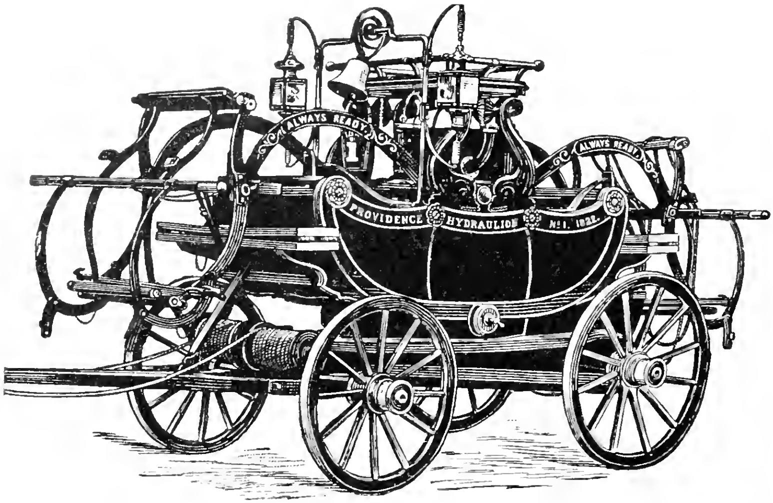


Fig. 5.—First Suction Hand Engine. (From a Sketch and Reminiscences of the Providence Fire Department.)

bly at that time many of the old engines, in different parts of the country, were changed to suction engines, while the first new one built was Hydraulion No. 1, of Providence. With the introduction of suctions the general efficiency of the engines was greatly increased. Every pond, brook, and bucketless well was at the service of the firemen, and a new impetus was given to the manufacture of fire apparatus.

In 1834, Button & Company, of Waterford, New York, entered the field. They continued building hand engines until the introduction of steam, when they followed the example of Hunneman & Company, of Boston, and began the building of steam engines. Their successors lately consolidated with the American Fire Engine Company, who, as the successors of Hunneman & Company have discontinued the manufacture of fire engines, now form the oldest house of the kind in the country. The Button hand engines are still placed upon the market for the use of small country departments.

In 1848, William Jeffers, of Pawtucket, Rhode Island, in connection with two or three other mechanics, altered over the pumps of a hand engine. He met with such good success that he began the manufacture of hand engines, and in 1861 added the making of steam fire engines to his business. Crockett, E. B. Juckett, Henry Waterman, Pake & Kells, John R. Adams, John Agnew, and several others were well-known names connected with the building of hand fire engines, but it is difficult to obtain the dates at which they entered the field. Many of them made steam engines at a later date.

It is hard to realize that at the end of the first half of the nineteenth century the fire departments of this country were still far behind the times both in organization and in apparatus. Steam railroads were pushing out in every direction, steam vessels were crossing the ocean, steam power was being used in countless mills, the electric telegraph had been invented, the equipments of the army and navy were being continually improved, and machinery was taking the place of hand work in every kind of manufactory. The firemen, on the other hand, were using manual engines drawn by hand, small and inadequate ladder trucks and hose reels, also dragged to fires by the firemen themselves. Their apparatus was removed but a few steps

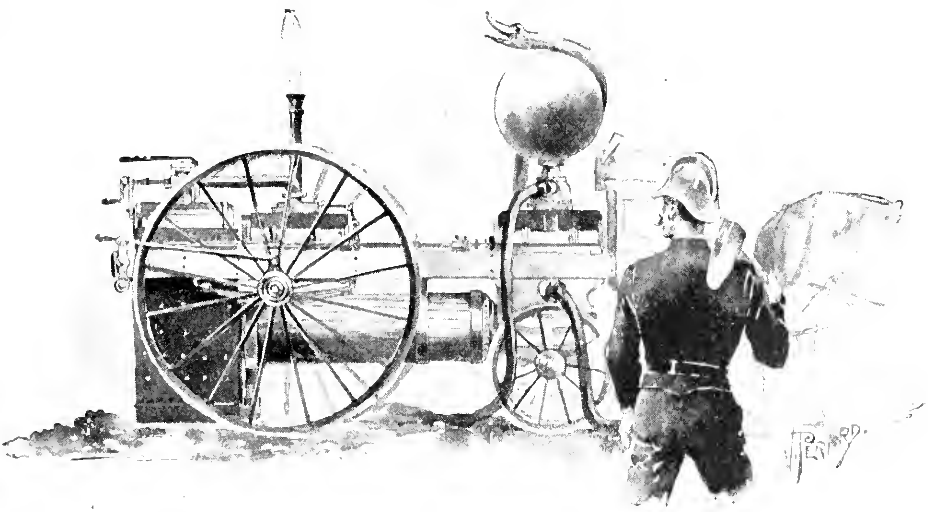


Fig. 6.—Ericsson's Engine. (From Scribner's Magazine, by permission of the publishers.)

from the old squirting syringes. The men were brave, but did their work of their own free will. After the city government had paid for the engines the firemen assumed all other expenses. It is not the purpose of this article to discuss the organization of the volunteer fire departments, but simply to show how handicapped they were by apparatus that was out of date, and entirely unfit to cope with the fires that were sure to occur in the inflammable and rapidly growing cities.

The year 1840 marks the beginning of a great era in the development of fire apparatus, although the stupidity of the general public prevented the adoption of the improved methods for several years later. Stationary steam pumps had been used in mills for some years previous to 1842, but up to that time a portable steam fire engine was a thing unknown in this country. In 1830 Captain Ericsson, then of London, but later famed as the builder of the Monitor, designed a steam fire engine, and the firm of Braithwaite & Ericsson built one machine and operated it in London entirely at their own expense in the hopes that more might be introduced. They met with so much opposition, however, not only from the press but forcible interference from the firemen, that they abandoned the attempt. The Prussian Government in 1832 ordered a steam fire engine built that threw a single stream one inch and a half in diameter.

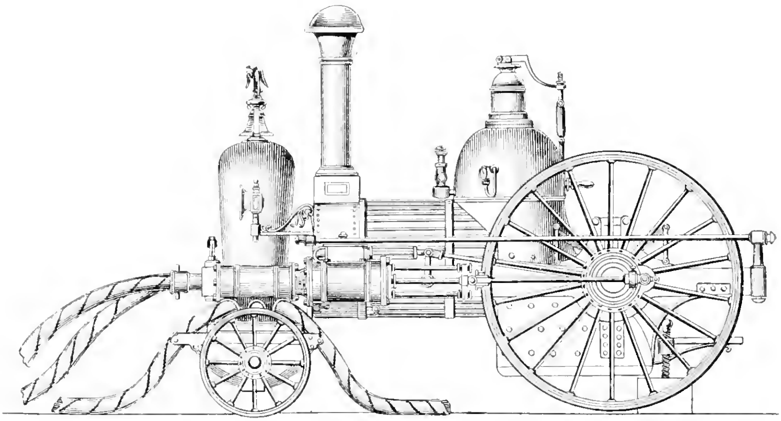


Fig. 7.—First Steam Fire Engine in the United States, 1840.

After his failure in London Captain Ericsson thought he would try again with the more progressive Americans, but he was doomed to disappointment. Designs that he made for an engine were awarded a prize by the American Institute in 1840, but no machine was built. The first steam fire engine ever built or used in the United States was one made by Mr. Paul R. Hodge for the Matteawan Insurance Company, of New York. The engine was a self-propeller, and when working at a fire was blocked up so that its hind wheels might be used as balance wheels. When housed it was connected with boilers, and fuel was always laid that steam might be got up quickly. This engine was operated at the expense of the insurance company, but continually met with opposition from the volunteer firemen. Finally, when playing at a fire in Dover Street, the machine did such excellent work that the firemen utterly refused to allow it to be used thereafter, and it was stored away, and New York's fire protection was limited again to the old hand tubs.

Such a marked improvement as a steam fire engine, however, could not long remain unadopted by the progressive people of this country, even though their protectors, the volunteer firemen, insisted that hand power was the only means that should be used. In 1852 Messrs. Latta & Shawk, of Cincinnati, placed a steam boiler and cylinder in connection with the pumps of a hand engine belonging to the Cincinnati department and mounted the whole contrivance on wheels and frame. A public trial was made of this crude affair, and it worked very successfully. In the short time of four minutes and ten seconds steam was raised from cold water, the engine started, and water discharged through three hundred and fifty feet of hose to a distance of one hundred and thirty feet from the nozzle. Although this exhibition was naturally looked upon with dislike by the volunteer firemen, the city government was greatly pleased and immediately contracted with the makers for a complete steam fire engine. This was built and put in service with a company organized and supported by the city. Thus the first paid fire company in the world to operate by steam power was brought into existence.

The volunteers made great opposition to the change in affairs, but the chief engineer of the paid department, Miles Greenwood, was so energetic and persevering that with the help of other level-headed men the opposition was overcome and the trouble adjusted. To Mr. Greenwood is due much of the credit for introducing the steam fire engine into this country. The firm of Latta & Shawk passed into different hands, until controlled by the celebrated Ahrens Manufacturing Company, which in turn has been absorbed by the American Fire Engine Company.

The fame of the Cincinnati engines spread, and other cities endeavored to introduce the system, always meeting with the most violent opposition from the volunteers. The press, however, advocated the change, and called for its universal introduction. A Boston gentleman, having visited Cincinnati, wrote in the Boston Transcript of August 7, 1857, that he was amazed at the efficiency of the Cincinnati department, and believed it had demonstrated the impossibility of extensive conflagrations. He was disgusted to return to Boston and find men and boys dragging hand tubs to fires, after having discarded a steam fire engine without giving it a fair trial. But the steam fire engine was bound to come. Chicago and other western cities closely followed Cincinnati by organizing paid departments equipped with steam engines. The more intelligent volunteers in the east began to see the error of their ways, and replaced their hand engines with the more modern apparatus. Boston was the first of the eastern cities to organize a paid department, which she did in 1860. New York did the same in 1865, and Philadelphia in 1871. Other eastern cities rapidly fell into line, but some of the southern cities, though equipped with the most modern apparatus, continue to the present day with volunteer firemen, New Orleans having only recently adopted a paid force.

When the success of the steam fire engine became an established fact the demand increased rapidly. Not only did many of the hand-engine builders begin their manufacture, but almost all the locomotive works and many machine shops did the same. Also many new firms sprang up. In almost every eastern and in many western States men went into the business, while in some cases the volunteer companies, notably one in Pittsburg, had the steamers built under their own supervision at the shop of one of the members. Philadelphia kept up her long-standing reputation by soon having ten or more competitive firms engaged in the work. Some of these numerous makers built but one engine, some of them only a few, while others continued in the business for several years.

The Portland Company Locomotive Works, of Portland, Me., made steam fire engines from 1859 until 1870. At the time their engines had the most powerful suctions of any in the market, and one of them, that is still on duty in Bangor, ably keeps up its reputation in this respect. The work was discontinued because the complicated nature of the machinery rendered it impossible to set a competitive price. In 1858 Thomas Scott and N. S. Bean, of Lawrence, Mass., made an engine for the Boston department. The business thus established was absorbed by the Amoskeag Manufacturing Company, of Manchester, N. H., and their engines are now built by the Manchester Locomotive Works.

Silsby, Mynderse & Company, of Seneca Falls, and Clapp & Jones, of Hudson, N. Y., were extensive builders, and their successors have combined with the successors of the Button Company and the Ahrens into the American Fire Engine Company. The multitude of firms in the eastern and a few in the western States that went into the business are too numerous to mention, and most of them soon discontinued the making of engines. The Philadelphia firms one by one dropped out, and that city's reputation in this line is a thing of the past. Ettenger & Edmund, of Richmond, made in 1860 an engine for St. Petersburg, Russia. This was one of the first American engines sent abroad.

These early machines were of all models and sizes, either large and cumbersome self-propellers or small and light to be drawn by men. Engines drawn by horses were not generally introduced until some years later. The different makers evidently made experiments to find the most satisfactory arrangement of the machinery. Some had the boiler at the extreme back, and the pumps and air chamber in the middle; in others the air chamber was far in front, while one builder put the air chamber and pumps behind, with the boiler in the center. Occasionally the self-propellers were three-wheeled affairs, while others on four wheels carried such an amount of chain and gears that they could hardly move their own ponderous weight. A comparison of pictures of the early machines would, to the most careless observer, show a marked difference in form, while the engines of the present day are nearly alike in general appearance.

The La France Fire Engine Company, Elmira, N. Y., and the Waterous Engine Works Company of St. Paul, have made engines but a comparatively few years, and with the Manchester Locomotive Works and the American Fire Engine Company are the only firms in the business to-day. Some few cities, notably

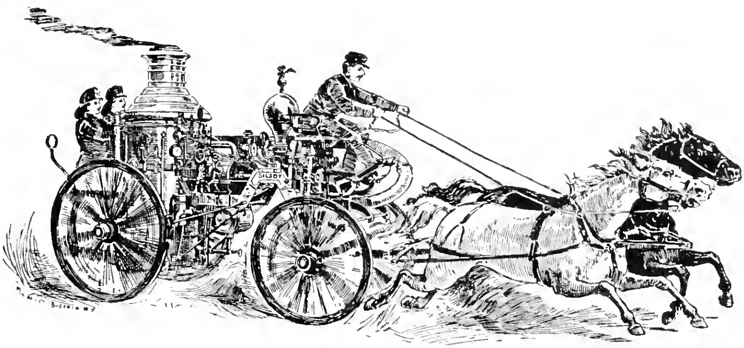


FIG. 8.—STEAM FIRE ENGINE OF TO-DAY.

Cleveland, encourage home industry by occasionally having engines built by local machinists.

It is not within the scope of this article to go into a technical description of the boilers, engines, and pumps used in the different styles of steamers made to-day. Each maker has endeavored to provide a boiler so arranged that steam can be generated in the shortest possible time. The engines must be light and capable of being worked in positions often far from level. The pumps must be powerful both in suction and in being able to throw streams to great distances. At the same time they must be as simple as possible and not easily clogged, for often the only available water is in some muddy pool or pond filled with foreign matter. When it is remembered that fire engines are often bought by village departments where there is no one of mechanical ability to care for them, it will be evident that every part of the machine must be of a quality and construction that will stand misuse and abuse.

The Amoskeag, Ahrens, Clapp & Jones, Button, and Water-

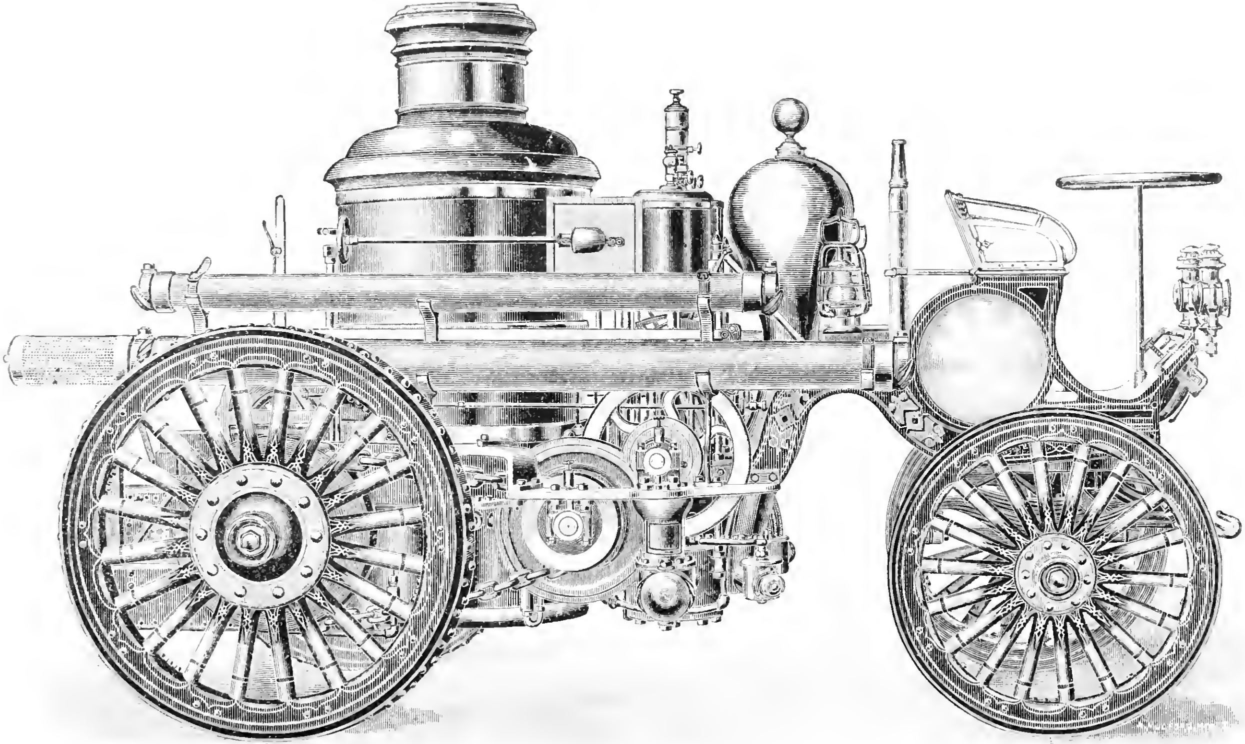


Fig. 9.—Self-propelling Steam Fire Engine.

ous engines have piston pumps; the Silsby engines have rotary pumps, and the La France Engine Company manufactures two distinct styles of engines—one with a piston pump and one with a rotary. The piston pump needs no description here, but it will be well to say a few words in regard to the rotary pump. The engine in this case is composed of two cams, which to the uninitiated are irregular cog-wheels with alternating large and small cogs, working in a steam-tight case. The steam entering from one direction forces these cams to revolve with great rapidity. The pump is composed of cams somewhat similar, which are connected with the engine cams, and when revolving suck the water and force it through the discharge pipe with great pressure. The capacities of steam fire engines differ from three hundred gallons per minute in the smallest sizes up to twelve and thirteen hundred gallons per minute in the largest.

Self-propellers are very little used at the present day. Boston, Providence, Hartford, New York, Brooklyn, Detroit, Chicago, Milwaukee, and other cities, have all tried them, but they have been very generally discarded for engines drawn by horses. Hartford is a notable exception to the list, there being two self-propellers in her department. The latest of these is an Amoskeag engine by the name of Jumbo, and has a capacity of thirteen hundred and fifty gallons per minute. This is probably the largest land fire engine in the world. The city departments are always furnished with the larger sizes of engines drawn by horses, but in many towns engines of lighter draft, that can be drawn by men, are often used. Crane-neck and straight frames are both used, but the former are more common. The American Fire Engine Company make a combination engine and hose wagon called the Columbian engine. The wagon part is forward, and the engine and boiler are over the rear wheels. This is very convenient in suburban departments, as it reduces the number of pieces of apparatus. The fire-engine makers of the United States supply the home market exclusively, and a number of machines have been sent to Canada and to foreign countries.

The most powerful allies of the land engines are fire boats, that are now used by all large cities bordering on the water. The capacity of a fire boat is often equal to that of ten to twenty land engines, and is limited only by the size of a boat that can be worked quickly and easily among the crowded shipping of a harbor. As has been seen, New York had a floating hand fire engine in use during the early part of this century, but it was not in service for any length of time. After steam vessels came into general use, harbor tugs were often provided with fire pumps, that they might aid in extinguishing fires on the water fronts. The first boat built expressly for fighting fire was launched in 1872, from the Atlantic Works, East Boston, for the Boston Fire Department. Her pumps were of the Amoskeag pattern. This boat has since been replaced by one more powerful. The next fire boat was the Havemeyer, built in New York in 1875, and followed in 1883 by the Zophar Mills for the same department. These boats are still in service.

The first very powerful fire boat was the Seth Low, built for the Brooklyn department by the Cowles Engineering Company of that city. This company has since built a number of fire boats

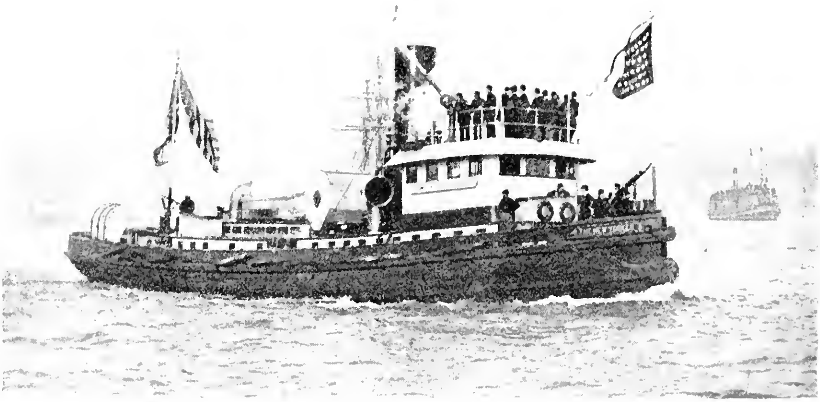


Fig. 10.—The Fire Boat New-Yorker, New York Fire Department.

for different cities, one of them being the New-Yorker, which is among the most powerful in the world. Chicago has four fire boats in her department. The modern fire boat is sometimes built of wood, but generally of iron, and in some cases the decks are so provided with corrugated iron shields and sprinklers that the boat can be worked to advantage in a perfect sea of fire. The whole power of the pumps can be concentrated in one stream from three to five inches in diameter, from a swivel nozzle on the forward deck, or, instead, a large number of ordinary fire streams can be played at once. When using the one powerful stream at the bow a brick wall can be penetrated, and the fire is not only deluged, but the force of the stream knocks the flaming timbers to pieces, and so distributes the fire that it can be quenched more rapidly. When playing a multitude of smaller streams the fire boat can go between a warehouse and a group of vessels, no matter how furious the fire may be, and there obtain a point of vantage impossible to a land engine. It is stated that the New-Yorker could sink herself in fifty seconds. The crew live in a house on the wharf where the boat is stationed, and can reach their places as rapidly as the members of a land fire company can reach their engines. Fires are kept banked at all hours, and every alarm within reach of the water front is answered. It will not be out of place to quote a passage from an article on Modern Fire Apparatus in Scribner's of January, 1891:

"It is not uninteresting to note that there are floating fire engines in London. They consist of steam pumps placed on scows which are moored at long intervals along the water front. When an alarm of fire comes in, the captain of the scow goes whooping up and down the water front to get a tug to tow him to the place from which the alarm has come!"

Many cities increase the possibilities of fire boats by laying empty pipe lines from the water front inland. The fire boat can couple on the line nearest the fire and the land engines can draw from this unlimited water supply in addition to the regular city system. The time is probably not far distant when every town and city bordering navigable water will have one or more fire boats in its department.

Steam locomotives can be made to serve as fire engines by attaching a device made by the Nathan Manufacturing Company of New York. It consists of a pipe placed at a point just below the level of the stationary water tanks in use on the railroad. There are two receiving nozzles in the center and two delivery nozzles at the base. The former are connected with a tank or an ordinary hydrant, and steam entering at the top of the pipe will force one eleven-sixteenths-inch stream one hundred and fifteen feet or two half-inch streams sixty feet. This device can be used very effectively in crowded freight yards where the regular firemen have difficulty in working with promptness, and also at way stations where there is no fire department.

It has long been known that certain chemicals will not support combustion, and during the middle of this century a number of chemists began to devise means by which such chemicals could be used to advantage at fires. The first practical results were five to ten gallon cans filled with a mixture of gas and water. Small hose was attached, through which the fluid could be played.

Fig. 11. Chemical Fire Engine.

In some instances the combination of gas and water aided greatly to extinguish the fire, while in others the gas escaped into the air and served only to force the water in a stream. The successful inventors soon tried large tanks on two and four wheeled trucks, and to-day all sizes, from tin and glass hand grenades up to large double-tank four-wheeled engines, are in use.

The first chemical engine was put on the market by the New England Fire Extinguisher Company of Northamption, Mass. The Babcock Company of Chicago took this up, and by the aid of one of their engineers, Mr. Wellington Lee, who had previously done much work with steam fire engines, soon made it much more successful.

The Holloway, of Baltimore, the Babcock and Champion, made by the Fire Extinguisher Manufacturing Company of Chicago, and the Hutson and the Lindgren-Mahan, also of Chicago, are the engines in general use at the present day. The chemicals used in these different engines are more or less the same, and the engines themselves consist of one or two tanks placed either horizontally or vertically, and having one or two lines of small hose attached. In some cases small extension ladders are carried. Combination chemical engines and hose wagons or carriages were used in Canada as early as 1883. Springfield, Ohio, Lawrence, Mass., Chicago, and Milwaukee had them in 1886. They have recently been adopted in Boston. The wagon is made deep and narrow, and a chemical tank placed on each side. Combination ladder trucks and chemical engines are also made. The New York department, the largest in the world, has discarded the use of chemical engines, but they are considered necessary adjuncts to most of the other fire departments of the country. Five or ten gallon tank extinguishers, however, are carried on all hose wagons and ladder trucks in New York and elsewhere. The chemical engine can go into action more quickly than a steam fire engine, and will extinguish small blazes with very little water damage. In connection with chemical engines it might be stated that for fires in electrical stations sand is the best extinguisher known. It has been found by experience that the application of water simply complicates matters by crossing currents, increasing the sparking, and ruining the plant.

It has been remarked that the Button hand engines are still made. Country departments, when old city tubs can not be bought, must have new hand engines made for them. The Gleason & Bailey Manufacturing Company, of New York, are extensive builders of these.

Several inventors have tried their hands at producing an electric fire engine, either to have the boiler and fire box of a steamer replaced with storage batteries, or else to have a trolley connection that could be used on any convenient electric railroad wire. In 1888, or thereabout, Mr. S. S. Wheeler, of New York, designed an electric engine which was constructed by placing a

Fig. 12.—Electric Fire Engine.

Sprague electric motor, directly attached to a Silsby rotary pump, on a Silsby crane-neck steam fire-engine truck. Several hundred feet of insulated wire were carried to be attached to electric connections. This engine is now the property of the Crocker-

Wheeler Electric Company. Mr. Joseph Sachs has also invented an electric engine, which is described in Cassier's Magazine for February, 1895. Undoubtedly in the future some machine of this kind will be introduced, but at present the industry is still in its infancy.

[*To be concluded.*]

THE MOTIVE FOR SCIENTIFIC RESEARCH.

By HUBERT LYMAN CLARK.

AT the meeting of the British Association for the Advancement of Science held at Oxford in August, 1894, the president, the Marquis of Salisbury, delivered a remarkable address on Unsolved Problems of Science, which called forth much criticism, particularly from scientific journals. The speaker called the especial attention of his audience to four great questions which, with all the boasted advances of science, still remain unsolved, and the solution of which seems as far distant to-day as ever. These questions were, the origin of the chemical elements, the problem of the ether, the origin of life, and the theory of evolution. The tendency of the address was certainly not to give encouragement that these problems would soon or even ultimately be cleared up by the work of scientists, but rather indicated a certain satisfaction that there were nuts to crack which even the British Association would find too hard. This tone was especially evident in the treatment of the subject of organic evolution, and the speaker made it plain that he considered certain of the objections to that doctrine conclusive and was ready, for one, to fall back on the doctrine of design to explain all the innumerable variations and adaptations which we see in animal and plant life about us. That the whole address was certainly reactionary there can be no doubt, but it seems to be unfortunately true that certain of the criticisms which it has called forth are to be equally condemned for going at once to the other extreme. In one of the leading scientific magazines of this country the reviewer says, under the heading Back to Dogma:

"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. . . . 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. 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 receive but the one reply, 'The Creator designed them so'?"

It is not my intention or wish to defend in itself the doctrine of design, nor is this the place to review the reviewer or criticise the above-quoted criticism; but such uncalled-for prejudice and illogical reasoning as shown therein do cause the question to arise, What, after all, is the real motive for scientific research?

A little over fifty years ago a young Englishman was busily engaged in gathering and arranging all kinds of facts in regard to changes in animals and plants, either under domestication or in a state of Nature. For twenty years or more he worked patiently and carefully gathering his facts, comparing and arranging them and mentally digesting all this mass of material, and, at last, in 1859, he offered to the world his theory of the Origin of Species. Before Charles Darwin, all naturalists were engaged in gathering and recording facts, and arranging them in a more or less natural order, but they failed to compare and digest them, as he did, because they were content with statistics and did not ask for reasons. That this was due to a belief in the immutability of species and the doctrine of design there can be little doubt; but that the great men who accepted that doctrine did so because it "saved intellectual toil" or "glorified ignorance" is a gross slander. They did so partly because of early training, but very largely because it was a satisfactory explanation of such problems as they happened to meet and so proved its sufficiency. When Darwin, however, came to apply it to the facts as he found them in his day, he soon proved it was *not* sufficient, and then was asked for the first time in biology, *How* did these things come to be so? The question had been asked long before in physics, chemistry, and astronomy; but until the middle of this century biologists and even geologists had been chiefly concerned with the question WHAT? and had neglected the far more important one HOW? It was the asking of this question, and the answer to it which he gave, which makes Darwin the bright particular star in the scientific firmament of the nineteenth century, and no lapse of time can ever dim the luster of that honored name. However inadequate we may consider the theory of natural selection to account for all the innumerable forms of animal and plant life which have existed or do now inhabit and beautify the earth, there can be no doubt that the question as an answer to which it was offered has been for thirty-five years the mainspring of research not merely in biology but in all the field of natural science. It is easy to see how this condition was itself the result of evolution, for one can not ask the means to an end until the end is seen or known. Up to the time of Linnæus there was little general interest in zoölogy and botany, but after he had placed in systematic order such facts as were known to the scientific world of his day, others began to find all about them additional facts which had been theretofore unrecorded, and so interest in Nature began its steady rise toward the high position which it holds to-day. So long as the great majority of forms were unknown or undescribed, the only question was concerning *what* existed, and naturalists everywhere were busy with these facts of the existence of species; but as the records became more complete and the knowledge of natural phenomena wider spread, of course the tendency would naturally be toward inquiry as to *how* these innumerable forms arose. Even as early as the latter part of the eighteenth century some of the deepest thinkers were turning this question over in their minds, although they did not appreciate its great importance or its bearing on the acquisition of knowledge. Darwin himself began his career as a gatherer of facts, but his active mind soon saw the inadequacy of the doctrine of special creations, and demanded something more in accordance with the facts. The history of the development in his own mind of the famous theory to which his name is attached is a most fascinating story, but it is not necessary to enter into any details here. Suffice it to say that he became thoroughly convinced in his own mind, and actually convinced the whole scientific world, even including his most bitter opponents, that the question of the hour was *not* one of which species was which, nor to what family it belonged when identified, but "*How did species arise?*" From that day to this the whole trend of scientific study has been toward the solution of that problem, and an enormous amount of investigation by biologists, far and near, has thrown much light on its intricacies, although, when we consider all phases of the subject, including the difficulties of heredity, we feel that we have hardly made more than a beginning.

This change of position in the subject-matter of scientific research has brought about a most remarkable and far-reaching change in method, which is universally recognized as vastly superior to the old. But it seems also to have brought about an equally radical change in the spirit of investigation; and instead of the reverent work of an Owen, an Agassiz, or a Lyell, who believed they were studying the creations of an Omnipotent God, Maker and Father of all, we have the enthusiastic, energetic, all-embracing investigations and theories of a Haeckel, a Huxley, or a Spencer, who certainly can not be accused of holding any pronounced religious beliefs whatever. There can be no doubt that this change too was a very natural one; for as long as men felt that they were studying immutable creatures, there was a sense of restraint in the work, a feeling that investigation had a definite limit beyond which we could not go, and so there was little chance for speculation or theorizing on the nature of causes. When this restraint was suddenly and entirely removed by the theory of evolution the reaction was inevitable, and a strong tendency toward the other extreme set in, clearly shown by the number and variety of the theories that have been suggested and published to explain all kinds of natural phenomena. Scientists have been so entirely taken up with explaining *how* all the wonderful things which we find in the world about us have taken place; the doctrine of evolution has proved so completely satisfactory at every turn that there is great danger that the ultimate motive for scientific research will be completely lost to sight. Indeed, one may search a great majority of scientific works without finding a hint as to any higher motive than mere curiosity,—a curiosity differing greatly in quality and extent in different writers, but very rarely that pure eagerness for "truth" which it sometimes professes to be. So long as the answer to the question How? is the all-important thing, and so long as that is considered the ultimate question, no proper conception of a nobler motive can be formed. But we must now consider if there is not still another question beyond the How? which is as far more important than that as that is beyond the question What? The extraordinary reverence which a certain school of scientists feel toward the question How? is clearly shown by the quotation in the earlier part of this article, and it will, no doubt, be considered impious by them that any one should presume to go beyond that question. At the same time one can not read that criticism without having forced upon him the belief that there is another and greater question to be considered, and that question may be briefly stated in the form of Why?

It is not by any means a new question, and I claim no merit of originality in bringing it forward here; but since we have come to see the importance of the *means* to the end, we seem to have lost sight of the far greater importance of the *causes* of those means. That is, while we have been busy inquiring *how* things came to be so, we have either confused with that question, or forgotten altogether to ask, the *why*. Probably the first objection that will be raised to the consideration of this question will be the futility of seeking ultimate causes; and the limits of human knowledge will be emphasized to show the folly of going beyond the How? Now, it is no part of my purpose to consider the question whether there is an Absolute Unknowable; but I will merely suggest that when it was first proposed to consider *how* species came to be what they are, it was not only the theologians who raised a great hue and cry about the impiety and folly of the act; a very large number of scientific men really supposed that the question was beyond the limits of actual knowledge. And yet is not the doctrine of evolution becoming less and less of an hypothesis and more and more of an actually established law every year? Is not the evidence all tending to establish it completely, and to prove that even the obscure problems of life and heredity are all within the limits of human knowledge? Can we then be sure that the knowledge of why evolution has worked as it has is unattainable? Is not the presumption strongly in favor of the probability that some day, somewhere, some race of men, our posterity and the legatees of our knowledge, will know and understand the causes and the "reasons why" which have led to and are now leading toward that

> ". . . one far-off divine event
> To which the whole creation moves"?

If, then, it is granted that this knowledge is a possibility, it is fitting that we should consider whether there is any clew to the solution of the problem in the work already done, and what effect the question will have on the methods and spirit of scientific research. We have already seen how long a time the doctrine of immutability of species held in check the tendency to theorize and led students to devote themselves to the collection and tabulation of facts. Both questions, how and why, were confused together and were answered promptly and positively: "The Creator designed them so"; and there was the end beyond appeal. When it was found, however, that this was really no answer at all to the question How? and that the true answer to that question was within the immediate grasp of the scientific world, the whole argument of design was promptly thrown aside as rubbish, and we were free! But we were not long to remain so, for now we find a new limit set to our knowledge beyond which there is no appeal, and the answer to our question Why? is now given us, "Evolution evolved them so"! Distinguishing now as we do between how and why, we find this limit is equally distasteful and causes a similar feeling of restraint; and it is only natural that, having been freed from the other, we should demand emancipation from this. Why did evolution evolve some birds into objects of such marvelous beauty? Surely we can conceive of peacocks, humming birds, and birds of paradise fully as well, perhaps even better, fitted for the struggle for existence without their gleaming colors and gorgeous plumes. Why are some flowers so fragrant to our sense of smell? We certainly know that it is no advantage to them to please us, as long as they attract insects, and we also know that odor without fragrance will answer that purpose. Was it only chance that brought about these results? It seems incredible that any person familiar with Nature's conformity to law and the mathematical improbability of inheritance of accidental variation along a favorable line can believe that these marvelous results have been governed only by chance. Surely Nature could never thrive under such a shiftless and haphazard system, and we are therefore justified in searching for the reason why. Not *how* beautiful birds and fragrant flowers were evolved is the essential question, but *why*. Yet we can never hope to know the causes until we know perfectly the means, just as we could never have hoped to know the means until we were tolerably familiar with the ends. Darwin could never have formulated his theory if he had not had the vast array of facts on which to base it, and it would never be proved if men were to give up the gathering of the still unrecorded facts. Of course, all this routine work appears in a new and far more glorious light now, and much the greater number of scientific workers are engaged in the collection of such facts as have hitherto been unknown or overlooked. Only a very few are giving the greater part of their time to theorizing on how evolution works, although we all realize the importance of that question. So it will be when we see that the question Why? is the ultimate one, for there can be no solution of this problem until the lesser ones are solved. It is neither probable nor desirable that any change of method will result, for the present historical system is so far ahead of any other that there is no danger of our giving it up; but it is both probable and desirable that investigators should approach the phenomena of Nature in a different spirit.

As we look about for a clew as to how the question Why? may be answered, let us examine more carefully that dogmatic assertion which we threw aside so promptly when we accepted the doctrine of evolution: "The Creator designed them so." Have we any hint here as to the causes which have governed the evolutionary methods? That depends on some other things which we must examine first. The means by which an end is accomplished we know by experience may be purely impersonal, but *causes* are always dependent on personality. This may not appear at first sight, so prone are we to confuse how and why, but it will be clearly seen by means of an illustration. We are accustomed to say that we know *why* it rains, but in reality we only know *how* it is that it rains—that is, we know the natural processes by which rain is produced. On the other hand, we say we know *why* we went to a given place at a given time, and in this case we not only know how we went, but we do know the actual reasons or causes which put the means at work. If this be granted, as it seems to me it must be, we are at once presented with the condition that the answer to our question *why* is dependent on our knowledge of the personality who is the cause of the phenomena. If, therefore, the phenomena are in point of time or space as compared with ourselves infinite, their cause must be infinite; and since it is admitted that cause is dependent on personality, we are justified in speaking of an Infinite Personal Being, and our knowledge of the cause of natural phenomena and the origin of natural law will be dependent on our knowledge of that Being whom we may reasonably call God. The dogmatic assertion, then, which we were examining does contain a clew to the solution of the problem. That "the Creator designed them so" is no answer to the question of the origin of species, is palpably evident, nor does it throw any light on the question of *how* things have come to be as they are; but it does *give a clew* as to *why* things are so, although, of course, it *does not answer* the query. If we examine the acts of any person we find that they throw light on his character, and if we become fully acquainted with the means which he has used, we become better acquainted with the character, and as we know that, we come to understand his motives. So we shall find it in the study of natural science. As we learn more and more of the facts of Nature, we shall become better acquainted with the means, and will understand then how things have been evolved; and as we solve these lesser problems we will become better and better fitted to understand why evolution has worked as it has, and to comprehend the character of God. This, then, is the true motive for scientific research, that we may know him who is the only true God, and by knowing his character and motives understand our relations to him. That the appreciation of this motive would have a marked effect on the spirit of scientific work is plainly evident, and, instead of the tone of shallow materialism so common to-day, we would have a religious reverence for truth as it is, without regard to possible effects on our pet theories—that truth which we shall some day know and which shall make us free. The doctrine of design certainly failed to explain the many phenomena of Nature, but that a re-examination of it, or even a temporary acceptance of it as explaining the *why* of those phenomena, means "the death of scientific investigation," is the most arrant nonsense. The universe certainly is the "theater of Will," otherwise there could be no universe; but *it is also* the theater of "forces the operation of which we can hope to understand," and to deny the latter fact is as ridiculous as to ignore the former. Much discredit has been cast on religious teachers and workers because of ignorance and shallow reasoning, but there is great danger that in the closing days of this century scientific teachers and workers will bring discredit on themselves and their calling by an equally erroneous position, not toward religion only but toward Science herself. As soon, however, as one comprehends the real motive for scientific research all such danger is dissipated, and he will earnestly seek to add his life work as—

"... a closer link
Betwixt us and the crowning race

"Of those that eye to eye shall look
On knowledge; under whose command
Is Earth and Earth's, and in their hand
Is Nature like an open book;

"No longer half akin to brute,
For all we thought and loved and did,
And hoped, and suffered is but seed
Of what in them is flower and fruit."

PLEASURES OF THE TELESCOPE.

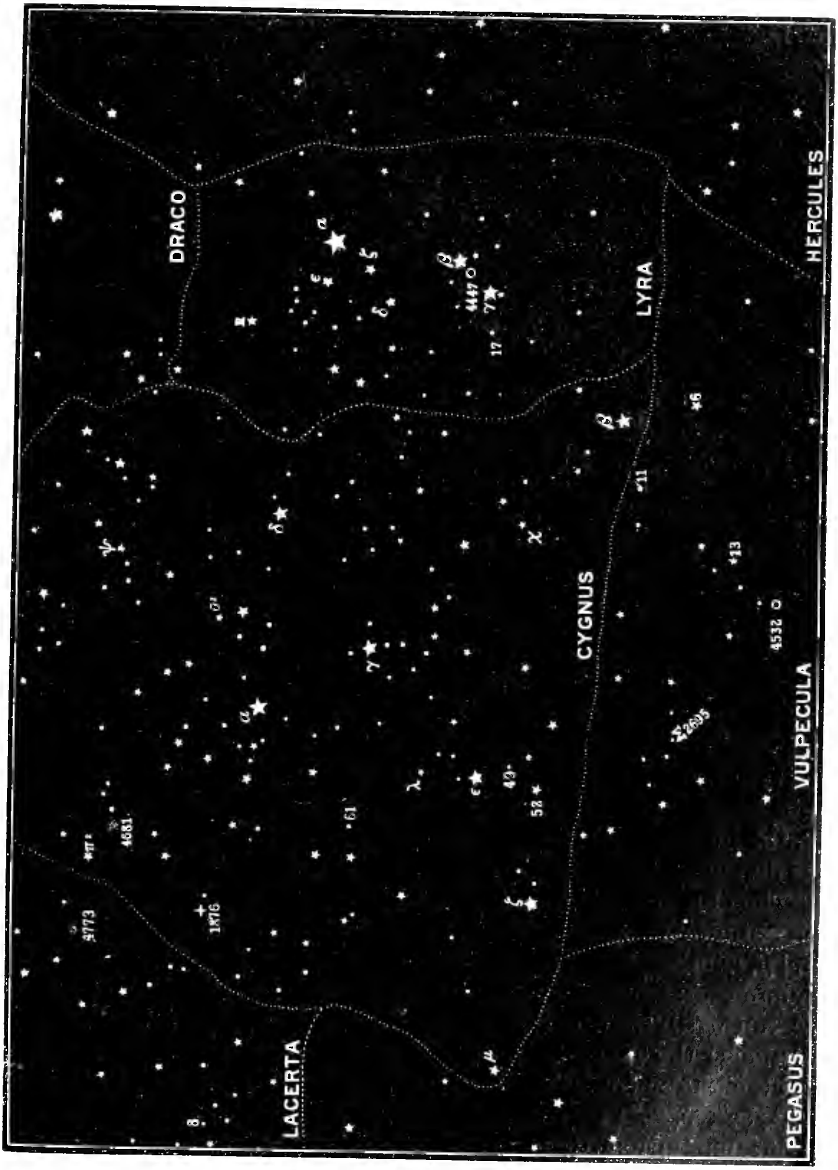
By GARRETT P. SERVISS.

VI.—FROM LYRA TO ERIDANUS.

WE resume our celestial explorations with the little constellation Lyra, whose chief star, Vega (α), has a very good claim to be regarded as the most beautiful in the sky. The position of this remarkable star is indicated in map No. 17. Every eye not insensitive to delicate shades of color perceives at once that Vega is not white, but blue-white. When the telescope is turned upon the star the color brightens splendidly. Indeed, some glasses decidedly exaggerate the blueness of Vega, but the effect is so beautiful that one can easily forgive the optical imperfection which produces it. With our four-inch we look for the well-known companion of Vega, a tenth-magnitude star, also of a blue color deeper than the hue of its great neighbor. The distance is 50″, p. 158°. Under the most favorable circumstances it might be glimpsed with the three-inch, but, upon the whole, I should regard it as too severe a test for so small an aperture.

Vega is one of those stars which evidently are not only enormously larger than the sun (one estimate makes the ratio in this case nine hundred to one), but whose physical condition, as far as the spectroscope reveals it, is very different from that of our ruling orb. Like Sirius, Vega displays the lines of hydrogen most conspicuously, and it is probably a much hotter as well as a much more voluminous body than the sun.

Close by, toward the east, two fourth-magnitude stars form a little triangle with Vega. Both are interesting objects for the telescope, and the northern one, ϵ, has few rivals in this respect. Let us first look at it with an opera glass. The slight magnifying power of such an instrument divides the star into two twinkling points. They are about two and a quarter minutes of arc apart, and exceptionally sharp-sighted persons are able to see them di-



Map No. 17.

vided with the naked eye. Now take the three-inch telescope with a moderate power, and look at them. Each of the two stars revealed by the opera glass appears double, and a fifth star of the ninth magnitude is seen on one side of an imaginary line joining the two pairs. The northernmost pair is named ϵ_1, the magnitudes being fifth and sixth; distance 3″, p. 15°. The other pair is ϵ_2, magnitudes fifth and sixth; distance 2·3″, p. 133°. Each pair is apparently a binary; but the period of revolution is unknown. Some have guessed a thousand years for one pair, and two thousand for the other. Another guess gives ϵ_1 a period of one thousand years, and ϵ_2 a period of eight hundred years. Hall, in his double-star observations, simply says of each, "A slow motion."

Purely by guesswork a period has also been assigned to the two pairs in a supposed revolution around their common center, the time named being about a million years. It is not known, however, that such a motion exists. Manifestly it could not be ascertained within the brief period during which scientific observations of these stars have been made. The importance of the element of time in the study of stellar motions is frequently overlooked, though not, of course, by those who are engaged in such work. The sun, for instance, and many of the stars are known to be moving in what appear to be straight lines in space, but observations extending over thousands of years would probably show that these motions are in curved paths, and some of them, perhaps, in closed orbits.

If now in turn we take our four-inch glass, we shall see something else in this strange family group of ϵ Lyræ. Between ϵ_1 and ϵ_2, and placed one on each side of the joining line, appear two exceedingly faint specks of light, which Sir John Herschel made famous under the name of the *debillissima*. They are of the twelfth or thirteenth magnitude, and possibly variable to a slight degree. If you can not see them at first, turn your eye toward one side of the field of view, and thus, by bringing their images upon a more sensitive part of the retina, you may glimpse them. The sight is not much, yet it will repay you, as every glance into the depths of the universe does.

The other fourth-magnitude star near Vega is ζ, a wide double, magnitudes fourth and sixth; distance 44″, p. 150°. Below we find β, another very interesting star, since it is both a multiple and an eccentric variable. It has four companions, three of which we can easily see with our three-inch; the fourth calls for the five-inch; the magnitudes are respectively four, seven or under, eight, eight and a half, and eleven; distances 45″, p. 150°; 65″, p. 320°; 85″, p. 20°; and 46″, p. 248°. The primary, β, varies from about magnitude three and a half to magnitude four and a half, the period being twelve days, twenty-one hours, forty-six minutes, and fifty-eight seconds. Two unequal maxima and minima occur within this period. In the spectrum of this star some of the hydrogen lines and the D_3 line (the latter representing helium, a constituent of the sun and of some of the stars, which, until its recent discovery in a rare Norwegian mineral, was not known to exist on the earth) are bright, but they vary in visibility. Moreover, dark lines due to hydrogen also appear in its spectrum simultaneously with the bright lines of that element. Then, too, the bright lines are sometimes seen double. Prof. Pickering's explanation is that β Lyræ probably consists of two stars, which, like the two composing β Aurigæ, are too close to be separated with any telescope now existing, and that the body which gives the bright lines is revolving in a circle in a period of about twelve days and twenty-two hours around the body which gives the dark lines. He has also suggested that the appearances could be accounted for by supposing a body like our sun to be rotating in twelve days and twenty-two hours, and having attached to it an enormous protuberance extending over more than one hundred and eighty degrees of longitude, so that when one end of it was approaching us with the rotation of the star the other end would be receding, and a splitting of the spectral lines at certain periods would be the consequence. "The variation in light," he adds, "may be caused by the visibility of a larger or smaller portion of this protuberance."

Unfortunate star, doomed to carry its parasitical burden of hydrogen and helium, like Sindbad in the clasp of the Old Man of the Sea! Surely, the human imagination is never so wonderful as when it bears an astronomer on its wings. Yet it must be admitted that the facts in this case are well calculated to summon the genius of hypotheses. And the puzzle is hardly simplified by Bélopolsky's observation that the body giving dark hydrogen lines shows those lines also split at certain times. It has been calculated, from a study of the phenomena noted above, that the bright-line star in β Lyræ is situated at a distance of about fifteen million miles from the center of gravity of the curiously complicated system of which it forms a part.

We have not yet exhausted the wonders of Lyra. On a line from β to γ, and about one third of the distance from the former to the latter, is the celebrated Ring Nebula, indicated on the map by the number 4447. We need all the light we can get to see this object well, and so, although the three-inch will show it, we shall use the five-inch. Beginning with a power of one hundred diameters, which exhibits it as a minute elliptical ring, rather misty, very soft and delicate, and yet distinct, we increase the magnification first to two hundred and finally to three hundred, in order to distinguish a little better some of the details of its shape. Upon the whole, however, we find that the lowest power that clearly brings out the ring gives the most satisfactory view. The circumference of the ring is greater than that of the planet Jupiter. Its ellipticity is conspicuous, the length of the longer axis being 78″

and that of the shorter 60″. Closely following the nebula as it moves through the field of view, our five-inch telescope reveals a faint star of the eleventh or twelfth magnitude, which is suspected of variability. The largest instruments, like the Washington and the Lick glasses, have shown perhaps a dozen other stars apparently connected with the nebula. Three of these, seen at Mount Hamilton, are within the inclosure of the ring. A beautiful sparkling effect which the nebula presents was once thought to be an indication that it was really composed of a circle of stars, but the spectroscope shows that its constitution is gaseous.

Not far away we find a difficult double star, 17, whose components are of magnitudes six and ten or eleven, distance 3·7″, p. 325°.

From Lyra we pass to Cygnus, which, lying in one of the richest parts of the Milky Way, is a very interesting constellation for the possessor of a telescope. Its general outlines are plainly marked for the naked eye by the figure of a cross more than twenty degrees in length lying along the axis of the Milky Way. The foot of the cross is indicated by the star β, also known as Albireo, one of the most charming of all the double stars. The three-inch amply suffices to reveal the beauty of this object, whose components present as sharp a contrast of light yellow and deep blue as it would be possible to produce artificially with the purest pigments. The magnitudes are three and seven, distance 34·6″, p. 55°. No motion has been detected indicating that these stars are connected in orbital revolution, yet no one can look at them without feeling that they are intimately related to one another. It is a sight to which one returns again and again, always with undiminished pleasure. The most inexperienced observer admires its beauty, and after an hour spent with doubtful results in trying to interest a tyro in double stars it is always with a sense of assured success that one turns the telescope to β Cygni.

Following up the beam of the imaginary cross along the current of the Milky Way, every square degree of which is here worth long gazing into, we come to a pair of stars which contend for the name-letter χ. On our map the letter is attached to the southernmost of the two, a variable of long period—four hundred and six days—whose changes of brilliance lie between magnitudes four and thirteen, but which exhibits much irregularity in its maxima. The other star, not named but easily recognized in the map, is sometimes called 17. It is an attractive double whose colors faintly reproduce those of β. The magnitudes are five and eight, distance 26″, p. 73°. Where the two arms of the cross meet is γ, whose remarkable *cortége* of small stars running in curved streams should not be missed. Use the lowest magnifying power.

At the extremity of the western arm of the cross is δ, a close double, difficult for telescopes of moderate aperture on account of the difference in the magnitudes of the components. We may succeed in dividing it with the five-inch. The magnitudes are three and eight, distance 1·5″, p. 310°. It is regarded as a binary of long and as yet unascertained period.

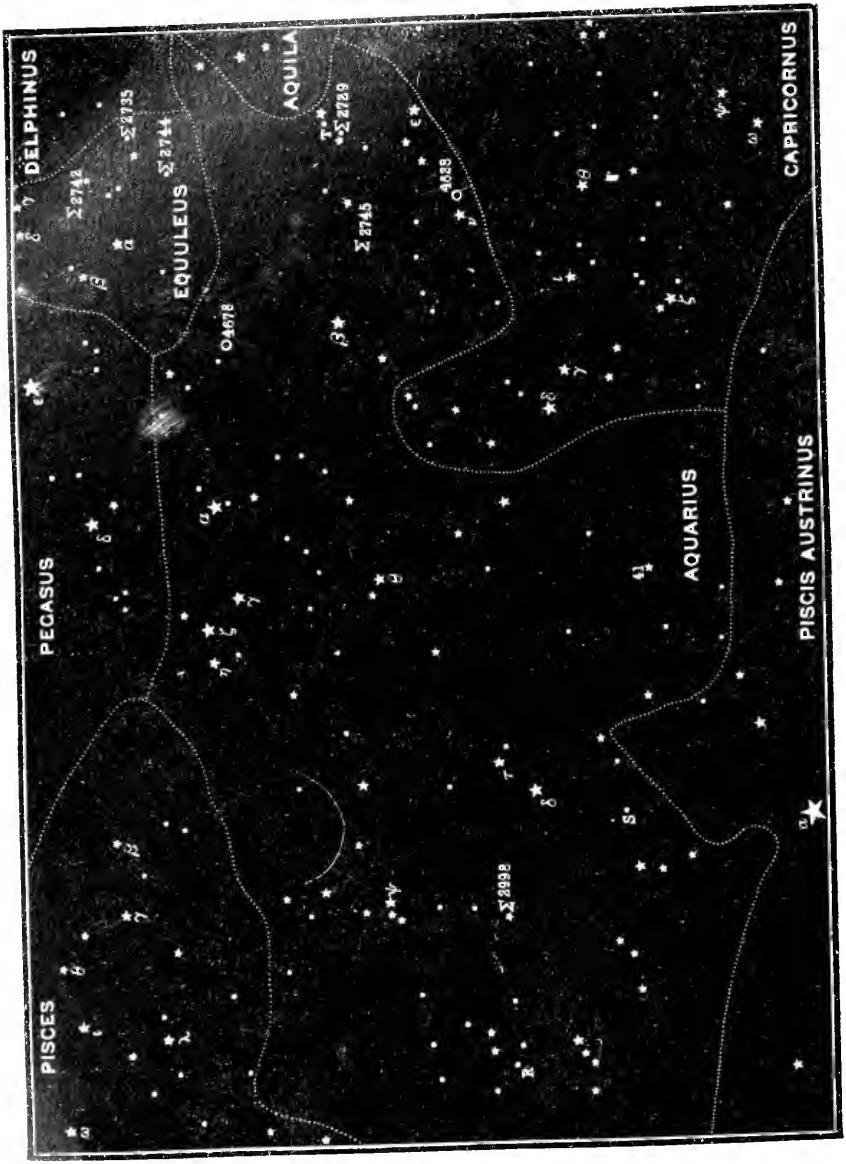
In o^2 we find a star of magnitude four and orange in color, having two blue companions, the first of magnitude seven and a half, distance 107″, p. 174°, and the second of magnitude five and a half, distance 358″, p. 324°. Farther north is ψ, which presents to us the combination of a white five-and-a-half-magnitude star with a lilac star of magnitude seven and a half. The distance is 3″, p. 184°. A very pretty sight.

We now pass to the extremity of the other arm of the cross, near which we find the beautiful little double 49, whose components are of magnitudes six and eight, distance 2·8″, p. 50°. The colors are yellow and blue, conspicuous and finely contrasted. A neighboring double of similar hues is 52, in which the magnitudes are four and nine, distance 6″, p. 60°. Sweeping a little way northward we come upon an interesting binary, λ, which is unfortunately beyond the dividing power of our largest glass. A good seven-inch or seven-and-a-half-inch should split it under favorable circumstances. Its magnitudes are six and seven, distance 0·66″, p. 74°.

The next step carries us to a very famous object, 61 Cygni, long known as the nearest star in the northern hemisphere of the heavens. It is a double which our three-inch will readily divide, the magnitudes being both six, distance 21″, p. 122°. The distance of 61 Cygni, according to Hall's parallax of 0·27″, is about 70,000,000,000,000 miles. There is some question whether or not it is a binary, for, while the twin stars are both moving in the same direction in space with comparative rapidity, yet conclusive evidence of orbital motion is lacking. When one has noticed the contrast in apparent size between this comparatively near-by star, which the naked eye only detects with considerable difficulty, and some of its brilliant neighbors whose distance is so great as to be immeasurable with our present means, no better proof is needed of the fact that the faintness of a star is not necessarily an indication of remoteness.

We may prepare our eyes for a beautiful exhibition of contrasted colors once more in the star μ. This is really a quadruple, although only two of its components are close and conspicuous. The magnitudes are five, six, seven and a half, and twelve; distances 3·2″, p. 121°; 208″, p. 56°; and 35″, p. 264°. The color of the largest star is white and that of its nearest companion blue; the star of magnitude seven and a half is also blue.

The star cluster 4681 is a fine sight with our largest glass. In the map we find the place marked where the new star of 1876 made its appearance. This was first noticed on November 24, 1876, when it shone with the brilliance of a star of magnitude



Map No. 18.

three and a half. Its spectrum was carefully studied, especially by Vogel, and the very interesting changes that it underwent were noted. Within a year the star had faded to less than the tenth magnitude, and its spectrum had completely changed in appearance, and had come to bear a close resemblance to that of a planetary nebula. This has been quoted as a possible instance of a celestial collision through whose effects the solid colliding masses were vaporized and expanded into a nebula. At present the star is very faint and can only be seen with the most powerful telescopes.

Underneath Cygnus we notice the small constellation Vulpecula. It contains a few objects worthy of attention, the first being the nebula 4532, the "dumb-bell nebula" of Lord Rosse. With the four-inch, and better with the five-inch, we are able to perceive that it consists of two close-lying tufts of misty light. Many stars surround it, and large telescopes show them scattered between the two main masses of the nebula. The star 11 points out the place where a new star of the third magnitude appeared in 1670. Σ 2695 is a close double, magnitudes six and eight, distance 1·4″, p. 82°.

We turn to map No. 18, and, beginning at the western end of the constellation Aquarius, we find the variable T, which ranges between magnitudes seven and thirteen in a period of about two hundred and three days. Its near neighbor Σ 2729 is a very close double, beyond the separating power of our five-inch, the magnitudes being six and seven, distance 0·6″, p. 176°. Σ 2745, also known as 12 Aquarii, is a good double for the three-inch. Its magnitudes are six and eight, distance 2·8″, p. 190°. In ζ we discover a beauty. It is a slow binary of magnitudes four and five, distance 3·3″, p. 325°. According to some observers both stars have a greenish tinge. The star 41 is a wider double, magnitudes six and eight, distance 5″, p. 115°, colors yellow and blue. The uncommon stellar contrast of white with light garnet is exhibited by τ, magnitudes six and nine, distance 27″, p. 115°. Yellow and blue occur again conspicuously in ψ, magnitudes four and a half and eight and a half, distance 50″, p. 310°. Rose and emerald have been recorded as the colors exhibited in Σ 2998, whose magnitudes are five and seven, distance 13·5″, p. 346°.

The variables S and R are both red. The former ranges between magnitudes eight and twelve, period two hundred and eighty days, and the latter between magnitudes six and eleven, period about three hundred and ninety days.

The nebula 4628 is Rosse's "Saturn nebula," so called because with his great telescope it presented the appearance of a nebulous model of the planet Saturn. With our five-inch we see it simply as a planetary nebula. We may also glance at another nebula, 4678, which appears circular and is pinned with a little star at the edge.

The small constellation Equuleus contains a surprisingly large number of interesting objects. Σ 2735 is a rather close double, magnitudes six and eight, distance 1·8″, p. 287. Σ 2737 (the first star to the left of Σ 2735, the name having accidentally been omitted from the map) is a beautiful triple, although the two

Map No. 19.

closest stars, of magnitudes six and seven, can not be separated by our instruments. Their distance in 1886 was 0·78″, p. 286°, and they had then been closing rapidly since 1884, when the distance was 1·26″. The third star, of magnitude eight, is distant 11″, p.

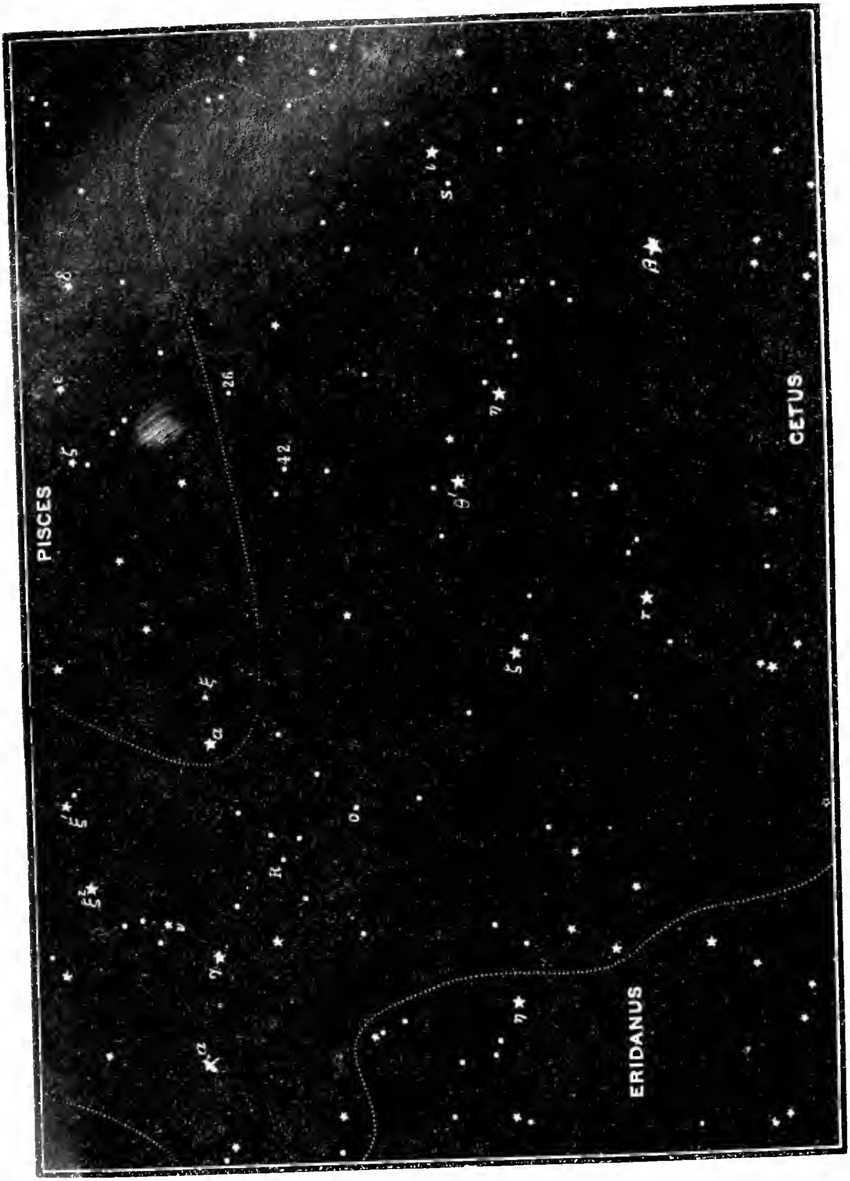
75°. Σ 2744 consists of two stars, magnitudes six and seven, distance 1·6″, p. 171°. It is probably a binary. Σ 2742 is a wider double, magnitudes both six, distance 2·6″, p. 225°. Another triple, one of whose components is beyond our reach, is γ. Here the magnitudes are fifth, twelfth, and sixth, distances 2″, p. 274°, and 366″. It would also be useless for us to try to separate δ, but it is interesting to remember that this is one of the closest of known double stars, the magnitudes being fourth and fifth, distance 0·4″, p. 198°. These data are from Hall's measurements in 1887. The star is, no doubt, a binary. With the five-inch we may detect one and perhaps two of the companion stars in the quadruple β. The magnitudes are fifth, tenth, and two eleventh, distances 67″, p. 309°; 86″, p. 276°; and 6·5″, p. 15°. The close pair is comprised in the tenth-magnitude star.

Map No. 19 introduces us to the constellation Pegasus, which is comparatively barren to the naked eye, and by no means rich in telescopic phenomena. The star ϵ, of magnitude two and a half, has a blue companion of the eighth magnitude, distance 138″, p. 324°; colors yellow and violet. A curious experiment that may be tried with this star is described by Webb, who ascribes the discovery of the phenomenon to Sir John Herschel. When near the meridian the small star in ϵ appears, in the telescope, underneath the large one. If now the tube of the telescope be slightly swung from side to side the small star will appear to describe a pendulumlike movement with respect to the large one. The explanation suggested is that the comparative faintness of the small star causes its light to affect the retina of the eye less quickly than does that of its brighter companion, and, in consequence, the reversal of its apparent motion with the swinging of the telescope is not perceived so soon.

The third-magnitude star η has a companion of magnitude ten and a half, distance 90″, p. 340°. The star β, of the second magnitude, and reddish, is variable to the extent of half a magnitude in an irregular period, and γ, of magnitude two and a half, has an eleventh-magnitude companion, distant 162″, p. 285°.

Our interest is revived on turning, with the guidance of map No. 20, from the comparative poverty of Pegasus to the spacious constellation Cetus. The first double star that we meet in this constellation is 26, whose components are of magnitudes six and nine, distance 16·4″, p. 252°; colors, topaz and lilac. Not far away is the closer double 42, composed of a sixth and a seventh magnitude star, distance 1·25″, p. 350°. The four-inch is capable of splitting this star, but we shall do better to use the five-inch. In passing we may glance at the tenth-magnitude companion to η, distant 225″, p. 304°. Another wide pair is found in ζ, magnitudes third and ninth, distance 185″, p. 40°.

The next step brings us to the wonderful variable ο, or Mira, whose changes have been watched for three centuries, the first observer of the variability of the star having been David Fabri-



Map No. 29.

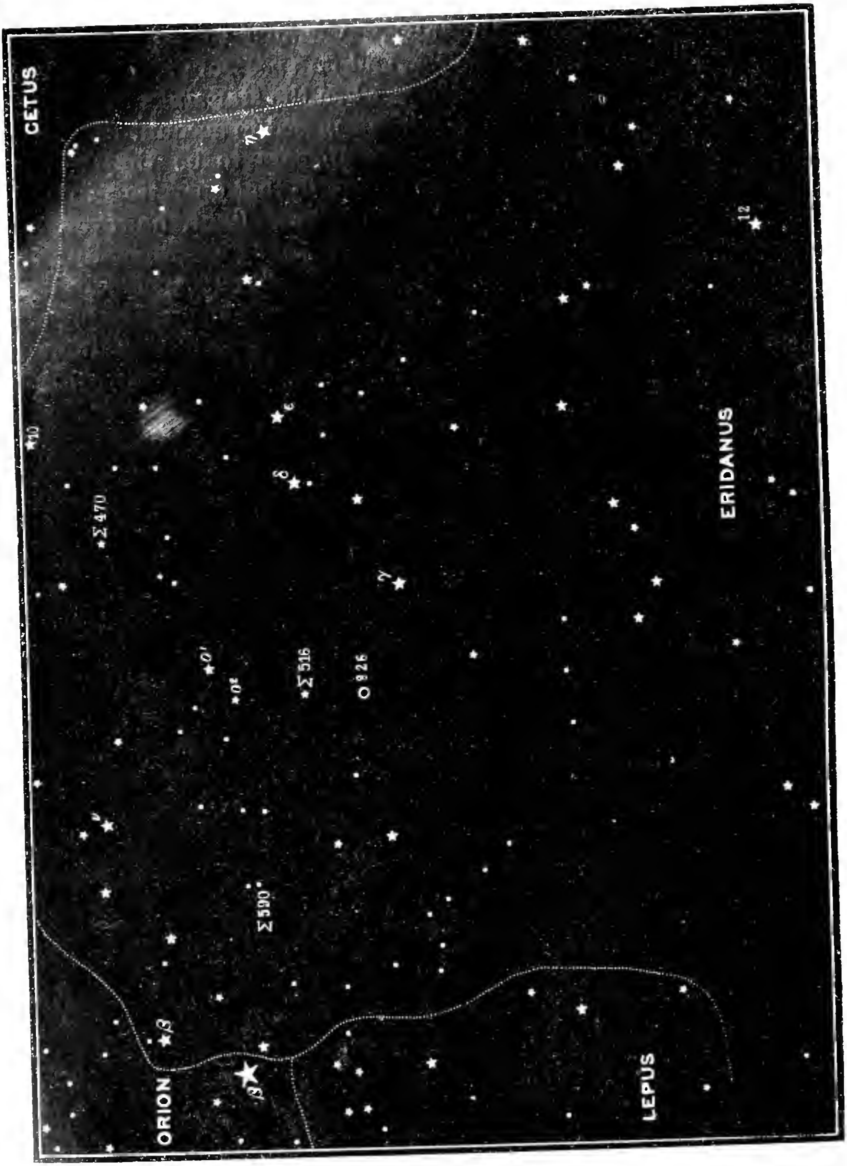
cius in 1596. Not only is the range of variability very great, but the period is remarkably irregular. In the time of Hevelius, Mira was once invisible for four years. When brightest, the star is of about the second magnitude, and when faintest, of the ninth magnitude, but at maximum it seldom exhibits the greatest brilliance that it has on a few occasions shown itself capable of attaining. Ordinarily it begins to fade after reaching the fourth or fifth magnitude. The period averages about three hundred and thirty-one days, but is irregularly variable to the extent of twenty-five days. Its color is red, and its spectrum shows bright lines, which it is believed disappear when the star sinks to a minimum. Among the various theories proposed to account for such changes as these the most probable appears to be that which ascribes them to some cause analogous to that operating in the production of sun spots. The outburst of light, however, as pointed out by Scheiner, should be regarded as corresponding to the maximum and not the minimum stage of sun spot activity. According to this view, the star is to be regarded as possessing an extensive atmosphere of hydrogen, which, during the maximum, is upheaved into enormous prominences, and the brilliance of the light from these prominences suffices to swamp the photospheric light, so that in the spectrum the hydrogen lines appear bright instead of dark.

It is not possible to suppose that Mira can be the center of a system of habitable planets, no matter what we may think of the more constant stars in that regard, because its radiation manifestly increases more than six hundred fold, and then falls off again to an equal extent once in every ten or eleven months. I have met people who can not believe that the Almighty would make a sun and then allow its energies "to go to waste," by not supplying it with a family of worlds. But I imagine that if they had to live within the precincts of Mira Ceti they would cry out for exemption from their own law of stellar usefulness.

The most beautiful double star in Cetus is γ, magnitudes third and seventh, distance 3″, p. 288°; hues, straw-color and blue. The leading star α, of magnitude two and a half, has a distant blue companion three magnitudes fainter, and between them are two minute stars, the southernmost of which is a double, magnitudes both eleven, distance 10″, p. 225°.

The variable S ranges between magnitudes seven and twelve in a somewhat irregular period of about eleven months, while R ranges between the seventh and the thirteenth magnitudes in a period of one hundred and sixty-seven days.

The constellation Eridanus, represented in map No. 21, contains a few fine double stars, one of the most interesting of which is 12, a rather close binary. The magnitudes are fourth and eighth, distance 2″, p. 327°. We shall take the five-inch for this, and a steady atmosphere and sharp seeing will be necessary on account of the wide difference in the brightness of the component stars. Amateurs frequently fail to make due allowance for the effect of such difference. When the limit of separating power for a telescope of a particular aperture is set at 1″ or 2″, as the case may be, it is assumed that the stars composing the doubles on



Map No. 21.

which the test is made shall be of nearly the same magnitude, or at least that they shall not differ by more than one or two magnitudes at the most. The stray light surrounding a comparatively bright star tends to conceal a faint companion, although the telescope may perfectly separate them so far as the stellar disks are concerned. Then, too, I have observed in my own experience that a very faint and close double is more difficult than a brighter pair not more widely separated, usually on account of the defect of light, and this is true even when the components of the faint double are of equal magnitude.

Σ 470, otherwise known as 32 Eridani, is a superb object on account of the colors of its components, the larger star being a rich topaz and the smaller an ultramarine; while the difference in magnitude is not as great as in many of the colored doubles. The magnitudes are fifth and seventh, distance 6·7″, p. 348°. The star γ, of magnitude two and a half, has a tenth-magnitude companion, distant 51″, p. 238°. Σ 516, also called 39 Eridani, consists of two stars of magnitudes sixth and ninth, distance 6·4″, p. 150″; colors, yellow and blue. The supposed binary character of this star has not yet been established.

In o^2 we come upon an interesting triple star, two of whose components at any rate we can easily see. The largest component is of the fourth magnitude. At a distance of 82″, p. 105°, we find a tenth-magnitude companion. This companion is itself double, the magnitudes of its components being tenth and eleventh, distance 2·6″, p. 98°. Hall says of these stars that they "form a remarkable system." He has also observed a fourth star of the twelfth magnitude, distant 45″ from the largest star, p. 85°. This is apparently unconnected with the others, although it is only half as distant as the tenth-magnitude component is from the primary. Σ 590 is interesting because of the similarity of its two components in size, both being of about the seventh magnitude, distance 10″, p. 318°.

Finally, we turn to the nebula 826. This is planetary in form and inconspicuous, but Lassell has described it as presenting a most extraordinary appearance with his great reflector—a circular nebula lying upon another fainter and larger nebula of a similar shape, and having a star in its center. Yet it may possibly be an immensely distant star cluster instead of a nebula, since its spectrum does not appear to be gaseous.

Prof. O. C. Marsh regards the discovery of the *Pithecanthropus erectus* in Java as an event equal in interest to that of the Neanderthal skull, and believes that no one can doubt that still other intermediate forms will eventually be brought to light. Nearly twenty years ago he placed on record his belief that such missing links existed, and should be looked for in the caves of the later Tertiary of Africa. The first announcement, however, has come from the East, where large anthropoid apes still survive, and where their ancestors were doubtless entombed under circumstances favorable to early discovery. The tropical regions of both Asia and Africa still offer most inviting fields to ambitious explorers.

ARGON.

THE NEW CONSTITUENT OF THE AIR.

By Dr. JOHN TAPPAN STODDARD,
PROFESSOR OF CHEMISTRY IN SMITH COLLEGE.

On the 31st of January last the Royal Society of England held a special meeting in Burlington Gardens. Formal invitation to this meeting had been extended to the members of two other scientific bodies, and an audience of at least eight hundred, which included the most distinguished scientific men of England, assembled to listen to the account of the discovery of a new substance in our atmosphere. This discovery, made by Lord Rayleigh and Prof. Ramsay, had been announced at the Oxford meeting of the British Association last August; but five months of patient and strenuous work proved necessary before the investigators felt prepared to publish the detailed results of their research.

Our atmosphere consists essentially of a mixture of oxygen and nitrogen. To the oxygen it owes its power of supporting respiration and combustion; while the nitrogen, inert and incapable of chemical union under ordinary conditions, acts as a diluent, tempering the fierceness of the chemical activity which unmixed oxygen possesses. Both of these gases were discovered more than one hundred and twenty years ago; they have long been recognized as elementary substances, and innumerable analyses have established the proportion in which they occur in air.

When a measured quantity of air, carefully freed from the moisture and carbon dioxide which it always contains, is passed through a tube filled with red-hot copper, the oxygen is fixed by the copper, and the residual gas, amounting to four fifths of the original volume, is found to be incapable of supporting combustion. It is, in fact, what all chemists have considered, up to the time of this brilliant discovery, pure nitrogen.

It is now proved beyond all possible doubt or question that this atmospheric nitrogen is not a single substance, but contains, mixed with it to the amount of about one per cent, another heavier gas, whose existence was previously unknown and unsuspected. To this new substance, which out-nitrogens nitrogen in its chemical inertness, its discoverers give the name of *argon*.*

Besides its occurrence in the free state in air, nitrogen is found in combination in animal and vegetable substances, in saltpeter or niter (from which its name is derived), and is a constituent of

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* Argon is derived from alpha privative, and ἔργον, and means not working, idle.

many chemical compounds, from some of which it can readily be prepared. The identification of atmospheric nitrogen with that contained in niter and nitric acid is due to Henry Cavendish, whose exact and skillful work not only established this fact, but led to an observation of great interest in connection with the discovery of argon. In a paper which appeared in 1785 Cavendish says: "As far as experiments hitherto published extend, we scarcely know more of the phlogisticated part of our atmosphere [nitrogen] than that it is not diminished by lime water, caustic alkalies, or nitrous air; that it is unfit to support fire, or maintain life in animals; and that its specific gravity is not much less than that of common air"; and raises the question "whether there are not in reality many different substances compounded by us under the name of phlogisticated air." He then describes an experiment for the purpose of deciding this point. By passage of electric sparks through a mixture of air and oxygen, the nitrogen was converted into a compound absorbed by the dilute alkali over which the gases were confined. The sparking was continued until no further diminution of volume took place, when, on removing the excess of oxygen by absorption in "liver of sulphur," "only a small bubble of air remained unabsorbed." From this he concludes that "if there is any part of the phlogisticated air of our atmosphere which differs from the rest, and can not be reduced to nitrous acid, we may safely conclude that it is not more than a hundred and twentieth part of the whole." Cavendish was apparently satisfied with this as a proof of the simple character of atmospheric nitrogen, and his work has been accepted as conclusive for more than a century; but we now know that this "small bubble of air" which survived his experiment must have been argon.

It seems strange that a substance present in the air all about us, and whose actual quantity is enormous, should have defied detection through so many years of exact and searching chemical work; but the explanation lies largely in the fact that argon forms no compounds, so far as is known, and thus fails to assert itself in the presence of the almost equally indifferent nitrogen with which it is mixed.

Indeed, the hint which led to its discovery was obtained in the course of a purely physical investigation. For some years Lord Rayleigh has been engaged in the exact determination of the densities of some of the more permanent gases. In dealing with nitrogen, it was found that this gas, when prepared from chemical compounds, was about one half per cent lighter than the nitrogen obtained from air. This discrepancy at once suggested contamination with some known impurities. A careful search proved, however, that this was not the case. The possible explanation then occurred, that the lightness of the "chemical" nitrogen was due to a partial dissociation or breaking up of the molecules of the gas into single atoms under the conditions of its preparation. This, too, was negatived by experiment. One or the other of the gases must be a mixture, containing an ingredient much heavier or much lighter than ordinary nitrogen. To suppose a lighter ingredient mixed with the chemical nitrogen required the existence of two kinds of nitric acid, which was out of the question. "The simplest explanation in many respects was to admit the existence of a second ingredient in air from which oxygen, moisture, and carbon dioxide had already been removed."

This explanation was put to the test by an attempt to isolate the suspected gas, with the result that by two entirely distinct methods a new substance was obtained from air.

One of these methods was that of Cavendish, already described. Air confined over dilute alkali is subjected to the action of electric sparks, while oxygen is added from time to time until, with an excess of oxygen present, no further absorption occurs. The oxygen is then removed by alkaline pyrogallate, and argon is left.

The second method for the separation of argon is based on the fact that red-hot magnesium unites with nitrogen, forming a non-volatile compound. Air from which moisture and carbon dioxide have been removed is freed from oxygen by passing it over heated copper, and then from nitrogen by means of magnesium turnings at a red heat. The removal of the last portions of nitrogen is a tedious operation, requiring some two days. The residual gas is pure argon.

The gas obtained by both of these methods is the same, and its behavior proves conclusively that it is a new substance. Prof. Crookes finds that it gives two spectra, according to the strength of the induction current, one characterized by red and the other by blue lines; and testifies that he has "found no other spectrum-giving gas or vapor which yields spectra at all like those of argon"; and that "as far, therefore, as spectrum work can decide, the verdict must, I think, be that Lord Rayleigh and Prof. Ramsay have added one, if not two, members to the family of elementary bodies."

The behavior of argon at low temperatures and under high pressures has been examined by Prof. Olszewski, of Cracow, who is well known for his researches on the liquefaction of air and other gases. Its critical temperature—that is, the temperature at which its liquefaction under pressure first becomes possible—is $-121°$ C., and at that point it is condensed to a liquid by a pressure of 50·6 atmospheres. Liquid argon becomes an icelike solid at a still lower temperature, melts at $-189·6°$, and boils under ordinary pressure at $-187°$. Its critical and boiling points lie between those of oxygen and nitrogen, nitrogen having the lowest of the three.

Argon is four tenths heavier than nitrogen, and much more soluble in water. As already stated, and as is evident from the methods employed for its preparation, argon is more inert than nitrogen; so great is its chemical indifference, that all attempts to bring about reactions with even the most active substances at high temperatures have thus far proved abortive. It is unaffected by phosphorus or sulphur at red heat; sodium and potassium may be distilled in it without loss of their metallic luster; it is unaltered by fused and red-hot caustic soda or niter; aqua regia and other wet oxidizing and chlorinating agents are entirely without action; and it resists the attack of nascent silicon and boron.

Though thus unique in its chemical inactivity, it would be premature to conclude that argon may not form compounds under conditions yet untried,* and that it is an absolutely "idle" and useless thing. Prof. Roberts-Austen suggests that it may possibly play a part in certain metallurgical operations in which air is largely employed. In making Bessemer steel, for instance, not less than one hundred thousand cubic feet of air are blown through each charge of metal for the purpose of removing the carbon, silicon, phosphorus, and other impurities. In this air there must be over one thousand cubic feet of argon. Now, Prof. Roberts-Austen has found by experiment that the nitrogen which can be pumped out of Bessemer-blown metal, and which is twice the volume of the metal, contains little or no argon; and the question arises, whether the argon may not have united with the iron, as nitrogen undoubtedly does, and confer upon Bessemer steel some of the peculiarities which distinguish it from other steel. It is, of course, possible and perhaps more likely that the argon passes through the molten metal without combining with it; but the suggestion is an interesting one, and well worth experimental examination.

Further, it may prove that argon is in some way taken up by plants, and contributes in an important manner to their nourishment and growth; although the attempts to extract argon from vegetable and animal substances have thus far yielded only negative results. As is well known, plants are unable to take nitrogen directly from the air, but obtain it from nitrogenous compounds which are absorbed in solution by their roots. The air is, however, the original source of these compounds, as well as of all

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* Berthelot announces that he has succeeded in causing argon to react with certain organic compounds, especially with the vapor of benzene, by means of the silent electric discharge.

other naturally occurring nitrogenous substances, most of which are produced by the life-activity of micro-organisms; and from the natural substances all chemical compounds containing nitrogen are prepared. Considering, therefore, the identity of the source, it seems improbable that the nitrogen of plants or animals should contain argon, while that of inorganic chemical compounds is without it. It is, however, possible that argon may enter the plant in a manner quite different from nitrogen; for it does not follow that, because it is associated with nitrogen in the air, argon must always play the part of an inseparable companion.

Is argon an element, a mixture of elements, or a compound? While the evidence that it is a new substance is indisputable, the facts thus far obtained do not warrant a final decision in regard to its simplicity. There is no reason, however, to believe that it is a compound, but, on the contrary, there is a piece of most conclusive evidence against this view. This evidence is the ratio of its specific heats at constant pressure and at constant volume. This has been carefully determined, and is found to be in exact agreement with the value required by the mechanical theory of heat for a monatomic gas—that is, a gas whose molecules consist of a single atom each. Such a state of things is obviously impossible for a compound, which must have two atoms, at least, in every molecule. It is also unusual in elementary gases, whose molecules are in most cases diatomic, or of two atoms each. Argon is therefore either an element or a mixture of elements having structureless molecules. This evidence throws out of court also the view, which has been repeatedly urged since the first announcement of the discovery, that argon is an allotropic form of nitrogen, consisting of triatomic nitrogen, and analogous to ozone, which is triatomic oxygen.

As to the question whether it is a single element or a mixture, the argument for the mixture is based on the fact that it gives two spectra. Though suggestive, this can not be looked on as conclusive, for certain well-known elements—hydrogen and nitrogen—show the same peculiarity. On the other hand, a definite melting point, a definite boiling point, a definite critical temperature and pressure, all of which argon possesses, are generally accepted criteria of a pure substance. The evidence, therefore, is largely in favor of the simple elementary character of argon.

If subsequent investigation confirms this view, and argon proves to be a single monatomic element, a question of great interest is raised. For many years an accepted law of chemistry has been expressed in the so-called periodic classification of the elements. When the elements are arranged in the order of their atomic weights, the series may be broken into a number of well-defined periods, whose members show marked analogies to the corresponding members of the other periods, and a regular gradation of properties among themselves; or, in other words, "the properties of the elements and of their compounds are a periodic function of their atomic weights." The exigencies of classification, so that the elements of different periods may fall into their proper places in the tabulated scheme, have left many gaps in the table, which may represent elements yet awaiting discovery. In fact, three such elements have been discovered since the first formulation of the periodic law by Mendeleeff, and found to agree very exactly with the prediction made several years previously by Mendeleeff for the properties of elements which might be expected to fill certain gaps.

Now argon, if it is a monatomic element, must have an atomic weight of about forty. There is, however, not only no vacant place in the table for an element of this atomic weight, but the properties of the elements occupying this region are wholly unlike those of argon. Thus for the first time in its history the periodic law would fail in its hitherto triumphant provision for the results of discovery.

A law which expresses so much undoubted truth, and which has proved of such great service in the past, is not, however, to be at once discredited because it seems not to provide for this case. So great is the confidence felt in it, that many chemists consider its apparent failure in this case a conclusive argument against the monatomic character of argon. It must be remembered, however, that the evidence for monatomicity is founded on a deduction from the thoroughly established mechanical theory of heat; while the periodic law is, after all, as Prof. Rücker says, "an empirical law, which rests on no dynamical foundation," for which no adequate theory has yet been found. More evidence is needed in the case, and more will probably soon be forthcoming. Meantime the present situation will strengthen the feeling, by no means new, that, while the periodic law is a grand generalization containing much that is true, it is certainly not a complete or final expression of the relations which exist between the properties of the elements and their atomic weights, but rather a first approximation to the law which may ultimately be formulated.

Whatever the outcome of these speculative issues, there can be but one opinion in regard to the discovery itself. From every point of view it is a masterly achievement. The elements of recent discovery have all been metals which occur in minute quantities in rare minerals. No nonmetallic element has been discovered for nearly seventy years, and the existence of another element belonging to this group did not seem probable; still less likely did it appear that such an element could be present in our atmosphere.

The discovery has well been called "the triumph of the last place of decimals"—that is, of work so exact that the worker knew that the small differences in the figures he obtained must be due to the presence of an unknown substance rather than to an error in his results. The prediction based on this observation, the search for the disturbing substance, and its discovery, form an achievement which, in the history of science, has perhaps only been surpassed by the prediction of Neptune by Adams and Leverrier, and its subsequent discovery by Galle.

THE NERVOUS SYSTEM, AND ITS RELATION TO EDUCATION.

By JOHN FERGUSON, M. A., M. D., Ph. D.,
TORONTO.

JOHN LOCKE, the physician and philosopher, long ago said that all our knowledge came from experience. Throughout his Treatise on the Human Understanding he develops this view of the acquisition of knowledge. This was followed by the writings of David Hume, the Scottish historian and metaphysician, who held that we knew nothing of objects in themselves, but only through their qualities; or, in other words, that we know of nothing but ideas. This was in turn followed by Immanuel Kant's Critique of Pure Reason, who took the ground that, though all our knowledge did not come from experience (as taught by Locke), yet it all came by experience. He held firmly to the ground that we had intuitions, or an *a priori* knowledge. It was this intuitive power that enabled us, by experience, *a posteriori*, to acquire knowledge of the qualities and of the forms of matter. Later came those who, like Ribot, Spencer, Romanes, have taught that there is no science of mind apart from the operations of the nervous system; that the operations of the brain constitute what is known as mental processes. Differing from these, the late T. H. Green held, as did Kant, that there is a science of ethics and psychology, independently of the study of physiology.

Fortunately for the purposes of this article, it will not be necessary to review the opinions of the above writers; it will not be necessary to prove which of the many views is correct. This much is definitely known: that certain physiological laws govern the human body, so as to determine what we know and how we came to know it. The intuitions of Kant, the common sense of Locke and Reid, the skepticism of Hume on knowledge, the idealism of Berkeley, need not detain us, as they have no special interest for the present. The object before us is to show that we come by our knowledge through experience, and in what manner experience acts upon our nervous system.

It is, therefore, the nervous system which we have to do with in every system of education. It will go with the saying that the better the condition of health in the nervous system, the better will it be for the plans of education. One of the fundamental laws that must govern all methods of education is the care of the health of those who are being taught. A normal condition of the conducting nerves and perceptive centers is necessary to a normal type of the perceptions gained by experience. In all schools and colleges sanitary principles ought to have the most thorough consideration. Impure air, either from bad ventilation or drainage, may do more harm to a number of children than the most eminent teacher can do good. If the brain is not well supplied with an abundance of nourishing and pure blood, its functions can not be well performed. It is a poor waste of time to teach a child, unless what is taught is imparted under such circumstances as to be remembered; and how can impressions made upon the brain become fixed and retained unless it is in a fit condition of health, activity, nutrition, and rest? *Mens sana in corpore sano* is now and always will be true.

Granting that the school or college is in a sanitary condition, and that there is a proper mixture of recreation in the hours of study, the individual characteristics of each pupil deserve to be taken into account. No teacher does his duty who does not make each pupil placed under his charge a careful character study. It is true this takes much time and requires much judgment; but it is far more than repaid by the greater progress that can afterward be made by the teacher with such a pupil. Some children who may be naturally truthful are, nevertheless, extremely sensitive to pain, and as a consequence will lie to escape punishment. Others, again, are instinctively prevaricators; while some are so constituted as to have no fear of corporal punishment. The hope of reward will stimulate one child to diligence; but no such result is produced in a second. One will study from a love of the work; whereas another looks upon all study as a useless waste of time, and a weary drudgery. Individualism should therefore play an important rôle in the management of every school. The teacher must ever fall far short of true success who does not or who can not become familiar with the many differences thus to be found in the mental and ethical qualities of his class.

Prenatal and postnatal influences may have seriously impaired the child's health, and especially that of its nervous system. Nature has done much to protect her works from the destructive and injurious effects of their environments. But, in spite of this, the conditions of life and development may have been so bad that the child is started on its journey with an organism full of twists and irregularities. Mirabeau was once asked when he would commence the education of a child. "Twenty years before it is born" was the philosophic answer. The prenatal influences of heredity can not be overestimated. An unhealthy, depraved, immoral, and vicious parentage tells its sad tale through the offspring. Tennyson is as correct to science as he was poetical when he said:

> "'Tis the blot upon the brain
> That will show itself without."

It matters nothing whether the views of Darwin shall stand the test of future investigation, that acquired characteristics can be inherited; or the views of Weissman, that they can not. The fact remains that a weak and diseased nervous organism is much more liable to take on a perverted growth and development than one that is ushered into the world free from such blemishes. One of the prime objects in every system of education ought therefore to be the studious care given to the health of the scholars, so as to avoid damaging those who are as yet sound, and in order to remove as far as possible the blots that have already been made upon the nervous mechanism of others, and that must show themselves without.

"*Nihil est in intellectu quod non prius fuerit in sensu* (There is nothing in the intellect that has not first come through the senses)." Philosophy and experience alike confirm the truth of the above. When the child is born, its mind is like a sheet of white paper, as Locke expresses it; but soon there begin to be impressions made upon it, as characters may be inscribed upon the paper. It is now some two hundred and seventy-five years since Comenius recognized that children gain their knowledge through the senses, and that these should be properly educated on suitable objects. He strongly urged that matter, and not form, should be presented to children. We should "cease to persuade, and begin to demonstrate; cease to dispute, and begin to look." An old Latin writer puts it thus: "*Iter longum est per precepta; breve et efficax per exempla* (The way is long by precept; short and effective by example)."

With Kant and Green I agree that there are certain *a priori* intuitions, such as those of time and space. But I also agree with Kant, Locke, Reid, Spencer, and others, that our knowledge comes through experience. It is of the utmost importance that the experiences to which a child is subjected should be of a proper kind; that they should be of such a kind as to develop the mind in wise directions, and store it with ideas of a useful and ennobling nature. The teachers under whom a child is placed, the company it is allowed to keep, the books it is permitted to read, should be the subject of the greatest care. John Stuart Blackie once said that the most inspiring thing for a young man was to be placed in the company of great and good men; and next to being in their company was to read their books and to read about them.

But while it is of the greatest importance that the experiences to which the child is exposed are of the best possible character, it is no less important that the nervous system and the sense organs of the child be in a sound and normal condition. The state, through the public-school system, is supplying buildings and teachers at great expense. All this outlay is for the purpose of imparting learning to the rising generation. Is it not right and proper that the state should see that the children upon whom this enormous sum of money is being spent are in a fit condition to receive the education that is offered? One would hardly think of any government spending millions upon an army, and making no selection of the men who were to form this army. Further, when the authorities had selected the men for the army, they would surely see that the benefits of training and drill would not be destroyed by dissipation and irregular habits among the soldiery.

Thus I think it is clearly the duty of the state to exercise its authority in the suppression of injurious books, papers, and advertisements. It is high time that stringent steps were taken in this direction. It does seem strange that large sums are paid annually to furnish children with good reason and morals, and at the same time numerous presses are turning out tons of reading matter of the most degrading and perverting nature. There is still another reform that could be well introduced. A proper medical inspector should be appointed to examine schools and determine their sanitary condition. All matters of drainage, heating, lighting, and ventilation would be subjects for his consideration. It is hardly to be expected that the nervous system and special senses of the pupils will be healthy if these children are pent up for a good portion of the day in an unhealthy schoolroom. Further, it ought to be the duty of this medical inspector to give the pupils of each school under his control regular instruction on hygiene, and especially on the hygiene of study and the care of the sense organs. A teacher may be a very intelligent person, yet the ordinary reading he may have bestowed upon these topics would not enable him to do them the same justice that a well-educated and experienced medical practitioner could. Cases of melancholia, hysteria, chorea, epilepsy, defects of vision, and such like, would be sent home by him for proper rest and treatment.

Children learn best what they like best. Pleasure in their studies is an all-important factor. I remember once reading in an old book a conversation that took place between Sir Walter Scott and the driver of a stagecoach. Scott was sitting on the seat along with the driver. The conversation turned upon a group of children coming out of an old-fashioned schoolhouse. The driver remarked that the teacher had great influence with his classes, and that his pupils made much progress in learning. Whereupon Scott inquired after the reason for such a happy state of affairs. He was informed by the stage man that the teacher worked on the lines of the old proverb that, "to be successful with children, you must allure the ear, inform the mind, and then impress the heart." This teacher was wise in his day. He sought to win the affections of the child. He established a confidence between himself and his pupil—in other words, he tried to make things agreeable. This accomplished, he commenced to fill the pupils' minds with new thoughts and new relations. The world of ideas was opened up to the child, which was made to see, feel, hear, and remember as it had never done before. On this an ethic or moral system was planted. The late George Paxton Young, Professor of Moral Philosophy in the University of Toronto, often repeated in my hearing that, when he was a boy, he would have been punished for using a translation in the study of a Greek or Latin author. Now, however, if he had had his way, he would punish a student who would not make use of such an aid to promote his advancement and increase his pleasure in the study of the classics. "Pleasure and pain," said Locke, "are the hinges on which all our passions turn." The school life of the child ought to be so managed that its search after knowledge would be one continuous pursuit of pleasure.

Then, again, while it is necessary to present objects to the various senses in order that an acquaintanceship with them may be formed, it is equally necessary that these objects be properly selected and graded according to the age and understanding of the learner. When a pupil is not learning, it is not the fault of the child so much as it is of the teacher. Things have not been presented to the child in proper order or of suitable kind. It is quite true the child may be dull. Its mental development may be a long way behind that of another child of the same age; but this is not the fault of the child. It is the duty of the teacher to take things as he finds them, and to grade his teaching to meet the capacities of the pupil. The age of the pupil does not enable one to decide what may be the degree of perceptive power. This must be tested. It is an utter waste of time to present to a child too complex thoughts or ideas; it must be conducted from the simple to the complex. A child is often found fault with for not giving attention to study. The truth is that things have not been presented to it in such a manner as to interest it. In all cases where the matter is brought under the child's notice in such a way that it clearly understands it, there will not likely be much ground for complaint on the score of lack of interest. But a still further reason for lack of interest in study is that too often the teaching seems to the child to have no connection whatever with its outside life. Children soon learn to make inductions from their experience. If they can see no connection between what they are being taught and their experiences in life, there will certainly be a want of interest in their studies. It is a matter for congratulation that so much has been done in this direction. The natural method of teaching has made great progress, but much remains yet to be done. The most primitive schoolhouse in the land affords abundant facilities for the education of the child's senses, and, through them, its powers of observation. It is all contained in the simple question, Does the teacher understand the rational method of appealing to the child's intellect through its senses?

The teacher ought to be a close student of Nature. There is placed under his control a large number of young persons of the most varied possibilities. In the schoolroom we have a collection of members of the highest order of animal life. Every member of the class should be made to realize that there is the possibility of a great future in store for him. The imagination and ambition should be enlarged in wise directions. It is quite true these ambitions may never be realized; but the mental stimulus they give the growing youth is of a most valuable character. A high code of ethics should be found in every school; but this must have its fountain head with the teacher. I am not confounding ethics with religion. There was a high ideal of ethics in Plato and Aristides, though pagans; there was a high code of ethics revealed in the life of Darwin, though an agnostic; and there was a high code of ethics running through the life and writings of F. D. Maurice, who was a beautiful type of Christian character. Schiller, the German poet, has truly said: "It is an admirable proof of infinite wisdom that what is noble and benevolent beautifies the human countenance; what is base and hateful imprints upon it a revolting expression." Through the child's senses, feelings, and affections you must reach its soul, whatever this may be regarded to mean by different schools of thought, avoid inflicting scars upon it, and endeavor to erase those that may unfortunately have been made by former bad environments. Such a work as Mantegazza's Expression and Physiognomy should be in the hands of every teacher.

But the teacher must carry his studies in this direction further than that of mere expression and physiognomy. He ought to be a careful student of physiology and the laws of health. A thorough knowledge of the scientific principles of healthy exercise and study enhances a teacher's usefulness. If the adage "knowledge is power" be true anywhere, surely it is true here. Possessed of a knowledge of the anatomy and physiology of the nervous system—a task which any intelligent teacher could master in a few months—he can deal with the whole question of the education of his class under a new and clearer light. Much that was a mystery to him regarding the acquisition of knowledge will become plain. The complex memory of a flower will be resolved into the memories of its several qualities, that were carried to the brain by conducting nerves. The association of ideas and the laws governing the same will be as simple as a lesson in elementary botany. The smelling of a rose reviving the memory of its color will cease to be an enigma. It will then become clear how a person may lose the power of speech and still be able to write and read; or how he may be able to read and write, although unable to hear spoken words; or, again, how he may have lost the power of hearing spoken words, and yet be able to speak, read, and write.

If any one should say that such a knowledge of the physiology of the nervous system in its relation to the acquisition of learning is of no use to the teacher, then I would reply that it is not necessary for the engineer to understand the engine he is running, the mariner the course he is sailing over, nor the farmer the nature of the soil he is tilling. The teacher has a number of young human beings placed under his charge. He is guiding them into the wide ocean of truth and thought. He is laying the foundations on which the future structure of their intellectual and moral natures are largely to be built. He is working with one of the grandest mechanisms known to man—the brain of the child! He ought therefore to know not only what he has to teach, but the subject that has to be taught and the best methods of teaching it. It can not be too strongly urged that if there be any derangement or want of harmony in these factors much of the good that might follow is lost. In order that the relationships between the nervous system and education be properly maintained the teacher must be thoroughly familiar with all three great divisions of his work—the things to be taught, the methods of teaching them, and the brain and sense organs that are to be developed. When the teacher has made himself master of the channels through which the child must acquire its knowledge it becomes an easier and a far more interesting work for him to select topics within the range of the child's understanding and experience. If he is a wise teacher he can build up the child's powers of observation for natural phenomena by leading from simple experiences to those that are more complex. But the great beauty of such teaching is that the child itself feels an interest in its work. It is learning as a pleasure and not as a drudgery.

People in general know what is meant by a natural or rational method of doing a certain task or carrying on to completion a given work. It is astonishing that the very opposite of a natural system should have prevailed so long in the important matter of the education of children throughout the schools of all countries. There have not been wanting some who, at different periods, have called attention to the wrong methods in vogue; but until recent years no very decided advance has been made. Too much importance can not be attached to the fact that in all well-regulated schools such subjects as botany, chemistry, and zoölogy should be taught by means of the objects under study. How much more natural it is to take a rose flower and carefully explain all its parts by pulling it to pieces than to attempt to give a class of young children a knowledge of the same flower by talking about it, without the object being in the hands of the teacher and class! By means of the objects the analogies and differences between the root, stem, and branch, or between the leaf, flower, and seed, can be shown and demonstrated to the class. Lessons conducted properly in this manner become a delight to children, and they come to regard their teacher as a true friend.

Let us examine how we come by a general idea, concept, or notion. Here we must call in the aid of language in naming abstractions. Under this there are ideas of complex character that exist in the mind without the need of language. Still more fundamental than these are simple conceptions carried to the perceptive centers by the ingoing nerve currents. Take the example of an ordinary cube. The child looks at it, and there is a visual impression formed of its color, of the length of each side, of the area of a surface, of the combination of the surfaces so as to give rise to the idea of solidity. The simple ideas are combined into the more complex idea—the visual one of a cube. But by the aid of touch other qualities can be ascertained. The hardness, weight, sharpness of edges and angles, smoothness or roughness of surfaces, form the tactual idea of a cube. But the visual and tactual ideas are still further combined into a general idea or concept to which the name cube is given. In this general idea or concept other qualities may enter, as, for example, the taste of the cube, if it is a sapient object. When the word cube is spoken, it recalls some, or all, of these qualities, according to the knowledge and observation of the person to whom the word is addressed. In the case of a child, the word cube may convey no definite recollection of the object mentioned. The child may not have been taught to observe the surfaces, edges, angles, etc., of a cube. The word will, therefore, recall only so many memory pictures of the cube as the child has acquired. But point out some new quality in the cube, and a new memory picture of the cube is formed in the child's mind. When in future the word cube is spoken the child will have a more complete memory of it—in other words, a more complete knowledge of it. The process can be continued until all the qualities of the cube are known to the child, and form parts of its concept or notion of the cube. This notion, or memory, is represented in language by the word cube. The simple ideas or conceptions of its color, shape, weight, hardness, go to form the general idea.

Now, grant that the teacher understands how the visual impressions are carried by the eye to a certain center in the brain; how the tactual are carried by conducting nerves to another center; and how the impression of the spoken word is carried by the ear to still another center. Further, he is supposed to know how these centers are connected with each other, so that hearing the word cube spoken recalls the memories of its shape, surfaces, angles and edges.

Armed with such a knowledge of the mechanism of the nervous system as the basis of thought, the teacher has a magic wand in his possession by means of which he can stimulate his pupils, and make what would otherwise be dreary enough work more interesting than a high-class novel or the story of an exciting adventure. There will then exist in the teacher's mind a reason for the natural method of teaching by appealing to the child's experience of things, and for showing it the object about which a certain lesson is to take place. The *Ding an sich* of Kant becomes known inductively, as Spencer and Romanes have shown, through an experience with its qualities. This sort of knowledge does not lead to either the idealism of Berkeley nor the skepticism of Hume, but to a true, scientific psychology as expounded by Wundt and Ribot.

In the past, and indeed at present, far too much time has been spent in instructing the child by telling it certain facts, and not enough time in teaching the child how to observe for itself. We can not see through other people's eyes, nor is their reasoning our reasoning. The power to repeat certain formulæ or to give answers to certain questions does not indicate knowledge on the part of the child. The great object of education is to make the individual capable of solving his own problems, of doing his own reasoning, of looking after his own affairs, of performing his duties as a citizen, of improving himself socially and morally, and of earning an honest living.

Thus it becomes clear that our knowledge is an aggregation of sensuous impressions. These senses must be made the special object of study and care on the part of the teacher. His great duty is, not so much to tell his pupils what to do or how things happen, as to instruct them how to find out for themselves. There are a number of avenues through which he can reach the child's internal mind. These avenues must be made use of, and the child must be taught how to use them for its own advancement. The ears can be educated, but only practically, to recognize what is meant by pitch, volume, quality, loudness, intensity, harmony, etc., in musical notes. Only by practice can the child be brought to recognize the many shades of color, the divergence of angles, the approximate lengths of objects, or the rapidity of motion in a passing object. The method of Zadig could be made use of in endless variety. A horse's footprints are seen in the sand. The child could be tested on its powers of observation as to whether the horse had been walking, trotting, or galloping; whether he was a large animal or not; whether shod or not, and if the shoes were new; or whether the horse was lame, as might be indicated by one of the footprints. In like manner the tactile and muscular senses may be developed and rendered extremely acute in their power of fine distinctions as to quality, weight, firmness, shape, composition, and such like of the objects that are made the subjects of study. See, for example, what a blind person can do, guided by the sense of touch and the muscular sense.

What has been said by no means exhausts the important relationships of the nervous system to the many problems of education. It is now time that a knowledge of physiological psychology should form a part of the qualifications of every person who becomes a public teacher. It is to be feared that there are many teachers at the present moment who know literally nothing of the wonderful organisms under their charge. We do not so act in business affairs. We do not permit a man to take charge of a locomotive until he has acquired a knowledge of the engine. But we allow men to become the educational engineers of our children without exacting from them the slightest knowledge of the beings they are going to take charge of. I need not state the case more strongly than that this should cease.

One word more. The time has come when strong opinions ought to be expressed against the too prevalent custom of crowding the child with studies and cramming its mind with disconnected facts. Away with the idea that such is education! It is not. Such a system is only a means of injuring the child's health and interfering with its proper mental development. The child's brain and nervous system must be developed along judicious lines, and through this development the mind is enlarged. Nothing is education that does not foster and bring about this result. I can not do better than end this article by quoting the resolution passed at the recent meeting of the Canada Medical Association: "That the system of education in force in the Dominion draws too largely upon the brain tissue of children and materially injures their mental and bodily health."

TO BÁRBARA.

(A Study in Heredity.)

By DAVID STARR JORDAN.

LITTLE lady, cease your play
For a moment, if you may;
Come to me, and tell me true
Whence those black eyes came to you.

Father's eyes are granite gray,
And your mother's, Bárbara,
Black as the obsidian stone,
With a luster all their own.
How should one so small as you
Learn to choose between the two?

If through father's eyes you look,
Nature seems an open book—
All her secrets written clear
On her pages round you, dear.
Better yet than this may be
If through mother's eyes you see;
Theirs to read—a finer art—
Deep down in the human heart.
How should one so small as you
Choose so well between the two?

Hide your face behind your fan,
Little black-eyed Puritan;
Peer across its edge at me
In demurest coquetry,
Like some Doña Plácida,
Not the Puritan you are.

Subtle sorcery there lies
In the glances of your eyes,
Calling forth, from out the vast
Vaults of the forgotten past,
Pictures dim and far away
From the full life of to-day,
Like the figures that we see
Wrought in ancient tapestry.

This the vision comes to me:
Sheer rock rising from the sea,
Wind-riven, harsh, and vertical,
To a gray old castle wall;
Waving palms upon its height,
At its feet the breakers white,
Chasing o'er an emerald bay,
Like a flock of swans that play;
Tile-roofed houses of the town,
From the hills, slow-creeping down;
Rocks and palms and castle wall,
Emerald seas that rise and fall,
Golden haze and glittering blue—
What is all of this to you?

Only this, perchance it be,
Each has left its trace in thee;
Only this, that Love is strong,
And the arm of Fate is long.

Deeply hidden in your eyes,
Undeciphered histories,
Graven in the ages vast,
Lie there to be read at last:
Graven deep, they must be true;
Shall I read them unto you?

Once a man, now faint and dim
With the centuries over him,
Wandered from an ancient town,
On its hills slow-creeping down,
O'er the ocean, bold and free,
Roved in careless errantry.
With Vizcaino had he fared,
And his strange adventures dared;
Restless ever, drifting on,
Far as foot of man had gone;

On his cheek the salt that clings
To the Headland of the Kings,
Flung from the enchanted sea
Of Saint Francis Assisi!
Rover o'er the ocean blue—
What has he to do with you?

Only this: he sailed one day
To your Massachusetts Bay,
And this voyage was his last,
For Love seized and held him fast.
Of that old romance of his
None can tell you more than this:
Saving that, as legacies
To his child, he left his eyes,
Black as the obsidian stone,
With a luster all their own,
Seeing as by magic ken
Deep into the hearts of men.
And mid tides of changing years,
Dreams and hopes and cares and fears,
Life that flows and ebbs alway,
Love has kept them loyally.

Once, it chanced, they came to shine,
Straight into this heart of mine.

Little lady, cease your play
For a moment, if you may;
All I ask is, silently,
Turn your mother's eyes on me!

Consulado Inglés, Calle de las Olas Altas, Mazatlan, Sinaloa,
January 10, 1895.

According to Captain Younghusband, lately assistant English resident at Chitral, a mountain district of India which has just been attracting considerable attention, the principal evil in the mountains outside of his station is the want of desire for money. The mountaineers, secluded from mankind amid their hills, have never used any money, and consequently have no idea of the value of coins. They took the rupees to be ornaments, and were greatly aggrieved when after carrying loads up the hills they were paid only in little bits of silver. But the government wanted work done, and, not being willing to force labor, had to train the people to the use of money, so they brought peddlers up from the plains. Then, when the people found they could get the goods they wanted with their rupees, they were willing to take them.

THE WORK OF IDEAS IN HUMAN EVOLUTION.

By GUSTAVE LE BON.

THE study of the different civilizations that have succeeded one another since the origin of the world proves that they have always been guided in their development by a very small number of fundamental ideas. If the history of peoples should be reduced to the story of their ideas, it would not be very long. We have shown in a previous essay that the evolution of a people is chiefly derived from its mental constitution. We found then that while the hereditary sentiments, the aggregation of which constitutes character, have great fixedness, they can nevertheless be transformed slowly under the influence of various factors. Among the most operative of these factors are ideas. But, for ideas to have influence, they must have progressively come down from the mobile regions of the conscious into the stable and unconscious regions of the feelings, where our thoughts and the motives of our actions are elaborated. They then form as it were a part of the character and act effectively on the conduct. When ideas have undergone this modification, and are fixed in the unconscious, their power over the mind is absolute. They cease then to be influenced by the reason. The convert who is dominated by a religious idea or by any belief is inaccessible to all arguments, however intelligent we may suppose him to be.

Governing ideas, formed as we have described, become established and disestablished very slowly. If it were otherwise, civilizations would have no stability. But if ideas, once established, could not be gradually transformed, and finally disappear, peoples would achieve no progress. In consequence of the slowness of our mental transformations, many human ages are required for the triumph of a new idea, and several ages more for its elimination. The most civilized peoples are those whose directing ideas have been maintained at an even distance from variability and fixity. History is strewn with the wrecks of those who have not been able to maintain this equilibrium.

The reader of history is struck with the paucity of the ideas of peoples, the slowness with which they are modified, and the power they exercise. Civilizations are the resultants of certain ideas, and when these ideas are changed, the civilization is inevitably transformed with them. The middle ages lived on two fundamental ideas—the religious and the feudal. From them issued all the arts of the period, its literature, and its whole conception of life. At the Renascence these ideas underwent a slight modification: an ideal recovered from the ancient Greek and Latin world imposed itself on Europe, and transformation of the conception of life, of the arts, philosophy, and literature at once set in. The authority of tradition was shaken, scientific truths began gradually to take the place of revealed truths, and civilization entered upon a new phase. To-day the old religious ideas have lost the greater part of their empire, and for that reason alone all the social institutions that rested upon them are threatened with dissolution.

Regarding ideas according to the importance of their working rather than to their worth, we may divide them into two classes. First are the great general directing and permanent ideas on which an entire civilization rests—the feudal and religious ideas of the middle ages, for example, and certain political conceptions of modern times; and, secondly, transient and changing ideas derived, to a certain extent perhaps, from the general ideas which arise and pass away in every age. Among these are the theories which guide art and literature at certain periods, such as those which have produced romanticism, naturalism, mysticism, etc. They are usually as superficial as the fashion, and change like it. They may be compared to the minor waves that are continually rising and vanishing on the surface of a river, while the fundamental ideas may be compared to the deep current that bears away the waters of the same river. Of the various transient ideas that arise in the course of ages, a few become in time fundamental directing ideas, but this is the result of rare combinations of special conditions.

It is as impossible to name the real creator of a great idea as to point out the author of a great invention. When an idea reaches the light and becomes capable of exercising influence, it is, like one of the great inventions, the sum of numerous anterior minor ideas. It has been subjected to long elaboration and numerous transformations. The originators of the idea are therefore far anterior to its propagators. The brains which conceived it live in regions inaccessible to the multitude. The results of their thought may exercise a considerable influence in the world, but they will not see it. If they were privileged to witness its development, they would not be likely to recognize the fruit of their meditations. From the intellectual heights whence the idea usually is derived, it comes down step by step, undergoing continual changes and modifications, till it takes on a shape accessible to the popular mind, when its triumph is assured. It then presents itself concentrated into a very small number of words, perhaps into only one, but that word evokes striking images, and consequently always impressive, whether they be seductive or terrible. Such were paradise and hell in the middle ages, short words that have the power of answering for everything, and to simple minds explaining everything. The word socialism represents to the modern workman one of these magical and synthetic formulas capable of ruling the mind.

We may discuss the value of an idea from a philosophical point of view; but from the point of view of its influence such discussion is without interest. The thing to be determined is not its value, but the action it exerts upon minds. In scientific affairs, the idea may have in itself a value independent of the time when it originated, and may preserve it beyond that time. In questions of institutions, creeds, morals, and government, the idea never having any but a relative value, its success depends primarily on the enthusiasm it inspires, and secondarily on the race and epoch in which it originated. Christianity could never have propagated itself till a particular epoch and among particular peoples. When the idea represented by the word Cæsarism dawned upon the Roman world, it had become necessary, because it survived its creator and every one of the persons who took his place, notwithstanding most of them died violent deaths. Two or three centuries earlier every effort to carry out such an idea would have miscarried. In this age representative governments, which are strongly rooted among some of the peoples of Europe, could not subsist among others.

The absolute truth of an idea is not, therefore, the thing to be considered. The value of an idea is measured by its success, its utility, or its danger, and these elements depend upon circumstances, media, and races. Only experience can demonstrate whether an idea is opportune. The notion of national unity, which is fundamental in modern politics, is very old, for Charlemagne tried to put it in operation. It could not be carried into the domain of facts, and the work of the great man perished with him. The idea of absolute religious submission to a representative of divinity, residing in the capital of Christianity, was for a long time an excellent one, but there came a time when, in the face of the advance of knowledge, it was no longer acceptable, and Philip II exhausted the force of his genius and the might of Spain, then predominant, in vain contentions with the spirit of free inquiry, which was then prevailing in Europe under the name of the Reformation.

The power of ideas, once fixed in the mind, is so great that no person is able to arrest their progress. Their evolutions must then inevitably be carried out, and all their consequences suffered. Most frequently, as with the socialists of the present time, their defenders are the ones marked to become their first victims. They are no better than sheep which docilely follow their leader to the slaughterhouse. We have to bow to the power of the idea. When it has reached a certain period of its evolution, no reasoning or demonstration can prevail against it. Centuries or violent revolutions—sometimes both—are required to free peoples from the yoke of a dominant idea.

Ideas are propagated in the minds of the multitude chiefly through affirmation, repetition, prestige, contagion, and faith. Reason does not come within the enumeration, its influence in the matter being substantially null.

Affirmation, pure and simple, without reasoning and without proof, is one of the surest means of planting an idea in the popular mind. The more concise it is, the more free from every appearance of proofs and demonstration, the more authority it has. The religious books and the codes of all ages have always proceeded by simple affirmation. Statesmen called upon to defend any political cause and manufacturers advertising their goods know what it is worth. Yet it has no real influence, except it is constantly repeated, and, so far as possible, in the same terms. Napoleon said that repetition was the only serious figure in rhetoric. By repetition an affirmation is incrusted in the minds of hearers till they at last accept it as a demonstrated truth. What is called the current of opinion is formed, and then the potent mechanism of contagion comes in. Ideas that have reached a certain stage, in fact, possess a contagious power as intense as that of microbes. Not fear and courage only are contagious; ideas are, too, on condition that they are repeated often enough.

When the mechanism of contagion has begun to work, the idea enters upon the phase that leads to success. Opinion, which repelled it at first, ends by tolerating and then accepting it. The idea henceforward gains a penetrating and subtle force which sends it onward, while at the same time creating a sort of special atmosphere, a general way of thinking. Like the fine road dust which penetrates everywhere, the idea becomes general, and insinuates itself into all the conceptions and all the productions of an epoch. It then forms a part of that compact stock of hereditary commonplaces, of ready-made judgments, which are registered in books and imposed upon us by education. The final factor that gives the idea thus developed and spread its immense power is that mysterious force it acquires called prestige. Everything that rules in the world, whether of ideas or men, imposes itself principally through the irresistible force expressed by this word. It is a term which, while we comprehend the full meaning of it, is applied in too various fashions to be easily defined. Prestige comports with such feelings as admiration or fear, and is sometimes even based upon them, but it can easily exist without them. There are dead persons, and consequently beings we need not fear, like Alexander, Cæsar, Buddha, and Mohammed, who possess the highest degree of prestige; and there are other beings or fictions which we do not admire at all—like the monstrous divinities of the subterranean temples of India—which appear to us invested with it.

Prestige is a kind of domination exercised over our minds which paralyzes all our critical faculties and fills our hearts with astonishment and respect. The feeling provoked by it is, like all our feelings, inexplicable, but it is probably of similar order to the fascination experienced by a magnetized subject. It is the strongest moving spring of all domination. The gods, kings, and women would never have reigned without it. Many factors enter into its genesis, of which one of the most important is always success. Every man who succeeds, every idea which prevails, cease by that fact to be disputed; and when success ceases, prestige vanishes with it. The hero applauded by the multitude in the evening is spat upon in the morning if his fortune has failed him; and the reaction is quicker in proportion as the prestige has been more brilliant. Prestige likewise tends to disappear under the light of discussion. One must hold the multitude at a distance to keep their respect.

The details of the psychology of prestige may be studied by setting them at the end of a series that descends from the founders of religions and empires to the particular person who is trying to astonish his neighbors with a new coat or a decoration. Between the extreme terms of such a series we should place all the forms of prestige in the various elements of a civilization—in the sciences, arts, literature, etc.—when we shall see that it constitutes the fundamental element of persuasion. Whether consciously or not, the being, the idea, or the thing possessing prestige is imitated at once, and imposes on a whole generation certain ways of thinking and of expressing thought. The four fifths of modern painters who reproduce the faded colors and stiff attitudes of the primitive school hardly suspect that they are imitators. They believe they are sincere; yet if an eminent master had not revived this form of art, they would still have seen in it only the childish side. Those who, at the instance of another illustrious master, flood their canvases with violet shades, do not see any more violet in Nature than was seen fifty years ago, but they have been infected with the personal and special impression of a painter who, in spite of this eccentricity, was able to gain great prestige. Similar examples might be found in all the elements of civilization.

Thus, through repetition, contagion, and prestige, men of each age come to possess a fund of ideas of an average sort which render them like one another, and to such a point that when centuries have accumulated over them, we recognize, by their artistic, scientific, philosophical, and literary productions, the age in which they lived. It is true that we can not say that they absolutely copied one another, but that they had in common modes of feeling and thinking conducive to productions strongly affiliated with one another. We have reason to felicitate ourselves that this is so, for it is precisely this interweaving of identical traditions, ideas, feelings, creeds, and ways of thinking that constitutes the spirit of a people. That spirit is stable in proportion as the texture is solid.

So far as we have as yet studied the imposition of the idea, we have found it existing only in the upper ranks of the nation. For it to descend to the lowest strata and be spread among them in such a way as really to influence the mob, the intervention is required of that sort of believers in it whose faith is so intense as to impel them to propagate it—apostles. Men of this kind are usually converts so fascinated by the new idea that everything else vanishes from their thoughts. They are recruited chiefly from among those nervous, excitable persons who live on the borders of madness. However absurd may be the idea they defend and the end they are pursuing, all reasoning is blunt against their conviction. Despite and persecutions do not touch them, but only excite them all the more. They sacrifice personal interest and family, and so annul the instinct of self-preservation as to seek martyrdom as their only recompense. The intensity of their zeal gives their words a great suggestive force. The multitude is always ready to listen to any strong-willed man who may impose himself upon it. Men in a throng lose all their will, and turn instinctively to one who has any. An assembly of men is capable of acting only when it has a leader at its head.

The peoples have never had any lack of such leaders; but it is not necessary that they should all be actuated by the strong convictions that make apostles. They are more frequently subtle rhetoricians seeking personal interests alone, and trying to persuade by flattering base instincts. The influence they thus exert is usually very ephemeral. The great fanatics who have raised the spirits of mobs—Peter the Hermit, Luther, and Savanarola—did not exercise their peculiar fascination till they had themselves been fascinated by some belief. They could then create in souls that formidable power called faith, a still very mysterious force of which psychology afforded no explanation till it turned its investigations upon hypnotic phenomena, studied the unconscious transformation and combination of ideas into images and sensations, the doubling of the self, the coexistence of several personalities in the same individual, dying sensations, etc. Persons possessed by their faith may be compared to hypnotic subjects. They are, as it were, absolute slaves of their dream.

Whatever may be the real nature of faith, its power can not be contested. There is profound reason for the gospel affirmation that it can move mountains. The great events of history have been brought about by obscure fanatics armed with nothing but their faith. The great religions which have governed the world and the vast empires that have extended from one hemisphere to the other were not built up by men of letters, of science, or by philosophers. The creed on which the civilization under which we live was founded was first spread by obscure fishermen of a Galilean market town. Shepherds from the Arabian deserts, whose contemporaries hardly knew of their existence, were the men who subjected a part of the Greco-Roman world to the dogmas of Mohammed, and founded one of the vastest empires known in history.

A strong conviction is so irresistible that only an equal conviction has any chance of struggling victoriously against it. Faith has no enemy to be really afraid of except faith. It is sure of triumph when the material force opposed to it is the servant of weak emotions and of weak belief. But if it is brought to face a faith of the same intensity, the contest becomes very active, and success is then determined by accessory circumstances usually also of a moral order, such as the spirit of discipline and better organization. In studying the history of the Arabians, to whom we have just alluded, we find that in their first conquests, which are the most difficult and the most important, they met morally weak adversaries. They first bore their arms into Syria. They found nothing more formidable than Byzantine armies composed of mercenaries with little disposition to sacrifice themselves for any cause. Inspired by an intense faith that multiplied their forces by ten, they dispersed these armies without ideas as in ancient days a little handful of Greeks sustained by love for their city scattered the innumerable hosts of Xerxes. Numerous examples in history stand in proof that when equally powerful moral forces meet, the best organized always carry the day.

In religion, as in politics, success always goes to believers, never to skeptics; and if the future threatens to belong to the socialists notwithstanding the annoying absurdity of their doctrines, it is because they are to-day the only persons who are really convinced. The modern directing classes have lost faith in everything. They do not believe in anything, not even in the possibility of defending themselves against the dangerous flood of barbarians all around them.

When, after a longer or shorter period of trials, transformations, discussion, and propaganda, an idea has acquired a definite form and has penetrated the spirit of the multitude, it constitutes a dogma, or one of those absolute verities which are not subject to discussion. It then forms a part of those general beliefs on which the existence of societies reposes. Its great characteristic is its immunity from discussion. When a new dogma is thus implanted in a people, it becomes the inspiration of its institutions, arts, and conduct. Its empire over the minds of the people is absolute. Men of action think of nothing else than of carrying it out and applying it; and philosophers, artists, and literary men occupy themselves with presenting it in various forms. Transient accessory ideas may arise from the fundamental idea, always bearing the impress of the one from which they issued. Egyptian civilization, European civilization in the middle ages, and the Mussulman civilization of the Arabs, were all derived from a very small number of religious ideas that put their mark on the most minute elements of those civilizations, and made them distinguishable at once.

In fact, the men of every age are surrounded by a network of traditions, customs, and opinions, created by their ideas, from the yoke of which they can not subtract themselves, and which make them very like one another. Men are more than anything else led, with a despotism which no tyrant ever exercised, by custom and opinion, which regulate the slightest actions of our existence, and from which the most independent man never thinks of extricating himself. Asiatic sovereigns are often represented as despots guided only by their fancies. These fancies are really confined within singularly narrow limits. The network of traditions and the yoke of opinions are especially strong in the East. Religious traditions, which have been loosened with us, retain all their empire there. The most self-sufficient despot would never strike at these two masters, which he knows are infinitely more powerful than he.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

SKETCH OF CHARLES UPHAM SHEPARD.

CHARLES UPHAM SHEPARD was born at Little Compton, a town in the southeastern corner of Rhode Island, June 29, 1804. He was fitted for college in the Providence Grammar School and entered Brown University in 1820, but left the following year to join the sophomore class of the new college which opened then at Amherst, Mass. He was graduated in due course in the class of 1824.

In a graphic sketch of Amherst College as it was during his student days, contributed to Prof. Tyler's History, Prof. Shepard has said:

"I remember that I was the youngest of my class. Most of my fellows were mature youths who did not appear to me youths at all—seniors in character and manlike in purpose, with an air which seemed to tell of years of yearning for the ministry, and of a brave struggle with the poverty which had kept them from their goal." After a description of the village and the mode of life in it, Prof. Shepard continues: "With such surroundings, what now were our interior advantages? Whatever we may have represented them to outsiders, whatever we may have persuaded ourselves concerning them, they were, in my day, extremely meager. The teachers were few, and in general were not distinguished in their departments. Our library did not surpass the scholarly range of a country clergyman in fair circumstances. Apparatus and collections were unknown in our first year, and they had made but feeble beginnings before our graduation. The only lectures which I remember were the two annual courses of Prof. Amos Eaton, in his day a distinguished botanist and geologist.

"In Dr. Moore, a gentleman of suave manners, of true Christain dignity, and of singular judgment in managing youth, we had an admirable president. I venture to suspect that he was the only college president in the United States who, from the beginning, personally subscribed for the somewhat expensive numbers of the Journal of the Royal Institution of London. From this source, and others similar, he appears to have gained a prevision of the importance of the modern sciences in education, and to him mainly are we indebted for the early foothold which they gained in the institution; to him, at all events, we owed the presence of Prof. Eaton. Rarely has college lecturer been more faithfully and enthusiastically listened to than Prof. Eaton in his courses on chemistry and botany, together with his abridged course on zoölogy. To supply the place of a text-book on the last-mentioned branch, he furnished us a highly useful printed syllabus, drawn mainly from the great work of Cuvier, then wholly inaccessible to us. . . . There were doubtless deficiencies to be regretted. In the larger and older universities we might have found better teachers and richer stores of libraries and collections, but in some unknown way, perhaps in the enthusiasm of comparatively solitary effort, compensation was made; and on the whole we may doubt whether higher life success would have attended us had we launched from other ports."

For a year after graduation he studied botany and mineralogy with Thomas Nuttall at Cambridge, and during most of this time taught the same branches in Boston. His study of mineralogy led to the preparation of papers on that subject which he sent to the American Journal of Science, and in this manner he became acquainted with its editor, the elder Silliman. He was invited in 1827 to become Prof. Silliman's assistant, and continued as such till 1831. For a year of this time he was Curator of Franklin Hall, an institution that was established by James Brewster in

New Haven for popular lectures on scientific subjects to mechanics.

In 1830 he was appointed to a lectureship in natural history at Yale, which he held till 1847. In the winter of 1832–'33 he investigated the culture of sugar cane and the manufacture of sugar in the Southern States, his results being incorporated in Prof. Silliman's report to the Secretary of the Treasury.

His investigation in the sugar States led to his appointment, in 1834, as Professor of Chemistry in the South Carolina Medical College, at Charleston. This position required his residence in the South for only part of the year, so that he was able to continue his lectures at Yale and to accept, in 1835, an appointment as associate to Dr. James G. Percival on the Geological Survey of Connecticut.

It was in the darkest hours of Amherst College, in December, 1844, that Prof. Edward Hitchcock was raised to the presidency of that institution, and in order to provide for the partial vacancy thus created in his department, Charles U. Shepard, of New Haven, was elected Professor of Chemistry and Natural History, this election "to take effect provided Prof. Hitchcock accepts the presidency." Both appointments were accepted. Prof. Shepard entered upon his new duties in the following year. Only two years were needed under President Hitchcock's able management to restore prosperity to the college. Prof. Shepard, being then satisfied that Amherst would be able to afford him a permanent field of labor, severed his connection with Yale and offered to bring his valuable collections to Amherst if the college would house them in a fireproof building and consider the purchase of them when it was able. This proposition was gladly accepted.

His professorship was divided in 1852, when the college became able to have a separate Professor of Chemistry. Prof. Shepard continued to deliver the lectures on natural history till 1877, when he was made professor emeritus. After leaving Amherst his northern home was at New Haven for the rest of his life.

The following history of the growth of Prof. Shepard's collections was written by him for the History of Amherst College, at the request of Dr. Tyler:

"My mineralogical cabinet was commenced at the age of fifteen, while a member of the Providence Grammar School, and was brought with me when I left Brown University to join the sophomore class of Amherst institution in 1821. An early visit after my arrival here to the tourmaline and other localities of Chesterfield and Goshen served to increase my eagerness as a collector, and at the same time placed me in possession of abundant materials for exchange. In 1823 my identification of the previously supposed white augite of Goshen with the species spodumene, gave me confidence in the study of minerals, while it increased my stock of specimens desirable to mineralogists. The exchange I then carried on with the Austrian consul-general, Baron von Lederer, in behalf of his own collection and that of the Imperial Cabinet of Vienna, rapidly enriched my little museum in foreign minerals. Indeed, from the first it was sufficiently ample to serve a useful purpose in the instruction of beginners; and was the sole resource of Prof. Amos Eaton in the lectures he gave during two seasons before the students of the institution.

"On leaving college I resided a year partly in Cambridge and partly in Boston, during which period I profited much in extending my collections, through visits to new localities in eastern Massachusetts and Rhode Island, and still more by exchanges with Prof. Nuttall and other active cultivators of mineralogy in the region. I soon after made a very successful tour into Maine, where, at Paris, I was the fortunate discoverer of the most remarkable green and red tourmalines then known. With some of these I made profitable exchanges with the British Museum and other large collections. My association in 1828 with Prof. Silliman as his assistant, and afterward with the college as a lecturer on natural science for many years, afforded me unusual facilities for the extension of my cabinet. All the best localities of Connecticut were frequently visited, specimens of rare interest secured, and the means of supplying scientific correspondents abundantly obtained. These objects were still further effected by journeys into adjoining States and the Canadas, until 1835, when I became Professor of Chemistry in the Medical College of the State of South Carolina, where a new and very ample field was opened for the extension of my collections. From that time to the present [1871], with the exception of the period of the civil war, I have passed nearly the half of each year in the South, and been engaged to a considerable extent in scientific and mining explorations, which have resulted in varied and rich contributions to my cabinet. These travels have also embraced the Western or Mississippi States, attended by similar results. But most of all have I gained by frequent excursions to the Old World, having since 1839 twelve times visited Europe, where my exchanges and purchases of specimens have been conducted on a scale, I am led to believe, not surpassed by any of my countrymen. Numbers, however, have never been my aim in these acquisitions. I have rather sought what was characteristic and instructive—not, however, to the neglect of the rare and beautiful."

The foregoing relates to the mineralogical part of Prof. Shepard's collections; his geological cabinet was also important, being especially remarkable for fossil remains. The meteoric collection, begun in 1828, he stated to be the fourth in extent and value known at the time of writing.

As to the transfer of the combined cabinets to Amherst College Prof. Shepard continues:

"The removal of these collections from New Haven to Amherst, in 1847, was the result of an understanding entered into between President Hitchcock and myself, that if the college would cause a fireproof building to be erected for their reception, I would deposit them therein, at least for a term of years, and with the hope, through arrangements afterward to be made, of leaving them with the college as a permanent possession. Such a building was provided in the Woods Cabinet; and, more recently, the conditions for the purchase of the collection have been agreed upon." When he wrote the above he was engaged in the more perfect cataloguing and arranging of the three collections.

When Walker Hall was built, the mineralogical cabinet was removed to rooms in that building, and was destroyed when the building was burned, in March, 1882. Although few could be classed as combustibles, a diligent search in the *débris* of the building revealed scarcely a trace of the specimens. This was a sad loss. Prof. Shepard valued the collection at seventy-five thousand dollars, and the college had actually paid forty thousand dollars for it. There was only fifteen thousand dollars of insurance on the whole contents of the building.

Dr. Shepard held his professorship at Charleston uninterruptedly until the civil war, and immediately after it closed he went back, at the urgent invitation of his former colleagues, and resumed his lectures. In 1869 he retired from the full discharge of his duties, but continued to give some lectures until shortly before his death. While in Charleston he discovered rich deposits of phosphate of lime in the immediate vicinity of that city. Their great value in agriculture and subsequent use in the manufacture of superphosphate fertilizers proved an important addition to the chemical industries of South Carolina.

The collection that was burned in 1882 was the finest in the United States, and was surpassed abroad only by that in the British Museum. But Dr. Shepard's collecting had not stopped with its formation, and he succeeded before his death in gathering a second cabinet of meteorolites and minerals which ranked among the very largest private collections. This he kept in a fireproof cabinet at his private residence in New Haven.

Prof. Shepard died, after a short illness, at Charleston, May 1, 1886.

In its obituary the Charleston News said of him: "He chose his profession well. A mind so analytic as his and so keen in the perception of relations could not have failed to see that the field in which he cast his literary fortunes was one which offered an undying reward for those who made it a successful arena of untiring and indomitable labor and energy. . . . Prof. Shepard discovered more new species of minerals which have attained permanent recognition than perhaps any other scientist of the present day. He was a member of many American and foreign societies, among which are the Imperial Society of Natural Science of St. Petersburg, the Royal Society of Göttingen, and the Society of Natural Sciences of Vienna. He published a Treatise on Mineralogy (1832 and 1835), a report on the Mineralogy of Connecticut, and numerous scientific papers." Many reports on mines made by him have been printed.

He announced in 1835 his discovery of his first new species of microlite, that of warwickite in 1838, that of danburite in 1839, and he afterward described many other new minerals until shortly before his death. His knowledge of minerals was wonderfully extensive, "and he was hence ready," it has been said, "with quick judgments as to new and old; sometimes too quick—but in any case imparting progress to American mineralogy."

The honorary degree of M. D. was conferred upon him by Dartmouth in 1836, and that of LL. D. by Amherst in 1857.

He was a man of refinement and great courtesy, and was held in high esteem wherever he resided.

He left two children, a son and a daughter.

Prof. Shepard's son, Charles Upham, was born at New Haven, October 4, 1842. He was graduated from Yale College in 1863, and took the degree of M. D. at Göttingen in 1867. He succeeded to his father's professorship at Charleston, and has been active in developing the phosphate and other chemical industries of South Carolina. In 1887 he presented the second cabinet of minerals that was formed by his father, numbering more than ten thousand specimens, to Amherst College, and his cabinet of representatives of more than two hundred different meteorites has been deposited in the United States National Museum.

SPECTROPHOTOGRAPHIC investigation by Prof. Keeler makes it certain that the rings of Saturn are not solid, but are composed of innumerable small bodies or meteorites. The observations show that the motion of the interior parts of the rings is more rapid than that of those of the outer part, which might be the case if the rings were composed of free moving bodies independent of one another; while if the rings were solid the outer parts would necessarily move the fastest.

EDITOR'S TABLE.

THE SPHERE OF SCIENCE.

We publish in this number a criticism by a gentleman who, we understand, is connected with one of our most distinguished universities, of the article which appeared in these columns some months ago under the title of Back to Dogma. In that article we maintained that the then recent address of Lord Salisbury, as President of the British Association, was, to all intents and purposes, an appeal to the scientific world to put on once more those dogmatic shackles from which the philosophical advance of the present century was supposed to have set it free; and we endeavored to show how fatal to the further progress of scientific theory a compliance with such a suggestion would be. The author of the article we are now publishing seems to agree with us entirely that the general drift of the address was reactionary; but he considers that we go too far in another direction when we say that the reintroduction of the doctrine of design, as an explanation of things which challenge our curiosity, would mean "the death of scientific investigation."

If we have published this article we have done so—and we think it right to make the statement—less upon its merits as a piece of scientific or philosophical argumentation, than because we are anxious to give every opportunity for the free and fair criticism of opinions expressed in this journal. Science does not admit of any one-sided expositions; and it knows no orthodoxy save that which open discussion, free from all bias of self-interest and prejudice, may at any given moment appear to establish. It has always been the aim of this journal to convey to its readers the idea that science is not a rigid system of unalterable deductions, but consists essentially in the gradual adaptation of the thought of mankind to the ever-unfolding aspects and meanings of the universe. While holding our own views, therefore, of the questions which from time to time occupy the attention of the scientific world, we not only have no desire to exclude contrary expressions of opinion, but are entirely prepared to extend to them a cordial hospitality, provided they are stamped with a reasonable degree of logical force and adequacy. The address delivered by the Marquis of Salisbury was a case in point: we could not agree with its main positions, but neither could we deny that it was a highly plausible and, upon the whole, extremely able presentment of a view which formerly found multitudes of adherents, and still finds not a few. We therefore made a point of transferring it to our columns, while reserving the liberty to criticise it, as we did, in this portion of our journal. In the same spirit we publish Mr. Clark's article in which our criticism is called in question; and we have now to consider how far his objections to the position taken by us are valid.

As already mentioned, our critic agrees with us as to the reactionary character of Lord Salisbury's address. We expressed our sense of this by the heading we gave to our article Back to Dogma! and we hardly think it can be denied that if a reactionary movement takes place in the scientific world it must carry us back to dogma. That scientific investigation was formerly dominated by dogma, our critic seems quite prepared to acknowledge. Indeed, he uses language which so fully agrees with our own that we almost wonder he thought it worth while to find fault with our position. We said that an acceptance of the doctrine of design would be the death of scientific investigation. Mr. Clark, speaking of the Darwinian doctrine of natural selection, says that for thirty-five years it has been "the mainspring of research not merely in biology, but in all the field of natural science." But the two doctrines are completely opposed: so that what Mr. Clark says of the one is virtually a confirmation of what we said of the other. Take away or break "the mainspring of research," and what would follow? If the metaphor is sound, arrest of movement would follow; and what is arrest of movement but death, for the time being at least? Before Darwin's time, our critic says, "naturalists were content with statistics, and did not ask for reasons." And he adds, "that this was due to a belief in the immutability of species and the doctrine of design there can be little doubt." And yet, because we said what we did about the doctrine of design, we are accused of displaying "illogical reasoning and uncalled-for prejudice"!

At this point Mr. Clark gives a little twist to our words which does not speak well for his candor or his carefulness: let us trust that it was the latter that was at fault. We said that "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." Our critic, referring to this remark, says that to accuse "the great men who accepted that doctrine" in pre-Darwinian times of having done so for the reasons mentioned, "is a gross slander." Well, as we were speaking of what made the doctrine "popular" in the present day, and said nothing whatever about the great men of the past, who had hardly any choice in the matter, the "gross slander" exists only in Mr. Clark's imagination—a faculty which a man of science, such as he professes to be, should learn to keep in subjection.

Our critic finds that the very success of the doctrine of evolution has brought in a new danger. These are his words: "The doctrine of evolution has proved so satisfactory at every turn, that there is great danger that the ultimate motive for scientific research will be completely lost to sight." That motive he declares to be expressed in the interrogation "Why?" The older naturalists set themselves to answer the question "What?" In other words, they sought out and classified facts. Darwin came on the scene with the question "How?" and his answer thereto. And now Mr. Clark steps forward with the question "Why?" to which he hopes an answer will some day be forthcoming. He is not content to understand the processes of becoming; he wants to know what objects God has in view in causing things to happen as they do. That he declares to be the true motive for scientific research, without which it is a matter of "mere curiosity." As to the possibility of attaining to a knowledge of the why, he considers, rather oddly, that the success of the doctrine of evolution in answering the question How? should give us great encouragement. "Is not," he argues, "the doctrine of evolution becoming less and less of an hypothesis and more and more of an actually established law every year? Is not the evidence all tending to establish it completely, and to prove that even the obscure problems of life and heredity are all within the limits of human knowledge? Can we then be sure that the knowledge of *why* evolution has worked as it has is unattainable?"

It is really somewhat lamentable that a man who has evidently had some training in science, and who perhaps either is, or is about to become, a teacher of it, should reason in this way. Because a certain line of inquiry, dealing with natural causes, has proved eminently fruitful, therefore we may—such is the argument—reasonably suppose that another line of inquiry, dealing not with natural causes at all, but with the supposed motives of an Absolute Being, will also prove fruitful. When will our institutions of learning knock a little common logic into the heads of their graduates, so that they shall not be at the mercy of the first idle and misleading analogy that happens to flit through their brains? We should like to know whether Mr. Clark has ever tried to form any clear idea of what he means by attaining to a knowledge of the why—what, exactly, it would be like to see into the mind of a Divine Being, and acquire an understanding of his thoughts and purposes. Straining his imagination to the utmost, can he give us any hint as to the steps by which such knowledge as he aims at could be approached? In all the ages that have passed, has the smallest commencement been made toward an insight into the "Why"? The religions of the past have all, in their manner, grappled with the question, but with what result? Absolutely none. We know no more on this subject than our ancestors of a hundred generations ago; but we differ a little from our ancestors in being more content than they to abide in a necessary ignorance. We find, moreover, that a knowledge of the How renders in many cases a knowledge of the Why not only unnecessary but inconceivable—renders the very idea of such knowledge absurd. When we have once grasped the law of gravitation in its application to the solar system, do we feel any special need to ask *why* it was arranged that the attraction exerted by the sun and the planets upon one another should be directly as mass and inversely as distance? When we learn the properties of oxygen, hydrogen, and nitrogen, do we feel as if we must also know *why* they are endowed with such properties? When we see how running water sifts earthy materials, how the action of the waves furrows the sand, wears away rocks, and smooths pebbles, do we exclaim, "But why? oh, why?" When we study the laws of mechanics and grasp the simple formulas which express the action of the lever, the screw, and the inclined plane, do we feel that it would elevate us greatly in the scale of being to know *why* these things are so? It may be said, perhaps, that these are not the phenomena which suggest the question Why? If so, we reply that if we would know the true nature of that question we must apply it to such matters as these. Applied to these, we see that it is a silly and meaningless question; but none the less is it silly and meaningless when applied to other matters. Men want to know why a pestilence or famine was *sent* (as they say) at a particular time; they do not trouble themselves with the prior question whether it was *sent* at all in any proper meaning of the word. What we know is that sanitary science is showing an admirable power of controlling pestilences, and that famines only occur where there is defective knowledge and inferior social organization. Here again, therefore, a knowledge of the cause renders any inquiry into the why absolutely idle.

The highest motive for scientific research we hold—in opposition to our critic—to be the improvement of the conditions of human life. That there are, in our day, adequate motives for research is evident from the advances which science is making in every department; and that such advances are possible is due to the fact that men have, for some generations, been mainly seeking answers to the question "How?" Were they now to betake themselves to the question which Mr. Clark commends to the attention of the scientific world, the result would be a disastrous arrest of progress. In the ages when pestilences were of frequent occurrence, all the conjecturing that men could do as to *why they were sent* did not avail one jot to check their virulence. The knowledge that was needed, we see clearly now, was the knowledge of *how they were caused.* If that could have been got through the wool of our ancestors, their sufferings would have been wonderfully abated. And to-day, as then, the knowledge that is most needful is the knowledge of causes. Take away from us our knowledge of causes, and all that we could conjecture of Divine purposes would not save us from plunging into barbarism.

PROFESSOR HUXLEY.

By the death of Professor Huxley the world has lost a man whom it could ill spare. He was one of the very few men who unite to a real capacity for original work the impulse and the ability to bring home the results of scientific research to the popular mind. He believed that a knowledge of science, and above all of scientific method, was good for mankind; and he turned aside from studies in which he had won renown, and might have won more, in order that he might preach what he considered the gospel of science to the multitude. Some of his friends regretted this; in the interest of his fame they would have preferred that he should never have quitted the higher walks of scientific investigation; but for our own part it seems to us impossible that Huxley should have chosen his course otherwise than as he did. He had, what few of the devotees of pure science possess, strong popular sympathies and an extremely active temperament. He could not so immerse himself in the minutiæ of anatomy, or the obscurities of physiological processes, as to be indifferent to what was going on in the world around him. He was interested in fishes and reptiles, but he was more interested in his fellow-men; and it would be difficult to overestimate the value of the service he rendered in promoting sound habits of thought in this generation. Having won complete intellectual emancipation for himself, he desired that others should share the same benefit; and wherever the cause of intellectual liberty seemed to be in danger, there he was ready to come forward in its defense.

No one could read a page of Professor Huxley's writings without being struck by the breadth of culture they displayed. He was not a university-bred man, and yet in his knowledge of literature and philosophy—to say nothing of his strictly scientific attainments—he put the vast majority of university men to shame. His culture, however, was never merely on exhibition as culture; it was employed in the most legitimate manner to strengthen the causes he had at heart. There was in him too broad a humanity and too much of earnest purpose to permit him to lapse into the arts of the rhetorician. Not often indeed has such a combination of gifts been seen in one writer; and, now that he has gone from us, it is a supreme satisfaction to reflect how nobly these gifts were used, how sincerely and courageously and untiringly they were devoted to the good of mankind. The world is poorer by the death of Huxley; but the greatest must pass sooner or later from the stage of existence, and, as they pass, the lesson of their lives comes out with greater distinctness. Of Huxley we may truly say that he enriched the life of our time by his thought and by his example, and that the forces which to-day make for progress in the world are better organized for victory, and move forward with steadier hope, through the help and inspiration which he afforded.

HONOR NOT HONORS.

When it was announced a short time ago that the Emperor of Germany had bestowed a knighthood of the "Ordre pour le Mérite" upon Mr. Herbert Spencer, many of the friends and admirers of the philosopher thought that possibly this had been done with his concurrence, and that in this case he had made an exception to his general practice of declining all such decorations. It seems, however, that such is not the fact. Mr. Spencer was not aware that any such recognition of his eminence as a thinker and writer was in contemplation; and when the offer was made to him he courteously and respectfully declined it. The question has sometimes been asked by persons of a shallow way of thinking how it is, if Mr. Spencer is really a philosopher of mark, that the title-pages of his books do not show the academic and other distinctions that he has received. The answer has been given more than once; but we may as well take advantage of the present incident to give it once more: that such distinctions have over and over again been offered to Mr. Spencer, but that he has made an invariable rule of declining them. Whether he has been altogether wise in this is a matter on which opinions may differ; but his motive, so far as we understand it, seems to be unquestionably sound. He does not wish to appeal to the world with any prestige borrowed from the approval of universities, academies, or constituted authorities of any kind. He wishes his works to be judged on their own merits, pure and simple, quite apart from the glamour which the possession of honorary degrees and membership in so-called learned societies is prone to shed. In the case of the German "Ordre pour le Mérite" it is stated, and we believe with truth, that Mr. Spencer had a special objection to the idea of receiving distinction from the hand of the autocratic head of the most military nation of modern times. In his mind militarism is associated with all that is retrograde and tyrannical; he holds it to be the chief influence which to-day retards the development of society; and we can well understand therefore that, apart from his general objection to official decorations of all kinds, he would feel compelled, on grounds of consistency, to decline an honor which would have brought him into a kind of personal relation with a system of government he totally disapproved.

To sum up Mr. Spencer's position, he writes for mankind at large, not for powers or principalities, for courts or for coteries. If his labors bring him the honor of his fellow-men, that is the highest reward he craves; to *honors* as commonly understood he is indifferent. He is the "Great Commoner" of philosophy, and without the aid of titles sways the thought of the world more potently than any other man of this generation.

LITERARY NOTICES.

Physics for University Students. By Henry S. Carhart, LL. D. Boston: Allyn & Bacon. Pp. 335.

This is Part I, including mechanics light, and sound, of a text-book, not a treatise, the necessity for which has grown out of the author's own needs as a teacher. The book does not pretend to cover the subject, nor to treat exhaustively those portions with which it deals. It has been written with the notion of giving the student a general survey, and only those portions of the science of most importance from this standpoint have been selected for treatment. Rather more space than is usual in an elementary book is given to a consideration of simple harmonic motion. The author explains this by pointing out its value in the study of alternating currents of electricity and in mechanics. After the statement and explanation of the various laws, the author has arranged problems for testing the student's knowledge. The following, which is one of the experiments given to illustrate surface tension, will convey a fair notion of the simplicity and clearness of the author's style: "Make a ring of stout wire three or four inches in diameter, with a handle. Tie to this a loop of thread so that the loop may hang near the middle of the ring. Dip the ring into a good soap solution containing glycerin, and obtain a plain film. The thread will float in it. Break the film inside the loop with a warm pointed wire, and the loop will spring out into a circle. The tension of the film attached to the thread pulls it out equally in all directions."

Electricity and Magnetism. By S. R. Bottone. London and New York: Whittaker & Co. Pp. 203. Price, 90 cents.

Prof. Bottone, who is the author of several other books on electrical subjects, has here presented in small compass and popular form an outline of what is known about electricity. "The work is not intended as a text-book," he says in his preface, "hence no recondite calculations and no mere enumeration of all the existing electro-magnetic appliances are introduced. . . . The two old theories are sufficiently dwelt upon to enable the reader to form an intelligent conception of them, while very special stress has been laid upon the modern and more satisfactory 'molecular' theory." The book has evidently been prepared for adult readers, as its language is not restricted to the vocabulary of the young. There are one hundred and two illustrations.

The Rise and Development of Organic Chemistry. By the late Carl Schorlemmer, LL. D., F. R. S. Revised edition. Edited by Arthur Smithells, B. Sc. London and New York: Macmillan & Co. Pp. xxvii + 280. Price, $1.60.

Much light is thrown upon any science by tracing the successive discoveries through which it has been built up. There is a chance also to give such a story an attractiveness which a general treatise on the subject might never hope to possess. Prof. Schorlemmer well improved this opportunity, and one who has any knowledge of chemistry will be interested in his account, telling when and by whom the principal advances in this field have been made, and pointing out the importance of each and its bearing upon the state of the science at the time. The vivacious movement of the author's style and his occasional anecdotes relieve the book from the dryness that might be thought inseparable from it. The volume first appeared some years ago, and the present edition has been revised partly by the author and partly since his death by Prof. Smithells, who has prefixed a biographical notice of Prof. Schorlemmer. There is also a frontispiece portrait of the author.

How to Make and Use the Telephone. By George H. Cary, A. M. Lynn, Mass.: Bubier Publishing Co. Pp. 117. Price, $1.

This is a little workshop companion, confining itself entirely to the practical parts of the subject: the materials and simplest methods of construction; the parts most liable to get out of order, and how to discover and repair them; the things *not* to do in handling the instruments; the simplest and most reliable batteries, etc. That the book is a really practical one may be gathered from the following extract: "The poles for an ordinary line to carry from one to four wires should be of chestnut, cedar, or other durable wood, and should be reasonably straight, at least twenty-five feet long, and at least five inches in diameter at the top," etc. An appendix contains a chapter on the Gibboney long-distance telephone, and another on how to make the phonograph.

A Florida Sketch-book. By Bradford Torrey. Boston: Houghton, Mifflin & Co. Pp. 242. Price, $1.50.

As a writer of out-of-door books Mr. Torrey must be given high rank. His style is chatty, he goes into no long disquisitions, and in his descriptions of Nature he does not forget that the human animal is part and parcel thereof. His favorite subjects of observation are birds, and he tells us much about the ways of the herons, the pelicans, and the gannets, of the kingfishers, the grackles, and the buzzards, and many others of the feathered tribe. Occasionally he tells us about creatures of other kinds, or some striking flower, and his experiences with crackers and negroes are frequent enough to give quite a human flavor to the book. A curious bit of local language here and there adds still further to the variety of his observations. The value of the little volume is increased by a serviceable index.

The Story of the Stars. By George F. Chambers, F. R. A. S. New York: D. Appleton & Co. Pp. 160. Price, 40 cents.

Ignorance of Nature can no longer be excused by the size and forbidding character of scientific books. An especially attractive series of little guides to various divisions of the world about us has begun to appear under the general title of The Library of Useful Stories, the first place in the series being given to the stars. Mr. Chambers is an experienced writer on astronomical subjects, and has a happy faculty for taking away the strangeness of unfamiliar things. He opens this little volume by telling of two legal cases which turned on the matter of standard time, and shows that in such matters, as well as in navigation, astronomy comes very close to everyday life. This, followed by a chapter on First Experiences of a Starlight Night, make an easy introduction to the subject. In speaking of the constellations and their history he improves the opportunity to bring in much curious lore. Of similar interest is the chapter on The Stars in Poetry, further along. Every one has wondered about the number of the stars, and Mr. Chambers does not neglect to tell us what attempts have been made to estimate them. Colored, moving, temporary, and variable stars are duly described; also stars arranged by twos, in groups, and in clusters. The nebulæ and the Milky Way have due consideration, and finally we are told something of what has been learned by the spectroscope about the stars and nebulæ. A Table of the Constellations and a List of Celestial Objects for Small Telescopes are appended. Twenty-four maps in white on black illustrate the text.

A Standard Dictionary of the English Language. Vol. II, M–Z and Appendix. Edited by Isaac K. Funk, D. D., Editor in Chief; Francis A. March, LL. D., L. H. D., Consulting Editor; and Daniel S. Gregory, D. D., Managing Editor. New York: Funk & Wagnalls Co. Pp. 1061–2318. Price (of two-volume edition, complete), russia, $17; morocco, $22.

A little over a year ago we pointed out the chief distinguishing features of this work in noticing its first volume. In the second volume the excellences of the first are well maintained. Among the special features falling in the latter half of the alphabet are colored plates showing national coats of arms, familiar flowering plants, signal flags, and typical colors, also plates showing typical heads of human races, and the seals of the United States, the several States, and the Territories. Several other terms have illustrations occupying a whole page. The color chart appears under "spectrum" and is accompanied by a table giving the percentages of primary colors to be combined for producing nearly five hundred shades. A list of varieties, subdivisions, or technical terms is given under many words, such as man, measure, officer, printing-press, science, soap, theology, watch, and weight. The appendix includes a collection of names in biography, fiction, geography, mythology, etc., with the pronunciation and definition of each, arranged in a single alphabetical list. There are also a glossary of foreign words and phrases, a list of cases of faulty diction, lists of disputed spellings and pronunciations, abbreviations, signs, and one giving the sentiments of flowers and gems. The scientific alphabet used throughout the dictionary to indicate pronunciation is explained at length in the appendix, and there is also a key showing the pronunciation of Anglo-Saxon, Latin, Greek, and thirteen modern languages with the aid of this alphabet. In the appendix, as in the body of the work, the form and arrangement of the matter have been carefully adapted to popular use. In a great many families the dictionary is the only reference book, and to these especially the Standard will prove highly satisfactory.

Dr. Judas: a Portrayal of the Opium Habit. By William Rosser Cobbe. Chicago: S. C. Griggs & Co. Pp. 320. Price, $1.50.

Nine years of dreadful experience joined to the facile diction of an able journalist are here applied to warning all who will read of the horrors of opium slavery. The author tells the story of his own subjection—vividly, impressively, fascinatingly—with incidents from the experience of others and observations on the effects of other narcotic drugs. The habit was fastened upon him from the administration of morphine during an illness by his physician. He declares that a great majority of the two million persons habitually using narcotic drugs in the United States were introduced to the habit by careless physicians, whom he censures severely. From the start he found himself compelled to deceive and lie in order to conceal the practice. For this he despised himself, and he was also in constant dread of being found out. Delusions as to hostile intentions of those about him and threatening voices haunted him. The unsettling influence of the drug caused him to endanger the support of his family several times by giving up his position. He had bewildering, grotesque, and dreadful dreams, and among his other ills were insomnia, periods of depression, and a variety of aches and pains. After many attempts to break his chains, he was cured by a treatment lasting thirty days, thus contradicting the verdict of many physicians that "the opium habit is a vice which can not be reached by medical science." The author vigorously denounces De Quincey's book, and contradicts many of its statements which are favorable to opium.

Elementary Lessons in Electricity and Magnetism. By Silvanus P. Thompson. London and New York: Macmillan & Co. Pp. 607. Price, $1.40.

This is a new and revised edition of a work which first appeared in 1881. The revision was rendered necessary by the large advances which have been made in the electrical world during the last ten years. These advances have occurred not alone in the practical electrician's department, in the way of perfecting old and creating new machinery and thus opening new fields for its application, but also in the general acceptance and extending of theories which ten years ago were mere speculations.

The most striking of the latter has been the establishment of the identity between light waves and electrical waves, a fact the probability of which Clerk Maxwell suggested many years ago, and which has since been practically established by the work of Heinrich Hertz. In view of the widespread and constantly growing uses and applications of electrical energy in the arts and in transportation, it seems quite essential that even a common-school education, to which, unfortunately, much the greater number are limited, should include such a study of electrical theory and practice as would, at any rate, teach the student the dangers and means of guarding against accident when in the neighborhood of this most subtle and silent of workers. This book, while rather more extensive than such a superficial knowledge would require, is simply and clearly written and well arranged, and, as its name implies, begins at the bottom.

The first three chapters have to do respectively with frictional electricity, current electricity, and magnetism, and together constitute Part I. Part II contains chapters on electrostatics, electro-magnetics, electricity as a heating, lighting, and motor agent, electro-chemistry, telegraphy, telephony, and electric waves. There is an appendix containing tables and various practical points, such as "directions for setting up a cell," etc. This is followed by a number of carefully prepared problems for school use. There is a magnetic chart of the British Islands and other illustrations.

The Cat: a Guide to the Classification and Varieties of Cats, and a Short Treatise upon their Diseases and Treatment. By Rush Shippen Huidekoper, M. D. New York: D. Appleton & Co. Pp. 148. Price, $1.

The first national cat show, held in New York in the early part of May of the present year, may be regarded as opening a new era in the life of Pussy in this country; and we may henceforth expect to have cat fanciers and cat breeders and the other appurtenances of a well-cultivated and really proper fad, as we have long had horse and dog fanciers and breeders. In view of her independence and individuality, it is well that Pussy be taken up and have more regard paid to her than heretofore. When it became certain that the exhibition would be held, and inquiries were made concerning the classification and qualities, it appeared that New York had no suitable book on the subject. Dr. Huidekoper perceived the emergency, and determined to supply the want. He has done it very well. The book is a practical one, as well as scientific. It treats of the zoölogical position of the cat family, the anatomy, origin, and varieties of the domestic cat, classified as long-haired and short-haired; the care of the cat; its diseases and the remedies, the etymology and synonyms, and the emblematic significance of the animal.

Electric Light Cables and the Distribution of Electricity. By Stuart A. Russell. With 107 Illustrations. London and New York: Whittaker & Co. Pp. 319. Price, $2.25.

This is to be one of the new series of books for students, practical engineers, and others, to be called The Specialists' Series. It is thoroughly practical, describing the primary systems of distribution and their combinations, the various forms of conductors and the insulating materials in use, modes of placing overhead and underground lines, internal wiring, modes of testing, etc. Among the problems discussed are the relative advantages of different materials for conductors, the relative economy of direct and transformer systems, the use of air insulation, and the comparative advantages and disadvantages of overhead and underground lines. Besides presenting the results of experience so far attained, the book has the additional purpose of helping the further advance of knowledge in its field.

Geological Survey of New Jersey. Report on Water Supply, Water Power, the Flow of Streams, and Attendant Phenomena. By C. C. Vermeule. Pp. 352 + 96.

The present is Volume III of the final report of the State Geologist. The waters of the State having been recognized by the Geological Survey as part of its mineral resources, much attention has been given to them in nearly all the reports. The subterranean as well as the accessible waters were studied by Mr. Cook, the late State Geologist, as to their accessibility, volume, and character, and the artesian wells along the Atlantic coast belt have demonstrated the accuracy of his studies. The work for the present volume was begun in 1890. Results of permanent value have been obtained, illustrating, among other points, the large influence of geological conditions upon storage and delivery of ground water; the bearing of evaporation and ground storage upon stream-flow; the preponderating influence of temperature in determining the amount of evaporation and the total run-off of streams for a given rainfall; the subordinate influence exerted by forests and other vegetation thereon; and the indicated certainty of occasional periods of small rainfall. The former part of the volume is occupied with discussion of the laws that govern stream-flow, rainfall, evaporation, ground storage, surface storage, and surface or flood flows. Gauging flows and the method of computing them are next considered. The local water systems are then described. The latter part of the book is devoted to generalizations as to water supply, chemical analyses, public water supplies, water power, evaporation, ground storage, effects of vegetation, and stream-flow; and a list of the developed water powers and the drainage systems is given in the appendix.

The Psychology of Childhood, by *Frederick Tracy* (Heath, 90 cents), would be better described by the title The Psychology of Infancy, for the view which it affords extends but little beyond the first two years of life. The author shows that he recognizes this fact, so perhaps the publisher is responsible for the title used. What is here undertaken is "to gather together, so far as possible, the best work that has been done in actual observation of children up to the present time, arrange this under appropriate headings, incorporate the results of several observations made by the writer himself, and present the whole in epitomized form, with copious references and quotations." The mental manifestations of early childhood are taken up in the following order: sensation, emotion, intellect, and volition. Language, in view of its peculiar importance, is treated in a chapter by itself. Prof. G. Stanley Hall testifies in an introduction to the thoroughness with which the work has been done.

The doctrine set forth by *Theodore C. Knauff*, in his *Athletics for Physical Culture*, is that gymnastics is good, but athletic sports are better. (Tait, $2.) Accordingly, after giving two short chapters to gymnasium work, he describes nearly a score of athletic games and contests, pointing out their valuable features and warning against their dangers. His descriptions are general, not aiming to give the technics of the sports treated. Other subjects discussed are Training, Questions of Hygiene, Athletic Clubs, and Professionalism. There is a special chapter on Women in Athletics, in which the matter of dress is prominent, and in the chapter on Equestrianism the riding of women receives separate attention, the cross-saddle position being strongly advocated. The volume contains a large number of instructive illustrations, most of them made from photographs.

The Twenty-second Annual Report of the Geological and Natural History Survey of Minnesota is a record of the regular work of the survey in 1893. *The Twenty-third Annual Report* is largely made up of discussions on interesting general and economic topics. In the first of these the origin of Archæan greenstones is treated by N. H. Winchell, the State Geologist. This is followed by a preliminary report on the gold region about Rainy Lake, by H. V. Winchell and U. S. Grant, and a record of the mineral discoveries in the Lake Superior region, which includes the Mesabi iron deposit. Another scientific topic considered is the late glacial subsidence and re-elevation of the St. Lawrence River basin.

The *Journey through Mongolia and Tibet in 1891 and 1892*, of which Mr. *William Woodville Rockhill* gives the story in a large and handsomely illustrated volume, was undertaken by him partly under the auspices of the Smithsonian Institution, and the work is issued as one of its special publications Tibet is now, as it has been many scores of years, the most isolated country in the world. Many travelers have attempted to reach its interior, but all have been turned away when they came within a certain distance of the capital. Mr. Rockhill himself was brought to a stop in the neighborhood of the Tengri nor and the Gart'ok. Although his route was not to any great extent through wholly new country, he has been able, through his knowledge of the Chinese and Tibetan languages, as well as by his own observations, to collect many data of interest and value. At any rate he has given us a very excellent book concerning a region of which very little is known.

The *Revue Franco-Américaine* is a new French magazine, especially designed for American readers; and with that view it promises to temper the freedom with which French writers are sometimes accustomed to express themselves, to suit American ideas of propriety and taste. It is edited in Paris, by Prince Poniatowski; will admit only masters of French literature and the principal artists of France (though we find Whistler named among them) as contributors; will give representation to the various schools of art and literature; and will "not be composed of extended, heavy studies, but will contain short, vivid, vigorous articles on subjects of universal interest." The first number, of one hundred and twenty-three pages, contains many articles of the character described, by well-known authors, with portraits of French authors in their work-rooms, and other pictures that deserve to be well spoken of. (83 and 85 Duane Street, New York; price, $10 a year.)

The microbe has, during the past few years, assumed so prominent a place, both in dietetics and therapeutics, that nowadays a medical school of any standing must include in its curriculum, some sort of a course in bacteriology. The book before us, *A Course of Elementary Practical Bacteriology*, by *A. A. Kanthack*, M. D., and *J. H. Drysdale*, M. B., has grown out of the teacher's and student's needs at the St. Bartholomew Hospital in London, and is designed simply as a laboratory handbook. It is arranged in three parts. Parts I and II, Elementary Bacteriology and Bacteriological Analysis, encompass three months' work. The third part consists of an introduction to bacteriological chemistry. (Macmillan, $1.10.)

A Report on the Geology of the Coastal Plain of Alabama has been issued by the Survey of that State. The coastal plain includes all but the northeastern two fifths of the State. It is an agricultural region, and contains only such useful minerals as fertilizers and building materials. It is interesting scientifically from the remarkably complete series of Eocene and Cretaceous strata exposed in its river banks.

The piece of special pleading for Greek in which *John Kennedy* essays to answer the question *Must Greek go?* is likely to be ineffective because of its extravagance (Bardeen, 50 cents). The author claims for Greek the excellence of Shakespeare, Burns, and Keats, to whom Greek culture was accessible only at second hand, also the "Spirit of '76" and the beauty of the Columbian Exposition, allowing no credit to our inheritance from our Germanic ancestors. His claims are tricked out in a multitude of jingling phrases, many of which are too hackneyed for the columns of a one-cent newspaper.

A manual of technical directions for the grinding, finishing, setting, testing, and computing of lenses, prepared by *Henry Orford*, has been issued under the title *Lens Work for Amateurs* (Macmillan, 80 cents). The directions are full and explicit, and are supplemented by two hundred and thirty-one cuts. The author disclaims any attempt to give an easy method for the manufacture of lenses, but he has aimed to furnish a serviceable guide to both young workmen and amateurs.

The Psychological Review has undertaken a series of Monograph Supplements, in which may be published longer dissertations than can be admitted to the Review. The first issued is *On Sensations from Pressure and Impact*, by *Harold Griffing*. The results obtained from the investigations herein described relate to discrimination between different intensities and durations of stimuli, between the same stimuli applied to different areas and different parts of the body, the difference in the discriminative powers of different individuals, etc.

In an article on *Evolution and Christianity*, reprinted from the Wooster Quarterly, Prof. *Horace N. Mateer* gives a popular statement of what evolution is, assenting to its validity, but affirming also the truth of all the important doctrines in the Bible. He says that the position of the Bible is strengthened by placing it upon a scientific foundation.

Four essays by as many writers, reprinted from The Engineering Magazine, have been issued as a pamphlet with the title *Architectural Education for America*. In the first of these Arthur Rotch tells what is the influence of the École des Beaux-Arts; Robert D. Andrews describes a practical training; the English method is set forth by R. W. Gibson; and Barr Ferree closes with An Outsider's View. The object of the pamphlet is to bring together the chief points of merit in the systems most familiar to the American architect, so as to throw some light on the question, How shall the American architect be trained professionally to reach the best results for architecture in his own country?

The first of the 1895 series of Ethical Addresses is *What we mean by Duty*, by *W. L. Sheldon* (S. Burns Weston, Philadelphia, yearly, $1; single number, 12 cents). After pointing out that popular conceptions of duty regard it as something stern and forbidding, the author shows that it should rather be regarded as the conformity of conduct to natural order.

In a pamphlet published by the Theosophical Society, Tacoma, Wash., *Fred G. Plummer* attempts to prove a *Change of the Earth's Axis*. His argument is clearly put and shows a wide acquaintance with both ancient traditions and modern geological writings. (Price, 25 cents.)

A pamphlet entitled *A Few Facts about Turkey under the Sultan Abdul Hamid II*, by *An American Observer*, tells of important advances in the railroads, docks, finance, education, army, navy, and other affairs of that country. Several pages are devoted to showing that the Armenians are deceitful and conscienceless agitators. Testimony is given also to the effect that the attitude of the American missionaries toward the Armenians is not always judicious. (Printed by J. J. Little & Co., New York.)

S. Baring-Gould is at his best as a student of mystery, antiquities, traditions, folklore, and myth; and whatever we may find under his name we are sure that some of the results of his studies in these fields are interwoven in the matter. His stories, consequently, depart from the overworked models on which too much of the usual fiction of the day is drawn, and are always certain to afford something novel, fresh, and instructive. These words apply well to his *Noémi*, which is published by D. Appleton & Co, in their Town and Country Library. The story takes us back to Guienne of five hundred years ago, in what is now southern France. The region—near Domme—is terrorized over by Le Gros Guillem, a leader of the Free Companies, whose supposed daughter—a girl stolen from the Fénelons, and from whom the story is named—and her lover—who has a leading part in delivering the region from its oppressors—are the central objects of interest. The story, in its plot and general structure, reminds one of Lorna Doone, although the style and method of treatment are vastly different.

The text of Prof. *F. E. Rockwood's* edition of *Cicero's Cato Major*, or *De Senectute* (American Book Company), is substantially that of C. F. W. Müller (Leipsic), but a few variations have been made. The text is supplemented by a general introduction concerning Cicero's life and works; illustrative notes on the pages with the text; grammatical and textual notes, a list of variations from Müller's text, and indexes to the notes and of proper names. The introduction has been made somewhat full in order to present, in convenient form, besides the sketch of Cicero's life, a brief account of what he has accomplished in literature and philosophy. Altogether, this is a very satisfactory edition of one of the most charming essays ever written.

PUBLICATIONS RECEIVED.

Agricultural Experiment Stations. Reports and Bulletins. Colorado: Hemiptera of Colorado. Pp. 137.—Cornell: Recent Chrysanthemums. Pp. 28.—Feeding Fat to Cows. Pp. 12.—Delaware: Spray Calendar; San José Scale Insect in Delaware.—Illinois: Russian Thistle; Potatoes.—Michigan: Vegetable Novelties and Notions; Potatoes; Pests of Orchard and Garden; Small Fruit Notes; Native Plums; Russian Cherries; The Apple Orchard.—New York: Forcing Lettuce in Pots; Mushrooms as a Greenhouse Crop; Comparative Profits from Milk, Butter, Cream, and Cheese.—Oregon: Zoölogy. Pp. 11.—United States Department: Protection from Lightning. Pp. 25; Use of Metal Railroad Ties. Pp. 353; Weather and Crop Service. Pp. 15.—Wisconsin: Pasteurization of Milk and Cream for Direct Consumption. Pp. 48.

Bailey, L. H. The Horticultural Rule Book. Macmillan & Co. Pp. 302. 75 cents.

Beddard, Frank E. Zoögeography. Cambridge Natural Science Manuals. Pp. 246.

Biological Lectures. Delivered at Marine Biological Laboratory of Woods Holl, Summer Session, 1894. Ginn & Co. Pp. 287. $2.65.

Blatchford, Robert. Plain Exposition of Socialism. Commonwealth Publishing Company. Pp. 172. 10 cents.

Bulletins and Reports: Academy of Natural Sciences, Philadelphia. Pp. 211 to 290.—American Humane Association: Vivisection and Dissection in Schools.—Coast Survey: Magnetic Declination in Alaska.—Columbia College: The Protolenus Fauna; The Effusive and Dyke Rocks near St. Johns, N. B.; Crystalline Limestones, etc.; Glacial Lakes of Western New York; Recent Glacial Studies in Greenland; On a Granite Diorite from Westchester County, New York.—Geographical Club of Philadelphia: Bulletin No. 5.—Geographical Society (National): Beaches and Tidal Marshes of the Atlantic Coast.—Health Bulletins: Iowa, Tennessee, Wisconsin; Trinity Church Tenements (Sanitary Condition of).—Wagner Free Institute of Philadelphia: Transactions, Vol. III.—Zoölogical Society of Philadelphia: Twenty-third Annual Report.

Fitzgerald, Joseph. Pitfalls in English. Pp. 125.

Galton, Francis. Fingerprint Directories. Macmillan & Co. Pp. 200. $2.

Hittell, John S. The Spirit of Papacy. Pp. 314.

Macdougal, D. T. Experimental Plant Physiology. Henry Holt & Co. Pp. 83. Teachers, $1.

Meunier, Stanislas. La Géologie Comparée. Pp. 292. Germer, Ballière et Cie.

Menschutkin, N. Analytical Chemistry. Macmillan & Co. Pp. 512. $1.50.

Monroe, James P. The Educational Ideal. D. C. Heath & Co. Pp. 262. $1.

Nevin, William M. Lectures on English Literature. Intelligencer Printing Office, Lancaster, Pa. Pp. 485.

Preston, Thomas. The Theory of Light. Macmillan & Co. Pp. 566. $5.

Quinn, Rev. D. A. Stenotypy. Continental Printing Company, Providence, R. I. Pp. 55. $1.50.

Reagan, H. C. Handbook and Chart of Brush Arc Light System. Norman W. Henley & Co. Pp. 48. $1.

Reynolds, A. R. Report of the Department of Public Health of the City of Chicago. Pp. 268.

Ribot, Th. The Diseases of Personality. Open Court Publishing Company. Pp. 163. 75 cents.

Seidel, Heinrich. Der Lindenbaum. American Book Company. Pp. 71. 25 cents.—Die Monate. American Book Company. Pp. 72. 25 cents.

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POPULAR MISCELLANY.

A Child's Thoughts about Providence.—A very instructive account of the mental aspects of childhood is given by Miss Isabel Fry, in a book called Uninitiated, one of the purposes of which is to show that it takes much longer for children to learn the real drift and meaning of the habits and expressions and feelings of their grown-up friends and attendants than it does to master the language in which those feelings are conveyed. She thus pictures the process gone through by a child in conceiving the meaning of God's constant observation and care of his creatures: "I was thinking dreamily about heaven, and how wonderful it was that God could always see me. Could he see, for instance, and did he notice that I had a button off my boot, or did he overlook some things and only trouble himself about that which was actually either good or naughty? I did not know. And then nurse said that he was always taking care of me every minute. Didn't he ever leave me alone at all? I supposed not. But surely if he saw that I was sitting on this chair, and knew that nurse had made up her mind not to come in for, say, twenty minutes, he might leave me at any rate for a little while. But no; I hardly thought he would. Then I went on to try to imagine what would happen. Supposing, for any reason, he did leave me. I should probably fall down through some vast open space and die. No, not exactly die, for then God would have to decide whether I was to go to heaven or hell, and I should be once more in his keeping, and in that case I should be just sitting here in the night nursery again for all the world, as I was doing at this moment. I could not make up my mind what would happen, and I felt it would be almost worth while to try the experiment." But if she should ask God to leave off taking care of her she might go so fast that she would not be able to pray him to take her back. But she would pray him to let her go for just one single second, and then take care of her again. After a long struggle with herself and much trembling, she did so—and nothing happened. "Breathless and motionless as I sat with eyes staring and ears strained, I could perceive no change whatever in myself or in my surroundings. The sewing machine in the nursery still purred on; little Samuel still knelt in the picture on the wall opposite me, with the yellow light still fiercely streaming upon him, and the bluebottle who had been keeping up a continual "fizzle" was still fighting on the window pane. I set myself rigidly, and tried again to feel the sort of falling or collapse which I had imagined. Still I felt nothing, and I had at last to give up the effort, and believe that for some reason, which perhaps I was not quite old enough to understand, God would not let go of my still sobbing body."

Science in Finland.—Besides the National University at Helsingfors, which had nineteen hundred and twenty-nine students in 1894, with the number increasing regularly, Finland has several scientific and other learned societies. The Finnish Society of Sciences, founded in 1838, has published, besides its regular volumes of transactions, a series of works on the nature, ethnography, and statistics of the country. Among its later achievements is the foundation of a central meteorological institute, which is assisted by the Government. It has, besides, taken part in a number of international polar expeditions, and has established a station at Sodankyla, in Lapland. Other societies are the Natural History Society (*Societas pro faunâ et florâ fennicâ*), founded 1821; the Society of Finnish Literature, the Finno-Ugrian Society, the Finland Historical Society, the Finnish Archæological Society, two geographical societies, a medical society, and a legal society. Among Finlanders distinguished in science and letters have been Lönnrot, grammarian and collector of the national literature; Ahlqvet, another able grammarian; Hallstrom, physicist; the illustrious astronomer Argeländer; the mathematicians Lindelof, Schulten, and Mittag-Löffler, the last editor of the international journal Acta Mathematica; the explorer Nordenskiöld, who removed to Sweden in 1857 to escape trouble on account of an address he had made at a students' festival; the botanist Nylander; the zoölogist Nordmann; and the surgeon Estlander. Swedish literature is also distinguished by several Finnish names of great writers; Finnish literature is very ancient, although it has only recently begun to receive special attention. The later poets and romancers have discussed in the fresh and spontaneous old poetry of the ancient folklore a nearly inexhaustible mine of rich images and striking epics. Finland has further produced eminent artists in various lines. The full story of the achievements of this too little known country of the far north is told in the book La Finlande au XIX siècle, which the writers and artists of the country have combined to make up, published at Helsingfors, in French, in 1894.

Report on Opium.—The opium commission appointed many months ago by the British Government was charged with the investigation of three questions—whether opium, when taken in moderation, is injurious; whether Indian opinion is opposed to its use; and whether prohibition is a practicable policy. The commission has published its report, and declares that by a vote of eight to one it answers all the three questions in the negative. The commission finds that an immense number of doctors in India believe opium to be less injurious than alcohol. Witnesses drawn from every grade and class testified that it is an excellent remedy against malarial fever; that it can be and is consumed in moderation all through life; and that its effect upon the constitution in health is practically *nil*. Among natives the belief in the value of the drug is nearly universal. The practice of opium-eating pervades every class, is considered allowable by every class, and the people are opposed to prohibition. The commission, therefore, though they believe some improvement in the restrictive laws may be possible, refuse to suggest any, and advise substantially that the present system be left alone.

Steel Buildings.—A steel building, as the words are now used by builders, is a structure supported by a steel frame, which frame should carry all the other materials used in the construction. If the frame is so arranged that it will always hold the building securely in the position and condition in which it was first erected, the other materials used in construction will be required chiefly to perform some other office than that of giving strength and support. As considered by Mr. C. T. Purdy, in his paper on the subject, the most important difference between the old brick and stone buildings and the new steel ones is in the construction of their exterior walls. Brick and stone in the older forms of construction were used first of all to make the building strong. In steel buildings this use of masonry has nearly disappeared. It is used instead only to inclose the structure from the outside air and elements, to protect the frame from fire, and to afford opportunity for architectural effects. Thick walls are useless with these frames, and no matter how high the building is, the exterior walls do not need to be heavier at the bottom than at the top. Openings may be made in them in almost any way or of any size. In some respects the larger they are the better, and the wall in any story may be removed without injury to that above or below. This is a great change. The steel frame has worked a great difference in the concentration of loads. Walls tend to diffuse and spread the loads which they carry. They act as beam and column at the same time, and it is not always easy to tell what part of the foundation supports a given load in the upper part of the building. With the column construction this indefinite feature becomes definite, for all the loads are sure to be concentrated at the column centers that carry them. Kindred to this change is the large independence of partition walls which the steel construction makes possible. Another radical change, and the most conspicuous to the eye that steel has introduced, is in the height of large buildings. Steel buildings—their construction admitting of unlimited bracing—may be carried to any height, the only restrictions being those imposed by the character of the foundations, the land, and economical considerations. The steel construction admits a vast increase of window space, the masonry walls which had to be built for strength being no longer required, and their place may be taken by glass.

The Weather and Mental Action.—Who has not felt the difference between a depressing and an exhilarating day? Sydney Smith wrote: "Very high and very low temperatures establish all human sympathy and relations. It is impossible to feel affection above seventy-eight degrees or below twenty degrees." Dr. Farr and Dr. Stark almost lead us to think morality is registered on the thermometer, so surely does it measure certain kinds of criminality. On suicides the effects of the weather are well kuown. Nearly all vocations are affected by weather. Men of science are often as much subject to weather as seamen. Some writers must have the weather fit the mood, character, or scene. If one will read poetry attentively, he will be surprised to find how many weather marks are scattered through it. Diverse weather states may be one cause of so much diversity and eveu disagreement in thought processes usually regarded as scientific. Many experienced teachers think there should be modifications of school work and discipline to correspond with the weather. The head of a factory employing three thousand workmen has said, "We reckon that a disagreeable day yields about ten per cent less work than a delightful day, and we thus have to count this as a factor in our profit and loss account." These are some of the ideas put forth in a preliminary statement by J. S. Lemon, who proposes to publish more at length upon the subject. "Laboratory investigation of the subject," he says, "meets at the outset the difficulty of distinguishing results of weather changes from similar states otherwise caused. This difficulty is no greater than in many other topics of research, and we believe will not invalidate our methods and results."

Characteristics of Recent Geological Study.—If one were asked, says Sir Archibald Geikie, to specify the feature which above all others has marked the progress of geology in Britain during the past five and twenty years, he would reply, the enlarged attention given to the study of the rocks, or petrography; and this study has been revolutionized by the introduction of the microscope as an adjunct to research. The rocks of the country have become a foremost object of study. In stratigraphical geology a much closer attention than ever before has been given to the investigation of the most ancient accessible parts of the earth's crust. The fundamental platform on which the fossiliferous rocks repose has been searched for and has been detected in several places where it was not before supposed to exist. We know more clearly than before the general outlines of two or more great geological periods anterior to the earliest relics of animal life. Among the applications of paleontology to the stratigraphical side of geology the most important in recent times has been the recognition of life zones among the stratified formations and the adoption of these as a clew to the interpretation of the sequence of strata, and even under some risk of error of tectonic structure. In the department of geotectonics one of the most interesting features has been the increased attention bestowed upon the nature and results of the great movements that have affected the crust of the earth. Another distinguishing characteristic of the period has been the increased interest taken in the history of the earth's surface or its superficial topography as contrasted with the almost exclusive attention given by the older geologists to the story of the rocks. The views respecting the possible age of the earth have undergone several modifications by geologists and physicists alternately, with accepted periods ranging from four hundred millions down to ten millions of years. The latest phase of them is that put forward by

Prof. Perry from the physical side, that, on the assumption that the earth is not homogeneous, as Lord Kelvin supposed, but possesses a much higher conductive and thermal capacity in its interior than in its crust, its age may be enormously greater than previous calculations have allowed.

Modoc Songs.—During his talks with Modoc Indians, Mr. Albert S. Gatchett has been able to record from dictation a number of curious songs which these people highly appreciate, and frequently sing while at work and while sitting idly in their lodges. Only a few of them are lugubrious, but the majority are merry utterances of a mind free from care. There are erotic songs, dance songs, satiric and mythologic songs, all delivered in a way that is half spoken and half sung. Some, however, have attractive and elaborate melodies, which, if well arranged for the piano or string instruments, would doubtless produce a sensation in cultured communities. A specimen is given of a song which is introduced as sung or spoken by a prairie owl, which has the faculty of turning its head around and then turning it instantaneously to the normal position; while, when it draws its body up, it appears almost ball-shaped, and when traveling over the prairie seems like a light-colored ball rolling over the ground. The man singing the song is supposed, after throwing off his garments and limbs, to appear also as a head only, and rolls on for many miles, when he may be seen partaking of food inside of his subterranean lodge. He has a dog who faithfully tries to gather up his discarded appendages, and take them first to his master and then home. With this is coupled an idyl of a young man carrying his sister on his back to her bridegroom, and leaving her close to a pine tree. A cradle song describes the habits of the robin, which is seen earlier than other birds flying toward the cedar to pick at the bark in search of ants; the mothers tell their babes that robin redbreast sings this song to its young, and sometimes also to its grandmother. A third song has a satirical application to another town than that of the singers.

Uses of Science Teaching.—Dr. Michael Foster defines two uses for the teaching of science in schools. The first he calls the "awakening" use, and the second the more distinctly "educational" training use. The minds of the young being differently constituted, one mind is especially awakened by one branch of knowledge, another by another. Physiology serves as awakening knowledge to a large enough number to make it desirable to teach it. For this purpose it should be taught "as a new independent subject, not demanding any previous knowledge. It should be presented as a wholly new field, into which the mind may wander at will without any restrictions as to being qualified for entrance. It also follows that the teaching must be of a most elementary kind; that as much of chemistry or physics as is necessary for the comprehension of the physiological matters should be taught with the physiology, and, as it were, a part of it, the pupil being led into chemistry and physics by his interest in physiology, and not being compelled to learn the one, for which he or she perhaps does not, at present at least, care, before beginning the other. The instruction given, however elementary, should consist in part of demonstrations and practical exercises." In this way, Dr. Foster would have physiology very widely taught, but not made a compulsory study. As a distinctly educational study, as a training for the mind, he regards it as unsuitable for schools.

American Life Zones.—Six life zones of animals and plants are described by C. Hart Merriam, in his Ornithological and Mammalogical Report to the Department of Agriculture, as having been defined in this country north of the tropical zone. They may be grouped under the two heads of northern or boreal, and southern or austral. The *Arctic* or *Arctic Alpine* zone is above the limit of tree growth, is the home of the polar bear, arctic fox, reindeer, etc., and has no agricultural importance. The *Hudsonian* zone comprises the northern or higher parts of the great transcontinental forest, and is likewise of no agricultural importance. The woodland caribou and the moose are probably its most striking animals. The *Canadian* zone, comprising the southern or lower part of the great transcontinental coniferous forest, is the first zone, coming from the north, of any agricultural consequence. It has its characteristic animals, and in it white potatoes, turnips, beets, the Oldberg apple, and the more hardy cereals may be cultivated with moderate success. In the *Transition* zone, the outlying boreal and austral elements overlap; the forests and the fauna are mixed, and northern and southern trees and animals grow and live side by side. In this zone we enter the true agricultural part of our country, and the hardier crop plants attain their highest perfection. In the *Carolinian* zone trees adapted to a warmer climate, like the sassafras and tulip tree, first make their appearance, and the semi-hardy fruits, the sweet potato, tobacco, and the hardier grapes reach their best conditions. In the *Austro-riparian* zone, the long-leaved pine, magnolia, and live oak are common on the uplands, and the bald cypress and cane in the swamps; the animals and birds are characteristic. This is the zone of the cotton plant, sugar cane, rice, pecan, and peanut, and of tender fruits. Still farther south is the *Tropical* region, which in the United States is restricted to southern Florida and extreme southeast Texas, along the Rio Grande and the Gulf coast. The Division of Ornithology and Mammalogy is engaged in tracing the courses of these regions across the continent, and in the preparation of large scale maps on which their boundaries are shown in different colors.

Antillean Elevations and Depressions.—A study by Charles Torres Simpson, on the distribution of the land and fresh-water mollusks of the West Indian region, touches upon the evidence they afford with regard to past changes of land and sea. The author finds that a considerable proportion of the land snail fauna of the Greater Antilles seems to be ancient and to have developed on the islands where it is now found. There appears to be good evidence of a general elevation of that region after most of the more important groups of snails had come into existence, at which time the larger islands were united and a land connection existed with Central America by way of Jamaica, and a considerable exchange of species went on between the two regions. At some time during this elevation there was probably a landway from Cuba across the Bahama plateau to the Floridian area, over which certain groups of Antillean mollusks crossed. This period was followed by one of general subsidence, during which Jamaica was first isolated, then Cuba, and afterward Hayti and Porto Rico. The connection between the Antilles and the mainland was broken, and the Bahama region, if it had been previously elevated above the sea, was submerged; the subsidence continuing until only the summits of the mountains of the Greater Antillean islands remained above water. Then followed another period of elevation, which has lasted, no doubt, until the present time, and the large areas of limestone uncovered in the Greater Antilles furnished an admirable field for the development of the groups of land snails that survived on the summits of the islands. The Bahamas have appeared above the surface of the sea, either by elevation or growth, and have been peopled by faunas drifted from Cuba and Hayti, and a number of land and fresh-water species have been colonized in south Florida. The Lesser Antilles have been peopled for the most part from South America.

Smoking in Mashonaland.—The luxuries indulged in by the Mashonas appear, according to W. A, Eckenberg, of the railroad survey, "to be confined to tobacco—not usually smoked, but taken as snuff—and beer manufactured from the seed of the millet. Drunkenness is an uncommon vice, except among certain of the chiefs. In the coast districts hemp is smoked in a hookah pipe of simple construction. A long, narrow gourd forms the body of the pipe. Halfway down it a hole is made of a convenient size for applying the lips. The gourd is filled with water halfway to the level of the hole. Through the closed top is inserted a small hollow reed, reaching nearly to the bottom of the water, and protruding well beyond the upper end of the gourd. To the upper end of the reed is fixed the clay or stone bowl of the pipe, and this is of very small size, capable of holding only a sufficient quantity of hemp for a few whiffs. The smoker, holding the gourd upright to prevent the escape of the water, applies his lips to the hole, and draws the smoke to his lungs, through the water, by two or three vigorous inhalations. The result is made known to the whole neighborhood by a violent and apparently purposely exaggerated coughing and spluttering; the louder the cough, the keener appears to be the enjoyment of the smoker and his companions. The pipe is passed round, until the whole of the smokers are engaged in violent contortions, accompanied by an almost terrifying coughing."

Aboriginal Art in Copper.—Very interesting specimens of objects made of wood and covered with copper have been found among the relics of the American aborigines. Several have been described by Prof. F. W. Putnam and by Warren K. Moorehead, both of whom have found them in Ohio. Other objects have been found of copper sheathed with silver, gold, or meteoric iron. It is shown clearly that the American aborigines in the Mississippi Valley and in South America had the art of cold-hammering copper, of beating it so as to overlie and fit upon a warped or curved surface, and of turning the edges under. Yet more elaborate work is exhibited in two specimens sent to the National Museum by Lieutenant G. T. Emmons, United States Navy, of figures of humming-birds in wood, well carved and painted red, each wing and tail of which is overlaid with a covering of sheet copper, pressed down to fit and turned under at the margins so as to be held fast. The surfaces are adorned with the conventional wing and eye signs of the Haidas. Especial attention is invited by Mr. Otis T. Mason to the carving on the copper. The furrows and ridges are all cut with steel tools. The work is regarded by Mr. Mason as "above and beyond the ability of the aboriginal metallurgists of the Mississippi Valley."

Korean Hats.—The hats of the Koreans are described by Mr. H. S. Saunderson as shaped somewhat like inverted flower-pots, with broad, straight brims, measuring nearly two feet across; while the crowns are about six inches high and three inches in diameter at the top. "The shape is undoubtedly due to the way the hair is dressed. These hats are made of horsehair or very finely split bamboo, beautifully plaited, and are varnished, as a protection against the weather. They are invariably stained black, except for half mourning, when they are string-color (that is, of natural hemp). They are usually fitted with bands which are tied under the chin, but in the case of high officials these bands are replaced by a long string of beads joined at each end to the hat. This hat does not fit upon the head itself, but rests upon a tightly fitting skullcap, held in place by strings tied round the head. The natives are very careful of their hats, for they are expensive, and when it rains they always protect them with little coverings of the oiled paper for which the country is famous, and of which they make their waterproof coats, tobacco pouches, and fans. The officials, when on court duty, wear even more extraordinary hats than these, but their shapes are so fantastic that it is perfectly impossible to describe them. In the winter, fur and wadded head-dresses are worn under the hats. . . . The official servants wear hats made of black or brown camel's-hair felt with small round crowns and large flat brims; while those worn by the soldiers are much the same in shape as the gentry's, but are made of black felt, have much smaller brims, and are bound with red." The most curious hats are those of the mourners, shaped like enormous toadstools, and so large as to hide the face. They are made of plaited bamboo strips, and are not colored. The women wear nothing on their heads, except in winter, when they put on curiously shaped fur caps, open at the crown and adorned in front and behind with red silk tassels.

Uses of Wire.—Wire is shown in Mr. J. Bucknall Smith's book on its manufacture and its uses, to be employed for a great variety of purposes, and these having a very extended range. It is used for the delicate hair springs of watches, and in the form of large cables supports suspension bridges. It is also used in the manufacture of pins, needles, and fish-hooks; it has been applied in coils to the construction of heavy ordnance, and it forms the periphery of a huge fly wheel recently constructed in Germany. Wire ropes are valuable in supplying the means of haulage in mines; by their help materials are transported in the air over a rough country; they are used for the traction of tram cars, and of barges along canals; and, being stronger, lighter, more durable, and cheaper, they advantageously replace hempen ropes for towing, moving, hoisting, and other purposes. Filigree work is formed of fine silver and silver-gilt wire; the finest wires are inserted to serve as the hairs within the eyepieces of the telescopes of surveying and astronomical instruments; and wire is largely used in fencing and netting. Steel wire forms the frames of spectacles, and has replaced whalebone in the ribwork of umbrellas. It is also employed for the strings of pianos and other musical instruments, and has found a more recent application in the spokes of cycle wheels. Copper wire forms the coils round the magnets of dynamo machines for generating electricity, and it transmits the electric current to a distance after its production, for the purposes of illumination. It, moreover, furnishes the vehicle for the transmission of messages by the telegraph and telephone; and when inserted in submarine cables it forms a connecting link between distant parts of the world, and permits the firing of under-water mines in security by an electric battery at a distance. The great diversity of uses to which wire is applied is due to the increased tensional strength possessed by metals when drawn into wire, which is owing to the great tensional resistance acquired by the outer skin; to the flexibility, combined with strength, possessed by wire cables; to the facility with which wire can be drawn out to a variety of gauges; and to the extreme fineness that can be attained with certain metals in the process of wire drawing.

Cereals in Japan.—The most important cereal crops of Japan, according to a report recently issued, are rice, barley, and wheat. Rice is cultivated in nearly all the provinces, and, either as flour or whole grain, boiled with rice, is a common food. It is whitened like pearl barley, steeped five or six hours in water, and then boiled. One of the most common articles of food is *miso*, which is prepared by pounding together boiled soy beans, salt, and the *koji* or yeast, prepared from common barley. Barley is also used for brewing beer and making confectionery, and as food for horses and cattle. Its straw, bleached and plaited, is used in summer hats. Wheat is also generally cultivated, and is principally used for preparing soy, vermicelli, and confectionery, and its straw for thatching roofs, etc. Some barley and wheat is exported to foreign countries, barley chiefly to Hong Kong and Vladivostock, and wheat, in flour, to Russia and Korea, and as grain to Hong Kong and England. The manufacture of straw plaits and other goods from bleached barley stalks is assuming large proportions. Although Japanese straw is not so good as that of Italy, it is better than that of China. Articles of straw, especially toys, have been made for many centuries, but recently, stimulated by the demand for exportation, the manufacture of plaits has increased rapidly.

Chitral.—Chitral, where the British recently conducted a successful military campaign for the relief of their post, is described by Captain Younghusband as "a mountainous country, which, if you could get a bird's-eye view of it, you would see to be composed partly of gigantic snowy peaks, partly of barren rocky mountains, and, in a very small degree, of cultivated land. The valleys are narrow and confined, the main ones in their inhabited portions running from five thousand to eight thousand feet above sea level. It is only in them that any cultivation at all is found, and even there it is not carried on very extensively. But what there is is generally very good, and Chitral is a country noted for its fruit." All the ordinary cereals are grown, though in the higher part of the valleys it is only possible to produce barley and buckwheat. The whole food production is small, and barely suffices for the people of the country. The climate varies, of course, according to the height of the valley. The population of Chitral is probably about seventy thousand or eighty thousand. The people are all Mohammedans, but not of a very strict or fanatical type. In the lower part of the Chitral Valley, where they touch on the Pathans, so noted for their fanaticism, they have become to a certain extent tainted by it; but in the upper valleys the people are very quiet, and do not seem to trouble themselves much about religious observances. On the whole, the Chitralis may be described as a peaceable race, who can fight well enough when they are roused to action, but who really prefer to keep quiet and be left alone to enjoy life in peace. They are very fond of sport, and delight in polo, which they play in an offhand, "go-as-you-please" way. The ruler of the country is designated the Mehtar, and has absolute power up to a certain point, beyond which he is hedged in by custom; and nearly all the affairs of state are transacted at the audience hall, where every man has his say and perfect freedom. The state is situated between Cashmere and the Hindu Kush Mountains.

Making the House Healthful.—The relation of the house to the prevention and treatment of disease is set forth by Dr. G. V. Poore, in The Practitioner, as a matter of prime importance. The danger of the communication of infectious disease to the other inmates of the house in which it appears has long been recognized, and the list of diseases communicable in this way is extending; yet sufficient account of this danger is seldom taken in planning and constructing the dwelling. The main object to be kept in view in building a house, and especially in building a house for invalids, is the supply of fresh air. Too much care can not be taken to insure that all the channels of internal communication—hall, passages, staircases—have independent ventilation of their own. Unless there be means of getting these internal channels blown out by through draughts, the house can not be wholesome; and in the event of any air-borne contagion getting a footing in the house, the liability to spread is enormously increased. These internal channels must have light also. If the house be of several stories, the ventilation of the staircase has an importance that bears a direct proportion to the height of the house. The shafts for elevators require independent ventilation as much as the staircases. One of the chief defects in the construction of city houses is the absence of provision for effective ventilation; so that the internal channels of communication, instead of serving for the supply of fresh air, merely facilitate exchange of foul air. This defect of construction is dangerous in proportion to the size of the building and the number of persons it contains. The suggestion has been made to place the secondary staircase (in invalid homes) between the wards and the sanitary offices, so that the staircase well forms a cut-off, with cross-ventilation between the ward on one side and the various sinks, closets, and baths on the other side. The point which requires more attention than any other in building a house is the aspect. This is too often neglected. A house should receive its maximum amount of sun. The best aspect for a house is generally conceded to be that which allows its chief rooms to look to the southeast. In this way the morning sun is enjoyed, and the rooms do not get the glare of the afternoon sun. It may be advisable to build a house in the form of a veritable sun-trap. The sanitary advantage of a large area for a house is very great indeed. In hospitals we now recognize that infinitely the most important element of the "cubic space per bed" is the floor area, and that a deficient floor space is not to be compensated for by giving great height to the wards. The same reasoning is applicable to a house.

Irrigation of the Nile Valley.—In projecting the irrigation works for the Nile Valley Engineer Scott-Moncrieff first undertook to restore the barrage built by Mohammed Ali—two stone bridges of seventy-one and sixty-one arches respectively thrown across the Rosetta and Damietta branches where they bifurcate. The arches were intended to be fitted up with gates, by lowering which the water would be dammed up and turned into three great brick irrigation canals. The idea of these works was excellent, but the execution was feeble, and they had so far failed to accomplish their purpose. They were again taken in hand and completed in 1890, since when the barrage has given no trouble. The three great canals carry off all the river supply from above it, so that practically now the low Nile is emptied every season at the barrage, and no water escapes to the sea. Attention was next directed to providing for the storage of the surplus waters of the upper Nile. The first scheme was to build a great dam at Philæ, to be one hundred and fifteen feet high, eighty-five feet at the base, and a mile and a quarter long, pierced by sluices large enough to allow the whole Nile at highest flood to rush through. The lake formed would have been one hundred and twenty miles long. The execution of this plan would have drowned the island of Philæ with its splendid Ptolemaic temples built on the sites of older buildings that disappeared centuries ago; and the civilized world protested against the vandalism, though it were perpetrated in the name of public utility. Even the French for once agreed with the English about what should be done in Egypt. The plan was changed. The majestic structure of the dam will be cut down thirty-seven feet, so as to be only eighty-eight feet high, and Philæ will stand in a lake, but will not be drowned.

Patinas of Japanese Bronzes.—Describing the patinas of Japanese bronzes, Mr. W. Gowland, late of the Imperial Mint, says that in many bronzes the beautiful color is due to a "stain" or colored film of infinitesimal thinness. In others, the surface of the metal is altered to a considerable depth, and in these only we have true patinas. Frequently both a stain and a patina are produced by similar treatment, but the operations required for the latter are of a more prolonged character than for the former, and are accompanied by special manipulations in addition to the application of what are called pickling solutions. For the production of patinas of the richest and darkest shades of brown by Japanese methods, it is essential that lead should form one of the constituents of the bronze, and that zinc should either be absent altogether or be present only in small proportions. On the other hand, stains of any color can be given to metal of any composition, and even to unalloyed copper. The substances used in the operations are copper sulphate, basic acetates of copper (verdigris), iron sulphate, sulphur in fine powder, alum, vinegar prepared from unripe plums, and a decoction of the roots or entire plant of *Calamagrostis Hakenensis* (natural order *Gramineæ*), potassium nitrate, and sodium chloride. The most important of these reagents are the first five. The processes for producing a patina by the use of the various solutions of these substances are somewhat complicated and difficult, and the intermediate operations, on which its production depends more than on the exact composition of the solution, are variously modified in different foundries.

The Peril of Color-Blindness.—Renewed attention has been called by Surgeon W. M. Beaumont, of the Bath (England) Eye Infirmary, to the importance of perfect color vision for railway servants, which is unquestioned in the minds of ophthalmic surgeons, however other doctors and railway directors may be disposed to ignore it. Some questions asked by one of the doubting doctors, whether, since attention has been turned to the subject, any accident has been brought home to defect in color vision, or other facts demonstrating the theory have been brought out in usual practical sailing and railway life, are answered by reference to several illustrative incidents that have been gathered. Of these are the wreck of the steamer City of Austin, on the Florida coast, with a color-blind pilot; the collision of the Corbet Castle and the T. H. Ramieu, due to the color-blindness or short-sightedness of the chief officer; the collision of the Lumberman and the Isaac Bell, near Norfolk, Va., the Lumberman's master being color-blind, and consequently taking the wrong course with his vessel; and the narrow escape of the steamer Neera from a collision through the color-blindness of its officer. In another instance the color-blindness of a railway fireman and the imminent danger of collision thereby were experimentally determined in the ordinary working of the train. Even where the color-blind engineer believes he can distinguish between the signals, and appears to do so, he does it, not by the color, but by the difference in intensity. This is a very uncertain and indefinite factor, and is liable to variations according to the weather, the condition of the engineer, and other causes not so well known, and can not be safely depended upon.

Farming on the Yang-tse Kiang.—The country in China along the Yang-tse River from Shanghai to Hankow, and for a hundred miles on either side of the river, is, in general, a rich alluvial plain, traversed by ranges of hills having an east and west trend. The tops of the hills give the best tea, and where the ground is stony fir and oil trees are planted, for oil, resin, timber, and firewood. On lands of intermediate height—or where the land is not suitable for rice—cotton, wheat, corn, buckwheat, sweet potatoes, and kitchen vegetables are grown in great profusion. Dairy farming is unknown, and milk is looked upon with disgust. The native buffalo is the domestic animal employed in cultivating rice. Three crops can generally be secured in a year. A little indigo is grown for domestic use, and almost takes care of itself. In many respects the bamboo takes the place of metals, although iron, copper, and brass are well known, and have been from very early times. The young shoots make an excellent vegetable, and paper and twine of great strength are produced from the fiber. The fields are cultivated like gardens, well hoed and clear of weeds. All the tools with cutting edges are of native manufacture, and steeled and tempered on the edge.

NOTES.

In the excavation of the ancient Roman city at Silchester, England, twelve rectangular inclosures or buildings have been found, all of the same type, and containing furnaces, obviously of an industrial character, and of various sizes. The circular furnaces correspond exactly with the dyeing furnace at Pompeii, and are supposed to have been used for a like purpose. The supposition is corroborated by the large number of wells discovered. A number of other furnaces with a straight flue are supposed to have been intended for drying. Several rooms are traceable which, it is presumed, were intended for the storage of goods and materials, and open spaces with no remains of flues which may have been used for bleaching grounds. A number of querns for hand-grinding the madder-roots used for dyeing purposes have been discovered.

A man shot through the brain, says Mr. Victor Horsley, dies, not through failure of the heart's action, but through the want of breath occasioned by the explosive effect of the bullet passing through the wet brain substance, and consequent injury to the base of the brain. The heart goes on beating, but respiration stops; indeed, the heart is stimulated, not depressed, when a bullet enters the brain; and the proper treatment of a man thus shot is the same as that resorted to in the case of drowned people—one should try to set up artificial respiration.

The investigation of the effect of metals on the growth of bacteria has been continued by Dr. Meade Bolton. His process was to inoculate a tube of melted jelly with particular microbes, and pour the contents out on a sterilized glass plate, after which bits of the metal under examination were laid on the jelly while it was still soft. If the metal has an inhibitory action on the microbes, then a clear zone is left around it after the colonies have developed in the other parts of the jelly. The width of this zone, Dr. Bolton found, varied very considerably with different organisms, as well as with different metals. Throughout the investigation it was found that those metals that are resistant toward chemical reagents in general failed to produce an effect on the microbes; while those metals which are readily attacked by chemical reagents all exhibited a marked inhibitory action upon the growth of bacteria. This result is probably due to a solution of the metal taking place in the medium.

Provision is made in the Missouri Botanic Garden for the furtherance of advanced research in botany and cognate sciences, and facilities are freely given to professors of botany and other persons wishing and competent to perform such work. The garden is rich in native and exotic species of plants, and horticulturists' varieties under cultivation; the herbarium includes nearly two hundred and fifty thousand species, fairly representative of the vegetable life of Europe and the United States, with specimens from other regions, and is supplemented by a large collection of woods; and the library is representative of the present condition of the science in its various departments, and contains besides nearly five hundred botanical volumes prepared before the period of Linnæus. Botanists wishing to pursue their studies here are invited to communicate on the subject with Prof. William Trelease, director, St. Louis.

The rapid decrease in the population of Ireland—from 8,300,000 to 4,600,000 in fifty years—is ascribed by Dr. Grimshaw, registrar general, to three causes: the frequent failure of the potato crop; the emigration stimulated by the high wages in America and the low wages at home; and the lack of manufacturing industries, the result of which is that when the crops fail the people become destitute and have to leave the country. Notwithstanding the decrease in the population, the registrar general believes that the country has gained in wealth.

Prof. Simon Newcomb has been elected by the French Academy of Sciences an associate academician as successor to the late Prof. Helmholtz.

In addition to the general courses of instruction of the Marine Biological Laboratory at Woods Holl, Mass., special lectures will be given on Embryology, by C. O. Whitman; Botanical Museum Development, by J. M. McFarlane; Matter and Energy, by A. E. Dolbear; and evening lectures will be delivered by specialists on biological subjects of general interest. Forty private laboratories are provided for investigators. The course of invertebrate anatomy will embrace simply a study of typical marine invertebrates, through lectures, laboratory work, and excursions; that in vertebrate anatomy has been arranged for those who desire a thorough study of the vertebrate body. The work in botany will be restricted to the study of the structure and development of types of the various orders of the cryptogamous plants Applications should be addressed to William A. Setchell, 2 Hillhouse Avenue, New Haven, Conn.

Dr. E. B. Tylor suggests the use of correspondence in culture as a means of tracing lines of connection and intercourse between ancient and remote peoples. The Egyptian conception of the judgment of the dead by weighing in a spiritual balance may be traced in a series of variants that seem to draw lines of intercourse through the Vedic and Zoroastrian religions. The associated doctrine of the Bridge of the Dead, which separates the good, who pass over, from the dead, who fall into the abyss, appears first in the ancient Persian religion, reaching to the extremities of Asia and Europe.

The subscription of $250,000 required by the law incorporating the New York Botanic Garden as a condition precedent to the city's furnishing $500,000 more and a site, has been completed, and the Garden may now be regarded as a near certainty. Its friends purpose to go on with their efforts and secure an increase of the subscriptions to $500,000. The site chosen, comprising 250 acres, is in Bronx Park, on both sides of the Bronx River.

The difference between European (continental) and our own methods of criminal procedure was strikingly illustrated in a trial for murder by poisoning which recently took place in Antwerp. The presiding justice freely expressed the opinion that the evidence was convincing, and questioned the prisoner as if he had been a prosecuting lawyer; and the prisoner, who expected this, had to prepare herself for such treatment. She was herself the principal witness. The jury was presumed to take the judge's questioning for what it was worth as it would have taken them from a prosecuting counsel, and not as carrying any authority, as whatever the judge might say would do with us. The prisoner had her advantages under this method, for she could be her own witness and counsel, and explain the circumstances herself. No prejudice appears to have existed in the minds of any except that which was raised by the evidence.

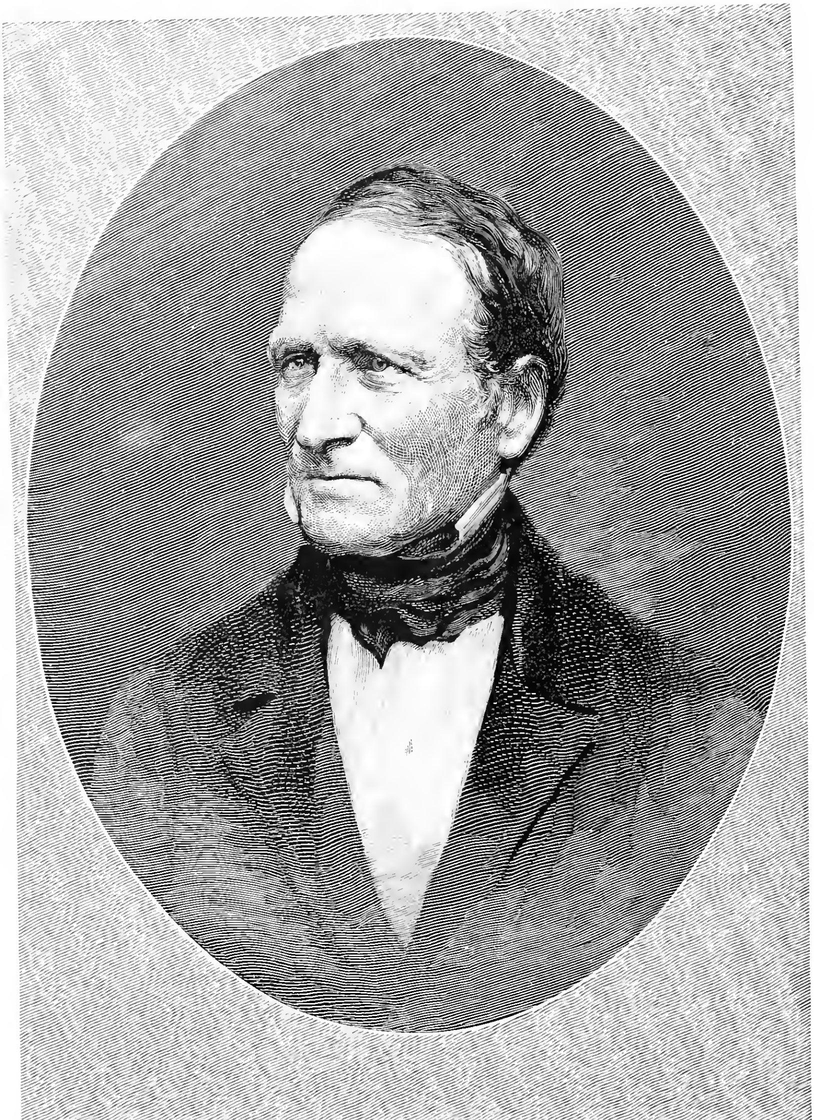
The Report of the Interstate Commerce Commission shows that the percentage of increase of railway mileage in 1894 was less than for any preceding year for which reports have been made to the commission. No better showing is anticipated for 1895. Sixteen roads were abandoned. The gain in the use of train brakes and automatic couplers was largely in excess of the increase of equipment during the year, but can not be considered as showing a marked tendency toward compliance with the law; for 74·80 per cent of the total equipment is still without train brakes and 72·77 per cent without automatic couplers. All must, by law, be supplied before January, 1898. The number of men employed was smaller than in any year since 1890, the largest decrease being in trackmen.

The man or woman, says Dr. B. Ward Richardson, who trains himself in the best bodily health makes the best of life. Bodily welfare is important, not for itself only, but because the health of the mind so largely depends on the health of the body. A good engine outlives many of its masters because they attend to it more carefully than they attend to their own bodies. The usual relations of the age of maturity to length of life, indicating a ratio of one to five, suggest that a man taking twenty-one years to mature should live one hundred and five years. The fact that such life is exceptionally attained shows its possibility; and it is owing to errors that it is not more widely attained in the human species.

OBITUARY NOTES.

Thomas Henry Huxley died at Eastbourne, England, on June 29th. A severe attack of influenza early in the spring had been followed by bronchitis and other disorders. He several times rallied, but was finally obliged to succumb. A sketch of his career, by Ernst Haeckel, and a portrait, were published in an early volume of this magazine. Prof. Huxley had recently completed the revision of his essays for an edition that has appeared in nine volumes. His last magazine article was on Mr. Balfour's Attack on Agnosticism. It appeared in the Nineteenth Century for March, and was to be followed by a second paper which his illness prevented him from completing.

Prof. William C. Williamson, well known as a biologist and paleontologist, died at Clapham, England, on June 23d, in his seventy-ninth year. When Owens College was founded in 1851 he was made its Professor of Biology and Geology, his researches having already won him an election as a F. R. S. Later this professorship was divided, and for many years he had held the chair of botany. He was the first to announce the existence in some of the deeper seas of what is now known as the foraminiferous ooze. He also made important researches upon the teeth and scales of fishes, and upon the fossil plants of the coal measures. He received the Royal Medal of the Royal Society, and the Wollaston gold medal of the Geological Society. The University of Edinburgh conferred upon him the degree of LL. D. He was elected by the Royal Society of Sweden to the foreign membership left vacant by the death of Asa Gray.



EDWARD HITCHCOCK.

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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XX.—FROM THE DIVINE ORACLES TO THE HIGHER CRITICISM.

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IV. THE CLOSING STRUGGLE.

THE storm aroused by Essays and Reviews had not yet subsided when a far more serious tempest burst upon the English theological world.

In 1862 appeared a work entitled The Pentateuch and the Book of Joshua Critically Examined, its author being Colenso, Anglican Bishop of Natal in South Africa. He had formerly been highly esteemed as fellow and tutor at Cambridge, master at Harrow, and author of various valuable text-books in mathematics. Had he exercised his powers within the limits of popular orthodoxy, he was evidently in the way to the highest positions in the Church; but he chose another path. His treatment of his subject was reverent, but he had gradually come to those conclusions, then so daring, now so widespread among Christian scholars, that the Pentateuch, with much valuable historical matter, contains much that is unhistorical; that a large portion of it was the work of a comparatively late period in Jewish history; that many passages in Deuteronomy could only have been written after the Jews settled in Canaan; that the Mosaic law was not in force before the captivity; that the book of Chronicles was clearly written as an afterthought to enforce the views of the priestly caste; and that in all the books there is much that is mythical and legendary.

These statements, which now seem so moderate, then aroused horror. Especial wrath was caused by some of his arithmetical arguments, and, among them, those which showed that an army of six hundred thousand men could not have been mobilized in a single night; that three millions of people, with their flocks and herds, could neither have obtained food on so small and arid a desert as that over which they were said to have wandered during forty years, nor water from a single well; and that the butchery of two hundred thousand Midianites by twelve thousand Israelites, "exceeding infinitely in atrocity the tragedy at Cawnpore, had happily only been carried out on paper." There was nothing of the scoffer in him. While preserving his own independence, he had kept in touch with the most earnest thought both among European scholars and in the little flock intrusted to his care. He evidently remembered what had resulted from the attempt to hold the working classes in the towns of France, Germany, and Italy to outworn beliefs; he had found even the Zulus, whom he had thought to convert, awakened to the legendary character of the Old Testament, and with his clear, practical mind he realized the danger which threatened the English Church and Christianity—the danger of tying its religion and morality to interpretations and conceptions of Scripture more and more widely seen and felt to be contrary to facts. He saw the especial danger of sham explanations; of covering up facts which must soon be known, and which, when all was revealed, must inevitably bring the plain people of England to regard their teachers, even the most deserving, as "solemnly constituted impostors"; ecclesiastics whose tenure depends on assertions which they know to be untrue. Therefore it was that, when his catechumens questioned him regarding some of the legends in the Old Testament, the bishop determined to tell the truth. He says: "My heart answered in the words of the prophet, 'Shall a man speak lies in the name of the Lord?' I determined not to do so."

But none of these considerations availed in his behalf at first. The outcry against the work was deafening; churchmen and dissenters rushed forward to attack it. Archdeacon Denison, chairman of the Committee of Convocation appointed to examine it, uttered a noisy anathema. Convocation solemnly condemned it; and a zealous colonial bishop, relying upon a nominal supremacy, deposed and excommunicated its author, declaring him "given over to Satan." On both sides of the Atlantic the press groaned with "answers," some of these being especially injurious to the cause they were intended to serve, and none more so than sundry efforts by the bishops themselves. One of the points upon which they attacked him was his assertion that the reference in Leviticus to the hare chewing its cud contains an error. Upon this Prof. Hitzig of Leipsic, probably the best Hebrew scholar of his time, remarked: "Your bishops are making themselves the laughing-stock of Europe. Every Hebraist knows that the animal mentioned in Leviticus is really the hare; . . . every zoölogist knows that it does not chew the cud." *

On Colenso's return to Natal, where many of the clergy and laity who felt grateful for his years of devotion to them received him with signs of affection, an attempt was made to ruin these clergymen by depriving them of their little stipends, and to terrify the simple-minded laity by threatening them with the same "greater excommunication" which had been inflicted upon their bishop. To make the meaning of this more evident, the vicar-general of the Bishop of Cape Town met Colenso at the door of his own cathedral, and solemnly bade him "depart from the house of God as one who has been handed over to the Evil One." The sentence of excommunication was read before the assembled faithful, and they were enjoined to treat their bishop as "a heathen man and a publican." But these and a long series of other persecutions created a reaction in his favor.

There remained to Colenso one bulwark which his enemies found stronger than they had imagined—the British courts of justice. The greatest efforts were now made to gain the day before these courts, to humiliate Colenso, and to reduce to beggary the clergy who remained faithful to him, and it is worthy of note that one of the leaders in preparing the legal plea of the committee against the accused was Mr. Gladstone.

But this bulwark proved impregnable; both the Judicial Committee of the Privy Council and the Rolls Court decided in Colenso's favor. Not only were his enemies thus forbidden to deprive him of his salary, but their excommunication of him was made null and void; it became, indeed, a subject of ridicule, and even a man so enwrapped in religious thought as John Keble confessed and lamented that the English people no longer believed in excommunication. The bitterness of the defeated found vent in the utterances of the colonial metropolitan who had excommunicated Colenso—Bishop Gray, "the Lion of Cape Town"—who denounced the judgment as "awful and profane" and the Privy Council as "a masterpiece of Satan" and "the great dragon of the English Church." Even Wilberforce, careful as

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* For the passages referred to as provoking especial wrath, see Colenso, Lectures on the Pentateuch and the Moabite Stone, 1876, p. 217. For the episode regarding the hare chewing the cud, see Cox, Life of Colenso, i, p. 240. The following epigram went the rounds:

> "The bishops all have sworn to shed their blood
> To prove 'tis true the hare doth chew the cud.
> O bishops, doctors, and divines, beware—
> Weak is the faith that hangs upon a *hair!*"

he was to avoid attacking anything established, alluded with deep regret to "the devotion of the English people to the law in matters of this sort."

Their failure in the courts only seemed to increase the violence of the attacking party. The Anglican communion, both in England and America, was stirred to the depths against the heretic, and various dissenting bodies strove to show equal zeal. Great pains were taken to root out his reputation; it was declared that he had merely stolen the ideas of rationalists on the Continent by wholesale, and then peddled them out in England at retail; the fact being that, while he used all the sources of information at his command, and was large-minded enough to put himself into relations with the best biblical scholarship of the Continent, he was singularly independent in his judgment, and his own investigations were of lasting value in modifying Continental thought. Kuenen, the most distinguished of all his contemporaries in this field, modified, as he himself declared, one of his own leading theories after reading Colenso's argument; and other Continental scholars scarcely less eminent acknowledged their great indebtedness to the English scholar for original suggestions.*

But the zeal of the bishop's enemies did not end with calumny. He was socially ostracized; more completely even than Lyell had been after the publication of his Principles of Geology thirty years before. Even old friends left him, among them Frederick Denison Maurice, who, when himself under the ban of heresy, had been defended by Colenso. Nor was Maurice the only heretic who turned against him; Matthew Arnold attacked him, and set up, as a true ideal of the work needed to improve the English Church and people, of all books in the world, Spinoza's Tractatus! A large part of the English populace was led to regard him as an "infidel," a "traitor," an "apostate," and even as "an unclean being"; servants left his house in horror; "Tray, Blanche, and Sweetheart were let loose upon him"; and one of the favorite

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* For interesting details of the Colenso persecution, see Davidson's Life of Tait, chaps. xiii and xiv; also the Lives of Bishops Wilberforce and Gray. For full accounts of the struggle, see Cox, Life of Bishop Colenso, London, 1888, especially vol. i, chap. v. For the dramatic performance at Colenso's cathedral, see vol. ii, pp. 14–25. For a very impartial and appreciative statement regarding Colenso's work, see Cheyne, Founders of Old Testament Criticism, London, 1893, chap. ix. For testimony to the originality and value of Colenso's contributions, see Kuenen, Origin and Composition of the Hexateuch, introduction, p. xx, as follows: "Colenso directed my attention to difficulties which I had hitherto failed to observe or adequately to reckon with, and, as to the opinion of his labors current in Germany, I need only say that, inasmuch as Ewald, Bunsen, Bleek, and Knabel were every one of them logically forced to revise their theories in the light of the English bishop's researches, there was small reason in the cry that his methods were antiquated and his objections stale."

amusements of the period among men of petty wit and no convictions was the devising of light ribaldry against him.*

In the midst of all this controversy stood three men, each of whom has connected his name with it permanently.

First of these was Samuel Wilberforce, at that time Bishop of Oxford. The gifted son of William Wilberforce, who had been honored throughout the world for his efforts in the suppression of the slave trade, he had been rapidly advanced in the English Church, and was at this time a prelate of wide influence. He was eloquent and diplomatic, witty and amiable, always sure to be with his fellow-churchmen and polite society against uncomfortable changes. Whether the struggle was against the slave power in the United States, or the squirearchy in Great Britain, or the evolution theory of Darwin, or the new views promulgated by the Essayists and Reviewers, he was always the suave spokesman of those who opposed every innovator and "besought him to depart out of their coasts." Mingling in curious proportions a truly religious feeling with care for his own advancement, his remarkable power in the pulpit gave him great strength to carry out his purposes, and his charming facility in being all things to all men, as well as his skill in evading the consequences of his many mistakes, gained him the sobriquet of "Soapy Sam." If such brethren of his in the episcopate as Thirlwall and Selwyn and Tait might claim to be in the apostolic succession, Wilberforce was no less surely in the succession from the most gifted and eminently respectable Sadducees who held high preferment under Pontius Pilate.

By a curious coincidence he had only a few years before preached the sermon when Colenso was consecrated in Westminster Abbey, and one passage in it may be cited as showing the preacher's gift of prophecy both hortatory and predictive. Wil-

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* One of the nonsense verses in vogue at the time summed up the controversy as follows:

"A bishop there was of Natal,
Who had a Zulu for his pal;
Said the Zulu, 'My dear,
Don't you think Genesis queer?'
Which converted my lord of Natal."

But verses quite as good appeared on the other side, one of them being as follows:

"Is this, then, the great Colenso,
Who all the bishops offends so?
Said Sam of the Soap,
'Bring fagots and rope,
For oh! he's got no friends, oh!'"

For Matthew Arnold's attack on Colenso, see Macmillan's Magazine, January, 1863. For Maurice, see the references already given.

berforce then said to Colenso: "You need boldness to risk all for God; to stand by the truth and its supporters against men's threatenings and the devil's wrath; . . . you need a patient meekness to bear the galling calumnies and false surmises with which, if you are faithful, that same Satanic working which, if it could, would burn your body, will assuredly assail you daily through the pens and tongues of deceivers and deceived, who, under a semblance of a zeal for Christ, will evermore distort your words, misrepresent your motives, rejoice in your failings, exaggerate your errors, and seek by every poisoned breath of slander to destroy your powers of service." *

Unfortunately, when Colenso followed this advice, his adviser became the most untiring of his persecutors. While leaving to men like the Metropolitan of Cape Town and Archdeacon Denison the noisy part of the onslaught, Wilberforce was among those who were most zealous in devising more effective measures.

But time, and even short time, has redressed the balance between the two prelates. Colenso is seen more and more of all men as a righteous leader in a noble effort to cut the Church loose from fatal entanglements with an outworn system of interpretation; Wilberforce, as the remembrance of his eloquence and of his personal charms dies away, and as the revelations of his indiscreet biographers lay bare his modes of procedure, is seen to have left, on the whole, the most disppointing record made by any Anglican prelate during the nineteenth century.

But there was a far brighter page in the history of the Church of England; for the second of the three who linked their names with that of Colenso in the struggle was Arthur Penrhyn Stanley, Dean of Westminster. His action during this whole persecution was an honor not only to the Anglican Church but to humanity. For his own manhood and the exercise of his own intellectual freedom he had cheerfully given up the high preferment in the Church which had been easily within his grasp. To him truth and justice were more than the decrees of a Convocation of Canterbury or of a Pan-Anglican Synod; in this as in other matters he braved the storm, never yielded to theological prejudice, from first to last held out a brotherly hand to the persecuted bishop,

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* For the social ostracism of Colenso, see works already cited; also Cox's Life of Colenso. For the passage from Wilberforce's sermon at the consecration of Colenso, see Rev. Sir G. W. Cox, The Church of England and the Teaching of Bishop Colenso. For Wilberforce's relations to the Colenso case in general, see his Life, by his son, vol. iii, especially pp. 113–126 and 229–231. For Keble's avowal that no Englishman believes in excommunication, ibid., p. 128. For a guarded statement of Dean Stanley's opinion regarding Wilberforce and Newman, see a letter from Dean Church to the Warden of Keble, in Life and Letters of Dean Church, p. 293.

and at the most critical moment opened to him the pulpit of Westminster Abbey.*

The third of the high ecclesiastics of the Church of England whose names were linked in this contest was Thirlwall.

He was undoubtedly the foremost man in the Church of his time—the greatest ecclesiastical statesman, the profoundest historical scholar, the theologian of clearest vision in regard to the relations between the Church and his epoch. Alone among his brother bishops at this period, he stood "four square to all the winds that blew," as during all his life he stood against all storms of clerical or popular unreason. He had his reward. He was never advanced beyond a poor Welsh bishopric; but, though he saw men wretchedly inferior constantly promoted beyond him, he never flinched, never lost heart or hope, but bore steadily on, refusing to hold a brief for lucrative injustice, and resisting to the last all reaction and fanaticism, thus preserving not only his own self-respect but the future respect of the English nation for the Church.

A few other leading churchmen were discreetly kind to Colenso, among them Tait, who had now been made Archbishop of Canterbury; but, manly as he was, he was somewhat more cautious in this matter than those who most revere his memory could now wish.

In spite of these friends the clerical onslaught was for a time effective; Colenso, so far as England was concerned, was discredited and virtually driven from his functions. But this enforced leisure simply gave him more time to struggle for the protection of his native flock against colonial rapacity, and to continue his great work on the Bible.

His work produced its effect. The impulse which it gave had much to do with arousing a new generation of English, Scotch, and American scholars. That a new epoch had come was now more and more evident, and out of the many proofs of this we may note two of the most striking.

For many years the Bampton Lectures at Oxford had been considered as adding steadily and strongly to the bulwarks of the old orthodoxy. If now and then orthodoxy had appeared in

* For interesting testimony to Stanley's character, from a quarter whence it would have been least expected, see a reminiscence of Lord Shaftesbury in the Life of Frances Power Cobbe, London and New York, 1894. The late Bishop of Massachusetts, Phillips Brooks, whose death was a bereavement to his country and to the Church universal, once gave the present writer a vivid description of a scene witnessed by him in the Convocation of Canterbury, when Stanley virtually withstood alone the obstinate traditionalism of the whole body in the matter of the Athanasian Creed. It is to be hoped that this account may be brought to light among the letters written by Brooks at that time. See also Dean Church's Life and Letters, p. 294, for a very important testimony.

danger from such additions to the series as those made by Dr. Hampden, these lectures had been, as a rule, saturated with the older traditions of the Anglican Church. But now there came an evident change. The departures from the old paths became many and striking, until at last, in 1893, came the lectures on Inspiration by the Rev. Dr. Sanday, Ireland Professor of Exegesis in the University of Oxford. In these, concessions were made to the newer criticism, which at an earlier time would have driven the lecturer not only out of the Church but out of any decent position in society; for Prof. Sanday not merely gave up a vast mass of the other ideas which the great body of churchmen had regarded as fundamental, but accepted a number of conclusions established by the newer criticism. He declared that Kuenen and Wellhausen had mapped out, on the whole rightly, the main stages of development in the history of Hebrew literature; he incorporated with approval the work of other eminent heretics; he acknowledged that very many statements in the Pentateuch show "the naïve ideas and usages of a primitive age." But, most important of all, he gave up the whole question in regard to the book of Daniel. Up to a time then very recent, the early authorship and predictive character of the book of Daniel were things which no one was allowed to dispute for a moment. Pusey, as we have seen, had proved to the controlling parties in the English Church that Christianity must stand or fall with the traditional view of this book; and now, within a few years of Pusey's death, there came in his own university, speaking from the pulpit of St. Mary's, whence he had so often insisted upon the absolute necessity of maintaining the older view, this professor of biblical criticism, a doctor of divinity, showing conclusively as regards the book of Daniel that the critical view had won the day; that the name of Daniel is only assumed; that the book is in no sense predictive, but was written, mainly at least, after the events it describes; that "its author lived at the time of the Maccabean struggle"; that it is very inaccurate even in the simple facts which it cites; and hence that all the vast fabric erected upon its predictive character is baseless.

But another evidence of the coming in of a new epoch was even more striking.

To uproot every growth of the newer thought, to destroy even every germ that had been planted by Colenso and men like him, a special movement was begun, of which the most important part was the establishment at the University of Oxford of a college which should bring the old opinion with crushing force against the new thought, and should train up a body of young men by feeding them upon the utterances of the fathers, of the mediæval doctors, and of the apologists of the seventeenth and eighteenth centuries, and should keep them in happy ignorance of the reforming spirit of the sixteenth and the scientific spirit of the nineteenth century.

The new college thus founded bore the name of the poet most widely beloved among high churchmen; large endowments flowed in upon it; a showy chapel was erected in accordance throughout with the strictest rules of mediæval ecclesiology. As if to strike the keynote of the thought to be fostered in the new institution, one of the most beautiful of pseudo-mediæval pictures was given the place of honor in its hall, and the college, lofty and gaudy, loomed high above the neighboring modest abode of Oxford science. Kuenen might rage in Holland, and Wellhausen in Germany, and Robertson Smith in Scotland—even Professors Driver, Sanday, and Cheyne might succeed Dr. Pusey as expounders of the Old Testament at Oxford—but Keble College, rejoicing in the favor of a multitude of leaders in the Church, including Mr. Gladstone, seemed an inexpugnable fortress of the older thought.

But in 1889 appeared the book of essays entitled Lux Mundi, among whose leading authors were men closely connected with Keble College and with the movement which had created it. This work gave up entirely the tradition that the narrative in Genesis is a historical record, and admitted that all accounts in the Hebrew Scriptures of events before the time of Abraham are mythical and legendary; it conceded that the books ascribed to Moses and Joshua were made up mainly of three documents representing different periods, and one of them the late period of the exile; that "there is a considerable idealizing element in Old Testament history"; that "the books of Chronicles show an idealizing of history" and "a reading back into past records of a ritual development which is really later," and that prophecy is not necessarily predictive—"prophetic inspiration being consistent with erroneous anticipations." Again a shudder went through the upholders of tradition in the Church, and here and there threats were heard; but the Essays and Reviews *fiasco* and the Colenso catastrophe were still in vivid remembrance. Good sense prevailed, and Benson, Archbishop of Canterbury, instead of prosecuting the authors, himself asked the famous question, "May not the Holy Spirit make use of myth and legend?" *

In the sister university the same tendency was seen. Robertson Smith, who had been driven out of his high position in the

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* Of Pusey's extreme devotion to his view of the book of Daniel there is a curious evidence in a letter to Stanley in the second volume of the latter's Life and Letters. For the views referred to in Lux Mundi, see pages 345–357; also, on the general subject, Bishop Ellicott's Christus Comprobator.

Free Church of Scotland on account of his work in scriptural research, was welcomed into a professorship at Cambridge, and other men, no less loyal to the new truths, were given places of controlling influence in shaping the thought of the new generation.

Nor did the warfare against biblical science produce any different results among the dissenters of England. In 1862 Samuel Davidson, a professor in the Congregational College at Manchester, published his Introduction to the Old Testament. Independently of the contemporary writers of Essays and Reviews, he had arrived in a general way at conclusions much like theirs, and he presented the newer view with fearless honesty, admitting that the same research must be applied to these as to other Oriental sacred books, and that such research establishes the fact that all alike contain legendary and mythical elements. A storm was at once aroused; certain denominational papers took up the matter, and Davidson was driven from his professorial chair; but he labored bravely on, and others followed to take up his work, until the ideas which he had advocated were fully considered.

So, too, in Scotland the work of Robertson Smith was continued even after he had been driven into England, and, as votaries of the older thought passed away, men of ideas akin to his were gradually elected into chairs of biblical criticism and interpretation. Wellhausen's great work, which Smith had introduced in English form, proved a power both in England and Scotland, and the articles upon various books of Scripture and scriptural subjects generally, in the ninth edition of the Encyclopædia Britannica, having been prepared mainly by himself as editor or put into the hands of others representing the recent critical research, this very important work of reference, which had been in previous editions so timid, was now arrayed on the side of the newer thought, insuring its due consideration wherever the English language is spoken.

In France the same tendency was seen, though with striking variations from the course of events in other countries—variations due to the very different conditions under which biblical students in France were obliged to work. Down to the middle of the nineteenth century the orthodoxy of Bossuet, stiffly opposing the letter of Scripture to every step in the advance of science, had only yielded in a very slight degree. But then came an event ushering in a new epoch. At that time Jules Simon, afterward so eminent as an author, academician, and statesman, was quietly discharging the duties of a professorship, when there was brought to him one day the visiting card of a stranger bearing the name of "Ernest Renan, Student at St. Sulpice." Admitted to M. Simon's library, Renan told his story. As a theological student, even before he entered the seminary, he had devoted himself most earnestly to the study of Hebrew and the Semitic languages, and he was now obliged, during the lectures on biblical literature at St. Sulpice, to hear the reverend professor make frequent comments upon the Scriptures, based on the Vulgate, but absolutely disproved by Renan's own knowledge of Hebrew. On Renan's questioning any interpretation of the lecturer, the latter was wont to rejoin: "Monsieur, do you presume to deny the authority of the Vulgate, the translation by St. Jerome, sanctioned by the Holy Ghost and the Church? You will at once go into the chapel and say 'Hail Mary' for an hour before the image of the Blessed Virgin." "But," said Renan to Jules Simon, "this has now become very serious; it happens nearly every day, and, *mon Dieu!* monsieur, I can not spend *all* my time in saying 'Hail Mary' before the statue of the Virgin." The result was a warm personal attachment between Simon and Renan; both were Bretons, educated in the midst of the most orthodox influences, and both had unwillingly broken away from them.

Renan was now emancipated and pursued his studies with such effect that he was made professor at the Collége de France. His Life of Jesus, and other books showing the same spirit, brought a tempest upon him which drove him from his professorship and brought great hardships upon him for many years. But his genius carried the day, and, to the honor of the French Republic, he was restored to the position from which the Empire had driven him. From his pen finally appeared the Histoire du Peuple Israel, in which scholarship broad, though at times inaccurate in minor details, was supplemented by an exquisite acuteness and a poetic insight which far more than made good any of those lesser errors which a German student would have avoided. At his death, in October, 1892, this monumental work had been finished; in clearness and beauty of style it has never been approached by any other treatise on this or any kindred subject. It is a work of genius, and its profound insight into all that is of importance in the great subjects which he treated will doubtless cause it to hold a permanent place in the literature not only of the Latin nations but of the world.

The anathemas lavished upon him by Church authorities during his life, their denial to him of Christian burial, and their refusal to allow him a grave in the place he had chosen, only increased popular affection for him during his last years and deepened the general mourning at his death.*

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* The facts as to the early relations between Renan and Jules Simon were told in 1878 by the latter to the present writer at considerable length and with many interesting details not here given. The writer was also present at the public funeral of the great scholar, and can

But, in spite of all resistance, the desire for more light upon the sacred books penetrated the older Church from every side.

In Germany, toward the close of the eighteenth century, Jahn, Catholic professor at Vienna, had ventured, in an Introduction to Old Testament Study, to class Job, Jonah, and Tobit below other canonical books, and had only escaped serious difficulties by ample amends in a second edition.

Early in the nineteenth century, Herbst, Catholic professor at Tübingen, had endeavored in a similar Introduction to bring more modern research to bear on the older view; but the Church authorities saw that all passages really giving any new light were skillfully and speedily edited out of the book.

Later still, Movers, professor at Breslau, showed remarkable gifts for Old Testament research, and much was expected of him; but his ecclesiastical superiors quietly prevented his publishing any extended work.

During the latter half of the nineteenth century much the same pressure has continued in Catholic Germany. Strong scholars have very generally been drawn into the position of "apologists," and, when this has been found impossible, they have been driven out of the Church.

The same general policy had been evident in France and Italy, but toward the last decade of the century it was seen by the more clear-sighted supporters of the older Church in those countries that the multifarious "refutations" and explosive attacks upon Renan and his teachings had accomplished nothing; that even special services of atonement for his sin, like the famous "*Triduo*" at Florence, only drew a few women and provoked ridicule among the public at large; that throwing him out of his professorship and calumniating him had but increased his influence; and that his brilliant intuitions, added to the careful researches of German and English scholars, had brought the thinking world beyond the reach of the old methods of hiding troublesome truths and crushing persistent truth-tellers.

Therefore it was that about 1890 a body of earnest Roman Catholic scholars began very cautiously to examine and explain the biblical text in the light of those results of the newer research which could no longer be gainsaid.

Among these men were, in Italy, Canon Bartolo, Canon Berta,

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testify of his own knowledge to the deep and hearty evidences of gratitude and respect then paid to Renan, not merely by eminent orators and scholars, but by the people at large. As to the refusal of the place of burial which Renan especially chose, see his own "Souvenirs," in which he laments the inevitable exclusion of his grave from the site which he most loved. As to calumnies, one masterpiece very widely spread, through the zeal of clerical journals, was that Renan received enormous sums from the Rothschilds for attacking Christianity.

and Father Savi, and in France Monseigneur d'Hulst, the Abbé Loisy, Professor at the Roman Catholic University at Paris, and, most eminent of all, Professor Lenormant, of the French Institute, whose researches into biblical and other ancient history and literature had won him distinction throughout the world. These men, while standing up manfully for the Church, were obliged to allow that some of the conclusions of modern biblical criticism were well founded. The result came rapidly. The treatise of Bartolo and the great work of Lenormant were placed on the Index; Canon Berta was overwhelmed with reproaches and virtually silenced; the Abbé Loisy was first deprived of his professorship, and then ignominiously expelled from the university; Monseigneur d'Hulst was summoned to Rome, and has since kept silence.*

The matter was evidently thought serious in the higher regions of the Church, for, in November, 1893, appeared an encyclical letter on The Study of Sacred Scripture by the reigning Pope, Leo XIII. Much was expected from it, for, since Benedict XIV in the last century, there has sat on the papal throne no Pope intellectually so competent to discuss the whole subject. While, then, those devoted to the older beliefs trusted that the papal thunderbolts would crush the whole brood of biblical critics, votaries of the newer thought ventured to hope that the encyclical might, in the language of one of them, prove "a stupendous bridge spanning the broad abyss that now divides alleged orthodoxy from established science." †

Both these expectations were disappointed; and yet, on the whole, it is a question whether the world at large may not congratulate itself upon this papal utterance. The document, if not apostolic, won credit as "statesmanlike." It took pains, of course, to insist that there can be no error of any sort in the sacred books; it even defended those parts which Protestants count apocryphal as thoroughly as the remainder of Scripture, and declared that the book of Tobit was not compiled of man, but written by God. His Holiness naturally condemned the higher criticism, but he dwelt at the same time on the necessity of the most thorough study of the sacred Scriptures, and especially on the importance

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* For the frustration of attempts to admit light into scriptural studies in Roman Catholic Germany, see Bleek, Old Testament, London, 1882, vol. i, pp. 19, 20.

For the general statement regarding recent suppression of modern biblical study in France and Italy, see an article by a Roman Catholic author in the Contemporary Review, September, 1894, p. 365. For the papal condemnations of Lenormant and Bartolo, see the Index Librorum Prohibitorum Sanctissimi Domini Nostri Leonis XIII, P. M., etc., Rome, 1891; Appendices, July, 1890, and May, 1891. The ghastly part of the record, as stated in this edition of the Index, is that both these great scholars were forced to abjure their "errors" and to acquiesce in the condemnation—Lenormant doing this on his deathbed.

† For this statement, see an article in the Contemporary Review, April, 1894, p. 576.

of adjusting scriptural statements to scientific facts. This utterance was admirably oracular, being susceptible of cogent quotation by both sides; nothing could be in better form from an orthodox point of view; but, with that statesmanlike forecast which the present Pope has shown more than once in steering the bark of St. Peter over the troubled waves of the nineteenth century, he so far abstained from condemning any of the greater specific results of modern critical study that the main English defender of the encyclical, the Jesuit Father Clarke, did not hesitate publicly to admit a multitude of such results—results, indeed, which would shock not only Italian and Spanish Catholics, but many English and American Protestants. According to this interpreter, the Pope had no thought of denying that there are different sorts of documents in the Pentateuch, or the plurality of sources of the books of Samuel, or the twofold authorship of Isaiah, or that all after the ninth verse of the last chapter of St. Mark's Gospel is spurious; and, as regards the whole encyclical, the distinguished Jesuit dwelt significantly on the power of the papacy at any time to define out of existence any previous decisions which may be found inconvenient. More than that, Father Clarke himself, while standing as the champion of the most thorough orthodoxy, acknowledged that, in the Old Testament, "numbers must be expected to be used Orientally," and that "all these seventies and forties, as, for example, when Absalom is said to have rebelled against David for forty years, can not possibly be meant numerically"; and, what must have given a fearful shock to some Protestant believers in plenary inspiration, he, while advocating it as a dutiful son of the Church, wove over it an exquisite web with the declaration that "there is a human element in the Bible precalculated for by the divine."

Considering the difficulties in the case, the world has reason certainly to be grateful to Pope Leo and Father Clarke for these utterances, which perhaps, after all, may prove a better bridge between the old and the new than could have been framed by engineers more learned but less astute. Evidently Pope Leo XIII is neither a Paul V nor an Urban VIII, and is too wise to bring the Church into a position from which it can only be extricated by subterfuges as ludicrous as those by which it was dragged out of the Galileo scandal, or by a policy as tortuous as that by which it writhed out of the old doctrine regarding the taking of interest for money.

In spite, then, of the attempted crushing out of Bartolo and Berta and Savi and Lenormant and Loisy, during this very epoch in which the Pope issued this encyclical, there is every reason to hope that the path has been paved over which the Church may gracefully recede from the old system of interpretation and quietly accept and appropriate the main results of the higher criticism. Certainly she has never had a better opportunity to play at the game of "beggar my neighbor" and to drive the older Protestant orthodoxy into bankruptcy.

In America the same struggle between the old ideas and the new went on. In the middle years of the century the first adequate effort in behalf of the newer conception of the sacred books was made by Theodore Parker at Boston. A thinker profound and of the widest range—a scholar indefatigable and of the deepest sympathies with humanity—a man called by one of the most eminent scholars in the English Church "a religious Titan," and by a distinguished French theologian "a prophet," he had struggled on from the divinity school until at that time he was the foremost biblical scholar and preacher to the largest regular congregation on the American continent. The great hall in Boston could seat four thousand people, and at his regular discourses every part of it was filled. In addition to his usual pastoral work he exercised a vast influence as a platform speaker, especially in opposition to the extension of slavery into the Territories of the United States, and as a lecturer on a wide range of vital topics. During each year at that period he was heard discussing the most important religious and political questions in all the greater northern cities; but his most lasting work was in throwing light upon our sacred Scriptures, and in this he was one of the forerunners of the movement now going on, not only in the United States but throughout Christendom. Even before he was fairly out of college his translation of De Wette's Introduction to the Old Testament made an impression on many thoughtful men; his sermon in 1841 on The Transient and Permanent in Christianity marked the beginning of his great individual career; his speeches, his Lectures, and especially his Discourse on Matters Pertaining to Religion, greatly extended his influence. His was a deeply devotional nature, and his public prayers exercised by their touching beauty a very strong religious influence upon his audiences. He had his reward. Beautiful and noble as were his life and his life work, he was widely abhorred. On one occasion of public worship, in one of the more orthodox churches, news having been received that he was dangerously ill, a prayer was openly made by one of the zealous brethren present that this arch-enemy might be removed from earth. He was even driven out from the Unitarian body. But he was none the less steadfast and bold, and the great mass of men and women who thronged his audience room at Boston and his lecture rooms in other cities spread his ideas. His fate was pathetic. Full of faith and hope, but broken prematurely by his labors, he retired to Italy, and there died at the darkest period in the history of the United States, when slavery in the State and the older orthodoxy in the Church seemed absolutely and forever triumphant. The death of Moses within sight of the promised land seems the only parallel to the death of Parker less than six months before the election of Abraham Lincoln and the publication of Essays and Reviews.*

But here it must be noted that Parker's effort was powerfully aided by the conscientious utterances of some of his foremost opponents. Nothing during the American struggle against the slave system did more to wean religious and God-fearing men and women from the old interpretation of Scripture than the use of it to justify slavery. Typical among examples of this use were the arguments of Hopkins, Bishop of Vermont, a man whose noble character and beautiful culture gave him very wide influence in all branches of the American Protestant Church. While avowing his personal dislike to slavery, he demonstrated that the Bible sanctioned it. Other theologians, Catholic and Protestant, took the same ground, and then came that tremendous rejoinder which echoed from heart to heart throughout the Northern States: "The Bible sanctions slavery? So much the worse for the Bible." Then was fulfilled that old saying of Bishop Ulrich of Augsburg: "Press not the breasts of Holy Writ too hard, lest they yield blood rather than milk."

Yet throughout Christendom a change in the mode of interpreting Scripture, though absolutely necessary if its proper authority was to be maintained, still seemed almost hopeless. Even after the foremost scholars had taken ground in favor of it, and the most conservative of these whose opinions were entitled to weight had made concessions showing the old ground to be untenable, there was fanatical opposition to any change. The Syllabus of Errors, issued by Pius IX in 1864, as well as certain other documents issued from the Vatican, had increased the difficulties of this needed transition; and, while the more able-minded Roman Catholic scholars skillfully explained away the obstacles thus created, others published works insisting upon the most extreme views as to the verbal inspiration of the sacred books. In the Church of England various influential men took the same view. Dr. Baylee, Principal of St. Aidan's College, declared that in Scripture "every scientific statement is infallibly accurate; all its histories and narrations of every kind are without any inaccuracy.

* For the appellation "religious Titan" applied to Theodore Parker, see a letter of Jowett, Master of Balliol, to Frances Power Cobbe, in her autobiography, vol. i, p. 357, and for Reville's statement, ibid., p. 9; for a pathetic account of Parker's last hours at Florence, ibid., i, pp. 10, 11. For the statement regarding Parker's audiences and his power over them, the present writer trusts to his own memory. There is a curious reference to Bishop Hopkins's ideas on slavery in Archbishop Tait's Life and Letters.

Its words and phrases have a grammatical and philological accuracy, such as is possessed by no human composition." In 1861 Dean Burgon preached in Christ Church Cathedral, Oxford, as follows: "No, sirs, the Bible is the very utterance of the Eternal; as much God's own word as if high heaven were open and we heard God speaking to us with human voice. Every book is inspired alike, and is inspired entirely. Inspiration is not a difference of degree, but of kind. The Bible is filled to overflowing with the Holy Spirit of God; the books of it and the words of it and the very letters of it."

In 1865 Canon MacNeile declared in Exeter Hall that "we must either receive the verbal inspiration of the Old Testament or deny the veracity, the insight, the integrity of our Lord Jesus Christ as a teacher of divine truth."

As late as 1889 one of the two most gifted pulpit orators in the Church of England, Canon Liddon, preaching at St. Paul's Cathedral, used in his fervor the same dangerous argument: that the authority of Christ himself, and therefore of Christianity, must rest on the old view of the Old Testament; that, since the founder of Christianity, in divinely recorded utterances, alluded to the transformation of Lot's wife into a pillar of salt, and to Noah's ark and the flood, the biblical account of these must be accepted as historical.

In the light of what was rapidly becoming known regarding the Chaldæan and other sources of the accounts given in Genesis, no argument could be more fraught with peril to the interest which the gifted preacher sought to serve.

In France and Germany many similar utterances in opposition to the newer biblical studies were heard, and from America, especially from the college at Princeton, came resounding echoes. As an example of many may be quoted the statement by the eminent Dr. Hodge that the books of Scripture "are, one and all, in thought and verbal expression, in substance, and in form, wholly the work of God, conveying with absolute accuracy and divine authority all that God meant to convey without human additions and admixtures"; and that "infallibility and authority attach as much to the verbal expression in which the revelation is made as to the matter of the revelation itself."

But the newer movement of thought went steadily on. As already in Protestant Europe, so now in the Protestant churches of America, it took strong hold on the foremost minds in many of the churches known as orthodox: Toy, Briggs, Francis Brown, Evans, Preserved Smith, Moore, Bacon, developed it, and, though opposed bitterly by synods and councils of their respective churches, they were manfully supported by the more intellectual clergy and laity. The greater universities of the country ranged themselves on the sides of these men; persecution but intrenched them more firmly in the hearts of all intelligent well-wishers of Christianity. The triumphs won by their opponents in assemblies, synods, conventions, and conferences were really victories for the nominally defeated, since they revealed to the world the fact that in each of these bodies the strong and fruitful thought of the Church, the thought which alone can have any hold on the future, was with the new race of thinkers; no theological triumphs more surely fatal to the victors have been won since the Vatican defeated Copernicus and Galileo.

And here reference must be made to a series of events which, in the second half of the nineteenth century, have contributed most powerful aid to the new school of biblical research.

PROFESSIONAL INSTITUTIONS.

V.—BIOGRAPHER, HISTORIAN, AND LITTERATEUR.

By HERBERT SPENCER.

HOW, in their rudimentary forms, the several arts which express feelings and thoughts by actions, sounds, and words, as well as the professors of such arts, originated together in a mingled state, we have seen in the last two chapters. Continuing the analysis, we have now to observe how there simultaneously arose, in the same undifferentiated germ, the rudiments of certain other products, and of those devoted to the production of them. The primitive orator, poet, and musician, was at the same time the primitive biographer, historian, and litterateur. The hero's deeds constituted the common subject-matter; and, taking this or that form, the celebration of them became, now the oration, now the song, now the recited poem, now that personal history which constitutes a biography, now that larger history which associates the doings of one with the doings of many, and now that variously developed comment on men's doings and the course of things which constitutes literature.

Before setting out to observe the facts which illustrate afresh this simultaneous genesis, let us note that in the nature of things there could not be any other root for these diverse growths; and that this root is deeply implanted in human nature. If we go back to a group of savages sitting round a camp-fire, and ask what of necessity are their ordinary subjects of conversation, we find that there is nothing for them to talk about save their own doings and the doings of others in war and the chase. Though they have surrounding Nature and its changes, sometimes striking, to describe and comment upon, yet even these are usually of interest only as affecting men and influencing their lives. Human actions are the perennially interesting things; and obviously, among human actions, those certain to be most discussed are those which diverge most from the ordinary—the victories of the courageous man, the feats of the strong man, the manœuvres of the cunning man. Thus in the first stages, merely from lack of other exciting matter, there goes, after the narratives of individual successes in the day's hunt or the day's fight, a frequent return to the always-interesting account of the great chief's exploits, his ordinary doings, his strong sayings. Gradually the description and laudation of his achievements grows into a more or less coherent narrative of his life's incidents—an incipient biography. As a reason, too, why biography of this simple kind becomes an early mental product, let us note that it is the simplest—the easiest both to speaker and hearer. To tell of deeds and dangers and escapes requires the smallest intellectual power; and the things told are, fully or partially, comprehensible by the lowest intelligence. Every child proves this. The frequent request for a story shows at once the innate liking for accounts of adventures, and the small tax on the mind involved by conceptions of adventures. And it needs but to note how the village crone, mentally feeble as she may be, is nevertheless full of tales about the squire and his family, to see that mere narrative biography (I do not speak of analytical biography) requires no appreciable effort of thought, and for this second reason early takes shape.

Of course, as above said, biography of a coherent kind, arising among peoples who have evolved permanent chiefs and kings, grows gradually out of accounts of those special incidents in their lives which the priest-poets celebrate. Let us gather together a few facts illustrative of this development.

Its earlier stages, occurring as they do before written records exist, can not be definitely traced—can only be inferred from the fragmentary evidence furnished by those uncivilized men who have made some progress. The wild tribes of the Indian hills yield a few examples. Says Malcolm, "The *Bhat* is both the bard and the chronicler of the *Bhils*." He also states that certain lands of the Bhils were taken by the Rajpoots, and that—

"Almost all the revered Bhats, or Minstrels, of the tribe, still reside in Rajpootana, whence they make annual, biennial, and some only triennial visits to the Southern tribes, to register remarkable events in families, particularly those connected with their marriages, and to sing to the delighted Bheels the tale of their origin, and the fame of their forefathers."

So, too, concerning another tribe we read, in Hislop:—

"The *Pádál*, also named Páthádi, Pardhán, and Desái, is a numerous class, found in the same localities as the Ráj Gonds, to whom its members act as religious counselors (Pradhána). They are, in fact, the *bhats* of the upper classes, repeating their genealogies and the exploits of their ancestors."

Here, then, the priest is the narrator and his narrative is biographico-historical. It consists of leading facts in the lives of persons, and these are so joined with accounts of tribal deeds as to form a rudimentary history.

In Africa where, for reasons before named, loyalty to the living ruler has not usually given origin to worship of the dead ruler, we meet with only the first stage in the development.

The king of the Zulus has "men who perform the part of heralds in the dances, and who now, at every convenient opportunity, recounted the various acts and deeds of their august monarch in a string of unbroken sentences."

In Dahomey, too, the union is between the courtier and the historian. In that kingdom, where women play so dominant a part, there are, as we have seen, female laureates; and "these troubadours are the keepers of the records of the kingdom of Dahomey, and the office, which is hereditary, is a lucrative one."

From Abyssinia we get an illustration of the way in which the united germs of biography and history make their appearance during burials of notables.

"Professional singing women frequently attend the funeral meetings of great people . . . Each person in waiting takes it by turn to improvise some verse in praise of the deceased." But "the professional singers will give minute details of the history of his ancestry, his deeds, character, and even his property."

When the deceased person is a conquering monarch, this funeral laudation by professionals, the first step in apotheosis, begins a worship in which there are united that account of his life which constitutes a biography and that account, of his deeds which forms the nucleus of primitive history.

From the accounts of ancient American civilizations, facts of kindred meaning come to us. Here is a passage from Bancroft concerning the Aztecs:—

"The preparation and guardianship of records of the higher class, such as historical annals and ecclesiastical mysteries, were under the control of the highest ranks of the priesthood."

Again we read:—

At this assembly the 'Book of God' was prepared. "In its pages were inscribed the Nahua annals from the time of the Deluge . . . religious rites, governmental system, laws and social customs; their knowledge respecting agriculture and all the arts and sciences."

It is instructive to observe how in this sacred book, as in other sacred books, religion, history, and biography were mingled with secular customs and knowledge.

Early civilized societies have bequeathed similar proofs. The biographico-historical nature of the Hebrew scriptures is conspicuous. As in other cases, incidents in the life of the national deity form its first subject-matter—how God created various things on successive days and rested on the seventh day. Accounts of his personal doings characterize the next books, and are combined with accounts of the doings of Adam and the patriarchs—biographical accounts. In what we are told of Abraham, Isaac, and Jacob, we see biography dominant and history unobtrusive. But with the transition from a nomadic to a settled life, and the growth of a nation, the historical element comes to the front. Doubtless for a long time the genealogies and the leading events were matters of common traditional knowledge; though we may fairly assume that the priest-class or cultured class were those who especially preserved such knowledge. Later times give some evidence of the connection, as instance these sentences from Kuenen and Neubauer.

"In the eighth century B. C. the prophet of Jahveh has become a writer."

"Upon their return from Babylon, Ezra, called 'the skilled scribe,' made disciples who were called *sopherim*, 'scribes,' and whose business it was to multiply the copies of the Pentateuch and to interpret it. 'Scribe' and scholar' in those days were synonymous."

A few relevant facts are afforded by the ancient books of India. Describing some of their contents Weber says:—

History "can only fittingly be considered as a branch of poetry," both on account of form and on account of subject-matter.

Kalhana, who wrote a history of Kashmir, in 12th cent. A. D. was "more poet than historian."

"In some princely houses, family records, kept by the domestic priests, appear to have been preserved."

From ancient Egyptian inscriptions come various evidences of these relationships. How naturally the biographico-historical element of literature grows out of primitive worship we see in the fact—allied to a fact above named concerning the Abyssinians,—that in an Egyptian tomb there was given in the ante-room an account of the occupant's life; and, naturally, that which was done on a small scale with the undistinguished man was done on a large scale with the distinguished man. We read in Brugsch that—

The Royal gods of the Egyptians, who "are referred to as kings," "have their individual history, which the holy scribes wrote down in the books of the temples."

Here are kindred passages from Bunsen and Duncker:—

Diodorus says "the priests had in their sacred books, transmitted from the olden time, and handed down by them to their successors in office, written descriptions of all their kings." "In these an account is given of every king—of his physical powers and disposition, and of the exploits of each in the order of time."

Priests daily read to the king accounts of the achievements of distinguished men out of the sacred books. "We know that poems of considerable extent on historical subjects were in existence."

Thus it is clear that in Egypt the priests were at once the biographers and historians.

Preceding chapters have indirectly shown the primitive connections between religion, biography, and history among the Greeks. The laudation of a god's deeds, now lyrical now epical, rhythmically uttered by his priests, involved with the sacred element both these secular elements. But a few more specific facts may be added.

"The history of the Greek families and states came to be systematically represented in a manner edifying according to the sense of the religion of Apollo and dictated by theocratic interests."

"In and near the sanctuaries the most ancient traditions were preserved."

"A list was kept of the priestesses at Argos and an account of the priestly dignity also of the Kings of Sparta . . . and thus arose historical archives."

And then, after the secularization of rhythmical speeches or songs, first uttered in honor of the gods, the biographico-historical character of their subject-matters is retained and developed. In hexameters, first employed by the Delphic priests, Homer, in the *Iliad* recites a story which, mainly historical, is in no part biographical —the wrath of Achilles being its most pronounced motive. And then in the *Odyssey*, we have a narrative which is almost wholly biographical. But though mainly secularized, these epics have not wholly lost the primitive sacred character; since the gods are represented as playing active parts.

As before said, Roman society, so heterogeneous in its composition, had its lines of normal evolution broken by intruding influences. But still we trace some connection between the priest and the historian. According to Duruy and others—

"The pontiffs were concerned in keeping up the memory of events, as accurately as possible. Thus the Romans had the *Annals of the Pontiffs*, or *Annales Maximi*, the *Fasti Magistratuum*, the *Fasti Triumphales*, the rolls of the censors, etc."

"Every year the chief Pontiff inscribed on a white tablet, at the head of which were the names of the consuls and other magistrates, a daily record of all memorable events both at home and abroad. These commentaries or registers were afterward collected into eighty books which were entitled by their authors *Annales Maximi*."

Further, by its associations, the body of *fetiales* was apparently shown to have had some sacerdotal character.

"By the side of these two oldest and most eminent corporations of men versed in spiritual lore may be, to some extent, ranked the college of the twenty state heralds (*fetiales*, of uncertain derivation), destined as a living repository to preserve a traditionary remembrance of the treaties concluded with neighboring communities."

If, as is alleged, Romulus was regarded by the Romans as one of their great gods, honored by a temple and a sacrificing priest, it seems inferable that the story of his deeds which, mythical as it may have chiefly been had probably some nucleus of fact, was from time to time repeated in the laudations of his priest; and that the speech or hymn uttered by his priest at festivals, had, like the kindred ones which Greek priests uttered, a biographico-historical character.

Though but indirectly relevant to the immediate issue, it is worth while adding that the earliest Roman historian, Ennius, was also an epic poet—"the Homer of Latium," as he called himself. The versified character of early history exemplified in his writings, as also we shall presently see in later writings, is, of course, congruous with that still earlier union of the two, which was seen in the laudatory narratives of the primitive priest-poet.

Of evidences furnished by Northern Europe, we meet first with those coming from the pre-Christian world. Though the stories of the Teutonic epic, *The Nibelungen*, were gathered together in Christian times, yet they manifestly belonged to pagan times; and we may fairly assume were originally recited, as among other European peoples, by attendants of the great—courtiers while these lived, priest-poets after they died. But for a long time after Christianity had been victorious, the Christian narrative alone, in which, as in other primitive narratives, biography and history are united, furnished the only subject-matter for literature, and priests were its vehicles.

"From the fourth to the eighth century, there is no longer any profane literature; sacred literature stands alone; priests only study or write; and they only study, they only write, save some rare exceptions, upon religious subjects."

So, also, the 57 authors named by Guizot as belonging to the 9th and 10th centuries (of whom only five were laymen), were doubtless similarly occupied.

Nevertheless, while the ordinary biographico-historical matter which priests devoted themselves to was that which their creed presented or suggested, there appear to have been, after the 8th century, some cases in which such matter furnished by other than Christian traditions, occupied them; as in the *Rolandslied* and *Alexanderslied,* written in the 12th century by the monks Konrad and Lamprecht.

For the rest it will suffice if we take the case of our own country. Chronicles and histories "were mostly compiled in the monasteries." Taking the illustrations in order, we come first to Bede, who was monk and historian; Cynewulf, bishop or abbot and writer of sacred history; Gildas, monk and chronicler; Asser, monk and biographer. The Anglo-Saxon chronicle was a year-book of events recorded by monks from the 8th to the 12th century. After the Conquest the chief authors were still ecclesiastics, and their works were usually chronicles or lives of saints. Among them were Marianus Scotus, Florence of Worcester, Eadmer, Ordericus Vitalis, William of Malmsbury, Wace, Geoffrey Gaimar, Henry of Huntington, Fitzstephen, Thomas of Ely, and so on through subsequent reigns, in which the relationship continues for a long time to be marked, but during which the rise of secular competitors in the sphere of literature becomes gradually manifest.

Even without specification of such facts we might safely infer that since, during mediæval days, there was scarcely any culture save that of ecclesiastics, the writing of biography and history was, by the necessities of the case, limited to them.

That fiction has developed out of biography scarcely needs proof. Unless a biographer is accurate, which even modern biographers rarely are and which ancient biographers certainly were not, it inevitably happens that there is more or less of fancy mingled with his fact. The same tendencies which in early times developed anecdotes of chiefs into mythological stories of them as gods, operated universally, and necessarily produced in narratives of men's lives exaggerations which greatly distorted them. If we remember the disputes among the Greeks respecting the birthplaces of poets and philosophers we see how reckless were men's statements and how largely the actual was perverted by the imaginary. So, too, on coming down to Christian times it needs but to name the miracles described in the lives of the saints to have abundant proof of such vitiations. As in our own days the repeater of an anecdote, or circulator of a scandal, is tempted to make his or her story interesting by making much of the striking points; so, still more in early days, when truth was less valued than now, were stories step by step perverted as they passed from mouth to mouth.

Of course the narrator who gave the most picturesque version of an adventure or achievement was preferred by listeners; and, of course, ever tempted to increase the imaginary additions, passed insensibly into a maker of tales. Even children, at first anxious to know whether the stories told them are true, by and by become ready to accept untrue stories; and then some of them, thus taught by example, invent wonderful tales to interest their companions. With the uncivilized or semi-civilized a like genesis naturally occurs among adults. Hence the established class of story-tellers in the East—authors of oral fictions. And how gradually by this process fiction is differentiated from biography, is shown by the fact that at first these stories which, as exaggerations of actual incidents, are partially believed in by the narrators are wholly believed in by the listeners. In his *Three Years in a Levantine Family* Mr. Bayle St. John tells us that when *The Arabian Nights* were being read aloud, and when he warned those around that they must not suppose the narratives to be true, they insisted on believing them: asking—Why should a man sit down to write lies? So that after fiction comes into existence it is still classed as biography—is not distinguished from it as among civilized nations.

The early history of these civilized nations shows that in the genesis of imaginary biography the priesthood at first took some part. In Henry I's time Wace, a reading clerk, was also a romance writer. So, in the next reign, we have Walter Map, chaplain to the king, who wrote religious and secular romances; and there are subsequently named romances which probably had clerical authors though there is no proof. But the general aspect of the facts appears to show that after that time in England, the telling of tales of imagination became secularized.

Meanwhile derivative forms of literature were showing themselves, mostly, however, having a biographical element. As a writer on Church government the Saxon abbot Dunstan diverged somewhat from the purely clerical sphere; and after the Conquest Sewulf, who, becoming a monk, wrote his travels, gives us a deviation into an autobiographical, as well as a geographical, form of literature. Then in Henry II's reign we have Nigel Wireker, a monastic who wrote a satire on the monks, as did also the chaplain Walter Map, in addition to his volume of anecdotes. Under Richard I there was Geoffrey de Vinsauf, an ecclesiastic who was also a critic of poetry, and Giraldus Cambrensis, who wrote topography. In the reign of Henry III came the monk Mathew Paris, who, in denouncing pope and king, wove biographical matter into a satire. In subsequent reigns Wiclif, John Trevisa, and others, added the function of translator to their literary functions; and some, as Bromyard and Lydgate, entered upon various subjects—law, morals, theology, rhetoric. Here it is needless to accumulate details. It is enough for us to recognize the ways in which in early days the priest took the lead as man of letters.

Of course along with the secularization of biography, history, and literature at large, men of letters have become more diversified in their kinds. History, at first predominantly biographical, has divided itself. There is the unphilosophical kind, such as that written by Carlyle, who thought the doings of great men the only subject-matter worth dealing with, and there is the philosophical kind, which more and more expands history into an account of national development: Green's *Short History* being an example.

Then biography, besides dividing into that kind which is written by the man himself and that kind which is written by another, has assumed unlike natures—the nature which is purely narrative, and that which is in large measure analytical or reflective. And besides the various classes of writers of fiction, laying their scenes among different ranks and dealing with them in different ways—now descriptive, now sentimental, now satirical—we have a variety of essayists—didactic, humorous, critical, etc.

There is little to add respecting the special unions which have accompanied these general separations. Men of letters, taken as a whole, have only in recent times, tended to unite into corporate bodies. The reasons are not difficult to find.

Carried on chiefly in monasteries or by endowed ecclesiastics, the writing of books in early days had not become an occupation pursued for the purpose of gaining a livelihood. Even after the invention of printing there was for a long time no public large enough to make literature a bread-winning profession; and when, at length, books were written to get money, miserable lives resulted: such rewards as could be obtained being chiefly obtained through the patronage of the wealthy. Indeed, it is curious to see how the modern man of letters for a long time continued to stand in the same relative position as did the minstrel of old. He was a hanger-on either of the king or of the great noble, and had to compose, if not in verse then in prose, fulsome laudations of his patron. Only in recent days has he been emancipated, and only by the extension of the book-buying public has it been made possible for any considerable number of writers to make tolerable incomes. Hence, until lately, men of letters have not been sufficiently numerous to make professional union feasible.

Remembering that in France the Academy has long existed as a literary corporation, we may note that in England our generation has witnessed movements toward integration. Forty odd years ago an effort was made to establish a Guild of Literature and Art, which, however, did not succeed. But we have now a Society of Authors, as well as a special periodical giving voice to authors' interests; and we have sundry literary journals which, at the same time that they are organs for criticism, bring the body of authors into relation with the general public.

One feature of the work of the national Weather Bureau which is not generally known consists in furnishing transcripts of its records for use as evidence in courts of law. The report of the chief of the bureau states that several hundred such transcripts were furnished in 1893. Cases involving large sums of money often turn upon the state of the weather, which is especially important where perishable goods are damaged in transit.

APPARATUS FOR EXTINGUISHING FIRES.

By JOHN G. MORSE.

DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS. XIX.

[*Concluded.*]

ONE of the most important modern additions to fire-fighting apparatus is the water tower. This invention has so greatly aided in flooding out fires that it will be no exaggeration to say that the date of its introduction marks another era in the history of fire-fighting in this country. Quite appropriately, in the centennial year, 1876, Mr. John Logan, a machinist in the employ of Mr. Abner Greenleaf, of Baltimore, invented a contrivance that was encumbered with the long name of "a portable standpipe fire-extinguishing apparatus." For convenience this term has been shortened to "water tower." Mr. Greenleaf was so sure of the future usefulness of the invention that he immediately made a full-sized machine which was completed in 1879. The apparatus consisted of a firmly built crane-neck truck, in the center of which rested a length of pipe supported on a pair of trunnions. Two more sections of pipe that could be coupled to the first section were carried detached. The three sections measured fifty feet when at full length and were braced with wire ropes. By turning a hand-screw at the back, the trunnions revolved and the pipe assumed an upright position. The nozzle at the top was controlled by guide ropes, and as the pipe was raised the lower end swung under the truck and could be connected to one, two, or three steam fire engines.

The great advantage claimed was that a powerful stream could be directed at short range on a fire in the upper stories of a building when a stream from the ground would spray and strike the ceiling, and when the heat would prevent a fireman from directing a stream from the top of a ladder. The later development and use of the water tower has proved this claim to be well founded. If the buildings opposite a fire are ignited, one sweep of the water-tower stream will be of more avail than several streams from the ground. Many other advantages could be named. The first water tower was put on trial in the New York Fire Department, and was so successful that it was purchased by the authorities. Firemen generally were greatly pleased, and the press lauded the inventor in praiseworthy terms. The Fireman's Journal of September 4, 1880, alluded to the water tower as follows:

"This apparatus is really the only absolutely new appliance for fire extinguishment that has been invented since the steam fire engine was introduced. There have been improvements in engines, ladders, hose, and rolling stock of all kinds, but of new inventions, original in all respects and of practical utility, there have been none for over twenty years."

Other towers were built for different cities, Boston buying one in 1882 that was destroyed in the great fire of Thanksgiving day, 1889. A few years later Messrs. Ashworth and Petrie, of the Chicago Fire Department, had built in the repair shops a telescoping brass tower of similar description, which is in use to-day in the Chicago Department. In 1888 Chief Hale, of the Kansas City Fire Department, invented a water tower that practically replaced

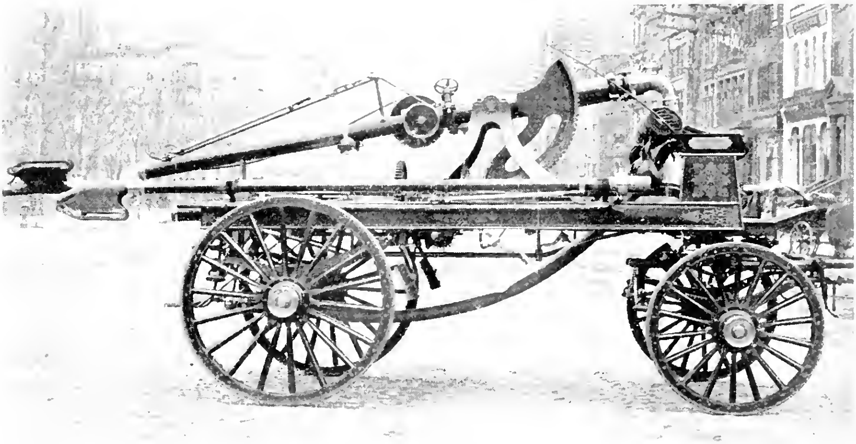

Fig. 13.—Greenleaf Water Tower.

the Greenleaf. The Kansas City Fire Department Supply Company took up the manufacture of the new machine. Two telescoping square steel shafts rest on trunnions at the forward end of the truck and a chemical engine takes the place of a hand-screw in raising the tower into position. The inner shaft, lined with hose, is raised by cable and pulleys, drawing after it a length of hose that is already attached to receiving nozzles at the base. The delivery nozzle is under perfect control by the aid of guide ropes. The tower is made in different sizes, varying from thirty to sixty feet in height.

In 1893 the Fire Extinguisher Manufacturing Company, of Chicago, placed on the market the Champion water tower, that differs essentially from the Hale tower. This was the invention of their superintendent, Mr. E. Steck, who has done much important work in the way of ladder trucks, chemical engines, and other fire appliances. Hand power replaces the chemical engine in raising, and the shape of the truck brings the base of the telescopic pipe much nearer the ground, enabling the men in charge to stand on *terra firma*. Two jacks act as adjustable legs to add steadiness while in action. The water connection is made by means of a three or four way Siamese coupling that rests on the ground, thus giving a free course to the stream. This tower can be raised to a much greater height than could previous towers. The above-mentioned company has recently purchased all the Hale patents, and now virtually controls the building of water towers in this country. Every large department in the United States is equipped with one or more towers, and the smaller cities are rapidly following the example. The Davol tower is a very useful contrivance manufactured by the Cornelius Callahan Company, of Boston. It is a curved nozzle attached to a flexible pipe, and can be placed on the upper rungs of an extension ladder. A guide rope enables a fireman to direct the stream from the ground. Recent tests have shown that a great deal of force is lost in a stream from the water tower on account of the friction, and there is still much room for improvement in this piece of apparatus. The small hose reels adopted in the early part of the century were the forerunners of the large and gayly decorated four-wheeled reels used by the volunteer hose companies. After the

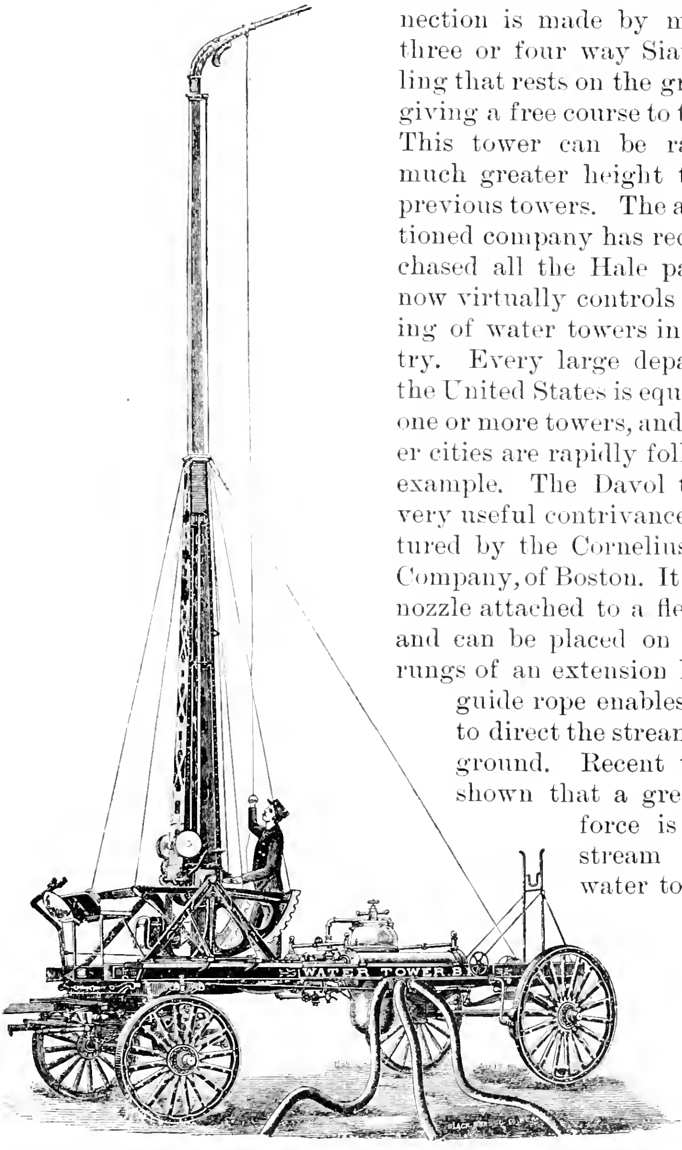

FIG. 14.—HALE WATER TOWER.

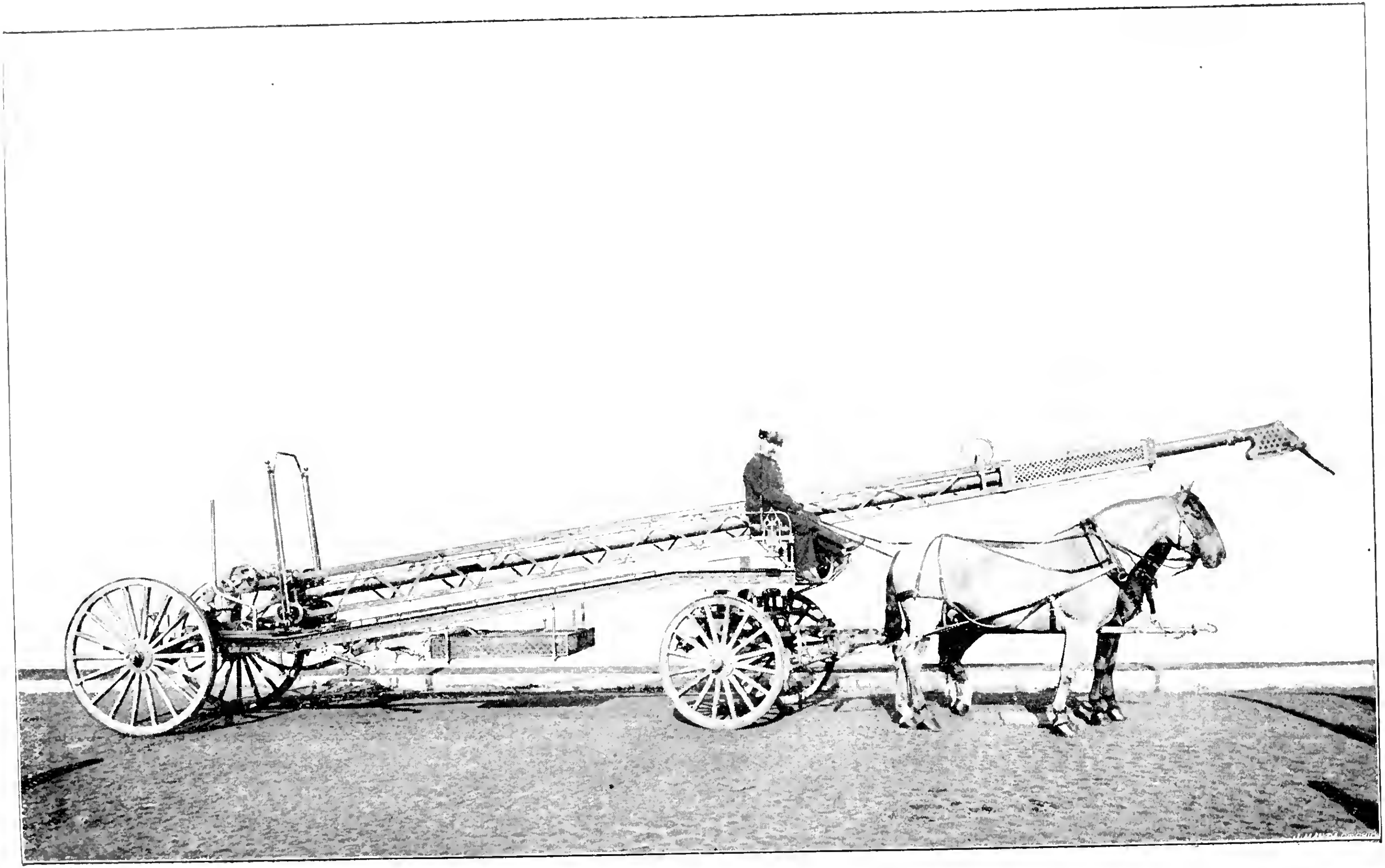

Fig. 15,—Champion Water Tower,

introduction of steam fire engines two and four wheeled reels, drawn by horses, were used as tenders. These have been replaced to a great extent by the modern hose wagon. It is claimed that hose can be drawn from flat coils in a wagon with greater rapidity than from a reel, and when once the hose is out the wagon can be used as an ambulance or to bring supplies. It will be impossible to give the names of the manufacturers of hose reels and wagons, for not only are innumerable firms engaged in the business, but often the apparatus is furnished by local carriage builders. All the makers of steam and hand fire engines and ladder trucks manufacture hose wagons and carriages of every variety.

For many years the only hose generally used was made of leather, but to-day this has been practically replaced by either

FIG. 16.—HAND HOSE CARRIAGE.

rubber or fabric. Samuel Eastman & Company, East Concord, N. H., make a specially tanned leather hose that is riveted together in such a manner that the friction is reduced to a minimum. The nature of the material makes it possible to place permanent leather straps at frequent intervals, thereby aiding the firemen in handling.

Rubber hose is made by combining fabric with solid rubber. In heavy hose an inner lining of rubber is combined with light cotton, and an outside lining is combined with heavier cotton. These two are firmly cemented together with the laps on opposite sides. It has been seen that fabric hose was invented in Holland in 1672, but generally discarded as being impracticable. The early canvas hose of this century was made of sail cloth riveted together, and was never very successful. The jacket hose of to-day is woven seamless and lined with rubber. Another seamless jacket is pulled over this, and as many more as may be desired, the heaviest hose being four or five ply. The fabric is treated with chemicals that it may be rot-proof, and the rubber lining is either made by cementing in a sheet of rubber, thereby making one long seam the length of the hose, or by a patented process, in making a seamless lining from melted rubber. The number of companies in the United States engaged either wholly or partly in the manufacture of rubber or fabric fire hose is too numerous to mention.

Fire hose must not only stand the heavy pressure of the powerful streams, but it must not be affected by the wear and tear of being drawn over rough pavements and around various corners while the heavy pressure is on. It must not absorb so much water

Fig. 17.—Hose Wagon.

from the outside that it becomes too heavy to handle, nor should it be of a nature to allow mud to adhere to its surface. The interior lining must be absolutely smooth, as the slightest friction materially affects the force of the stream. Fire hose has to be washed in a washing machine, and then dried by hanging in hose towers, after every fire, otherwise the length of its life would be greatly lessened.

Suction hose is of large diameter. It is made of heavy rubber, and wound either inside or out with round or flat wire to give it strength. When water is drawn from a hydrant the suction hose is coupled to an opening of its size, but a large strainer is always carried to use when taking water from the harbor, lakes, etc.

There are a great many different hose couplings in use, both screw and snap. The Rhode Island Coupling Company, of Providence, and many other firms engaged in the manufacture of other apparatus, furnish the screw couplings. The National Coupling Company, of Pomona, Cal., has introduced a very serviceable snap coupling that fastens with a catch, needing no screw. The representative firemen of this country have tried for many years to adopt a universal coupling, as a difference in screw threads often causes serious delays. Owing to the enormous expense that would be incurred in changing every department to one standard, the efforts in that direction have so far been unsuccessful.

FIG. 18.—PERFECTION NOZZLE-HOLDER.

The Siamese coupling is a very simple contrivance that has one large opening on one side, and two, three, or four smaller openings on the other. By use of this, several fire streams can be converted into one powerful body of water. In some cases these couplings are provided with valves so that one or more of the different lines of hose can be shut off if necessary. The Siamese coupling has been referred to in connection with the Champion water tower. A reducing coupling is also made by which a hose of large diameter can be coupled to a smaller line, and thus prevent water damage at an incipient fire.

Hose nozzles have been varied to suit about every requirement of the firemen. The outlets of the ordinary nozzles vary, being in some cases a smooth bore, and in others lessened in size by a ring.

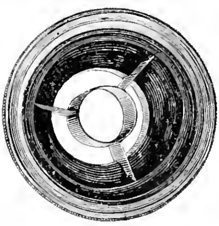

FIG. 19.—SECTION OF NOZZLE SHOWING RING.

The larger nozzles are sometimes provided with an inner tube that will make a division in the stream, and therefore tend to close the stream on itself and prevent spraying. In some cases the nozzle is divided into sections to destroy the revolving motion of the stream, and one nozzle is made with a small hollow tube in the center. The stream having an air space, closes upon it and hangs together for a longer time. The solid body of the nozzle is generally wound with cord to give better holding surface, and again the solid body is replaced by a flexible pipe made of cotton-lined rubber wound with wire. This device enables the fireman to change the direction of the pipe when at close quarters. Spray and shut-off nozzles are used that can instantly reduce the size of the stream or change it into a fine spray. The ball nozzle is one of the latest inventions in this direction. A funnel-shaped opening contains a ball that, when not in use, is held in place by a light staple. When the stream is playing, however, the ball is forced into the opening by outside pressure and an extensive spray is the result. The cellar pipe is a modification of an ordinary nozzle. Being bent and in some cases formed in the shape of a letter S, it can be thrust through the floor and the stream easily delivered in any direction. A similar contrivance is used to extinguish a blaze between the ceiling and roof of a flat-roofed building. The distributing nozzle consists of a metal globe provided with several nozzlelike outlets. This globe is attached to the end of a line of hose, and the force of the stream causes it to revolve and distribute a number of small powerful streams in every direction. This is especially efficient when hung in a sub-basement that is filled with smoke. There are also small sprinkling nozzles used to clear a smoky room.

The enormous force of a fire stream renders it a difficult matter to retain control, and many are the accidents reported of firemen who have been disabled by failing to hold the nozzle. The Perfection nozzle holder, manufactured by Samuel Eastman & Company, of East Concord, N. H., is composed of two bars between which the nozzle lies securely strapped. Two handles are on each side, and a removable bar is carried, that can be let down to the ground as a brace. An inner ring at the end of the nozzle, called the Hopkins patent, destroys the twisting tendency, and the ground brace carries off any electric current with which the stream may come in contact. One man can safely direct a stream that ordinarily would require two or three to hold it.

Breaks in hose are mended by strapping a prepared sleeve to the injured part, or inserting a convex brass plate under the break and clamping to it a corresponding concave plate from the outside. To facilitate pulling hose up a ladder, through a window, or over the edge of a roof, a simple hook-shaped frame, provided with rollers, called the Bresnan hose hoist, is used.

The absolute shut-off nozzles can not be used without bursting the hose, unless the engine or hydrant is provided with an automatic relief valve that will open and allow the water to run back into the suction pipe. The valve can be regulated to suit the pressure that the hose will stand. During the sixties several valves were tried, the first very successful one being that invented

Fig. 20.—Ordinary Ladder Truck.

by Mr. Alvarado Mayer, a member of the Detroit Fire Department, in 1869. Mr. L. D. Shaw, of Boston, also introduced a successful valve in 1874. Since then there have been a number of different valves in use. Mr. Cornelius Callahan, of Canton, Mass., perfecting one in the neighborhood of 1888. These three are about the only ones in general use to-day.

It has been seen that the first ladder trucks were introduced at the beginning of this century, and the patterns then adopted have been followed more or less to the present day. Portable escapes were invented by the score, some in the form of extension ladders, others as lazy tongs, and others in the form of cranes, by which a bucket could be raised and lowered. None of these came into general use, because they had not reached a stage of development at which apparatus of that nature could be made light and strong enough to be practicable. The ordinary ladder truck consists of a long frame, with crossbars at different heights provided with rollers. These are equipped with several ladders of different lengths, and an extension ladder. The latter is a combination of ladders that slide over each other by means of a chain and pulley. The whole length is rested against a building, and the center is supported by props. The Bangor Extension Ladder Company and several others make ladders of this kind. The Gleason & Bailey Manufacturing Company, the Stewarts, C. T. Holloway, Seagrave & Company, P. J. Cooney, and some of the engine-makers, manufacture ladder trucks that differ simply in minor details too numerous to describe.

The aërial truck consists chiefly of an extension ladder that rests on trunnions on a turntable at the forward end of the truck. The extension ladder is raised in much the same manner as is the water tower, and when erect is capable of supporting itself with several working firemen without resting against a building. The Hayes, the Gleason & Bailey, the Arrow, and the Babcock are among those well known. The aërial trucks carry a full complement of ladders.

The largest ladder trucks are provided with a steering wheel over the rear axle to facilitate the turning of corners, and Mr. Steck, of Chicago, has invented a depressed rear axle which lends stability to the truck, while a lever in place of a steering wheel directs the rear wheels.

In addition to the regular ladders, a variety of apparatus is carried on every truck. The axes, or hooks as they are called, are too well known to need description. In olden times large, heavy hooks were used to tear down buildings, but these have since been abandoned. It is interesting to note in this connection that as late as 1857 the Scientific American published an illustration of an enormous hook mounted on wheels. The hook was intended to be attached to a house and pulled by a crowd of men until the house collapsed. Probably a hook of this nature was never used. The firemen of to-day extinguish a fire instead of being content to stop it within certain boundaries, unless an extensive conflagration renders it necessary to raze buildings by dynamite. The hooks of to-day are used to cut through into a hidden fire, and for other purposes of like nature.

The pompier or scaling ladder is a most necessary article, and is used in connection with the distinct pompier service. Christ Hoell, of St. Louis, who had served in European pompier companies, believed that the system could be advantageously introduced into this country. In 1877 he formed a volunteer company in St. Louis, and drilled the men in the use of the apparatus connected with the system. The members of the city government were so pleased with the exhibition given by this volunteer company that the system was introduced into the fire department, under Chief Engineer Sexton, in December of the same year. Since then the pompier service has found its way into all large departments, and many cities support training schools that every fireman may be thoroughly drilled. The pompier ladder is made of one pole, from twelve to eighteen feet long, provided with cross-rungs. At one end an iron hook projects at right angles from two to three feet. By the aid of this ladder one man can scale the side of a building by putting the hook over a window-sill above, climbing the ladder, and repeating the operation. If flames are coming from the window directly above, the window at the side is used, and the fireman has to swing into position by the aid of his ladder. Two men with two ladders can climb together much more speedily, as they take turns in steadying each other's ladders. The pompier fireman wears a belt, in the front of which is a snap-hook. He also carries a hatchet and a coil of rope one hundred feet long. By fastening the rope to some convenient point, and taking two turns round the snap-hook, he can descend rapidly and safely. If carrying a person with him, another turn of rope is taken round the hook. A long canvas chute is sometimes carried, through which inmates of a burning building can slide to the ground.

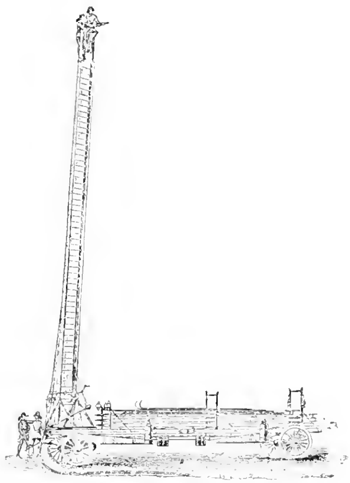

Fig. 21.—Aërial Truck.

The "grip-sack," or what is more generally called the life net,

Fig. 22.—Scaling a Building with Pompier Ladders.

is a piece of leather-bound canvas, ten feet square. Handles along the sides enable a group of firemen to hold the net taut to catch any one who may jump from above. The life net did not originate in this country with the pompier service. Canvas nets have been in use for some time, and at the present day their place is being taken by circular rope nets that are more yielding. Being formed in a circle, each man obtains a direct pull from the center. The Hunter net is composed of a spiral of rope, and the Empire net is made of concentric circles of rope, the ropes in each case being supported with radial lines. It is a most difficult matter to hold a life net securely and receive the shock of a falling body. When a man has jumped from an upper story, possibly sixty feet above the street, and his helpless body suddenly emerges from a cloud of smoke and flame that is pouring from lower windows, the firemen must instantly have the net directly under him and then brace themselves to receive the shock. The pompier ladders, etc., are also often carried on hose wagons, that every chance may be given to put them in use at the earliest moment.

There are several other articles carried on ladder trucks. The life gun or life pistol is used to shoot a slug or arrow, to which is attached a loosely coiled rope, over the roof of a building. The inmates can then pull up a stronger rope and descend to the ground. There are also short roof ladders with hooks to cling over the ridge-pole, and some departments carry a tripod ladder that may be stood under an electric wire, where a fireman with insulated shears can remove the dangerous obstruction. This ladder is the invention of Captain Griffin, of the Boston Fire Department. The ram, a heavy battering pole worked by three or more men, held a place in departments for a long time, and was used to batter down doors, etc. This is being replaced to a great extent by the Detroit door opener, a simple prying device which rips the entire lock out of place or the door off its hinges in a shorter space of time than that in which the same could be battered down. Ladder trucks are also provided with chemical extinguishers, rubber blankets, medicines for burns, and several sundries.

Although the protective departments had a forerunner in some of the early fire companies whose members carried canvas bags to be used in saving property, the insurance companies did not introduce their patrols or salvage corps for several years later. Some of the insurance companies of New York in 1839 organized a corps of bagmen, who saved what they could of endangered property. Later a two-wheeled hand wagon, supplied with half a dozen rubber covers, was put in service. Later a permanent station, equipped with a four-wheeled wagon, drawn by horses, was established. To-day there are several stations with nine wagons and a Silsby steam fire engine, which latter is used to pump out cellars. In Boston, as early as 1849, the insurance firm of Dobson & Jordan employed some men to carry bags holding oil covers. In 1858 these were carried on Ladder No. 1. In 1868 an old milk wagon was purchased by the insurance companies and filled with covers, brooms, shovels, etc. A regular protective department was established in 1870. The insurance companies in all large cities now support protective departments, and in some places an effort is now on foot to merge them into the regular fire departments.

All departments are equipped with supply wagons that resemble hose wagons in their construction and carry baskets of coal, extra hose, etc., to every fire. In 1879 the New York department built a wrecking truck. The Boston department built

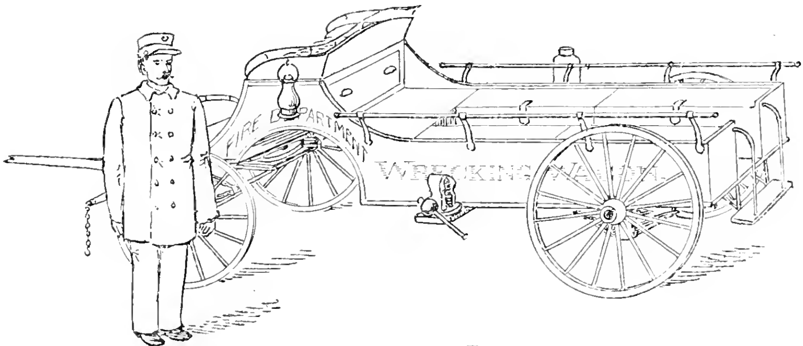

Fig. 23.—Wrecking Truck.

a similar truck in 1893. So far as learned, these are the only distinct wrecking trucks in use. The truck is long and low and supplied with a variety of tools for making repairs on apparatus at a fire. An extra wheel, hose, nozzles, etc., are also carried. On one side of the truck is a vise, and on the other a chemical extinguisher.

In 1883 the New York City Department tried the experiment of building a five thousand gallon tank, mounting it on wheels and drawing it to some place between the water front and a fire, that the fire-boats might pump into it and the engines draw therefrom. The apparatus proved unsuccessful, however, and has been abandoned.

The wheels used on fire apparatus have to be of unusual strength to stand the heavy weights, great speed over rough pavements, slewing in car tracks, and other strains that would demolish ordinary wheels. In the Archibald wheel the tire, spokes, and hub are put together under heavy pressure. The hub is of malleable iron, from which a flange extends on the inner side of the wheel. An outer removable flange is bolted through the spokes to the inner flange. The Sarven wheel has a wooden hub with an outer and inner flange that are pressed into position and then bolted through the spokes. The Warner wheel has a wooden hub upon which is shrunk a solid metal band with openings to receive the spokes. The spokes are driven through the openings into mortises cut in the hubs to receive them. The Archibald wheel is made by a company of that name in Lawrence, Mass. The Sarven and Warner, and some other wheels not described, are made by several different firms.

A distinct feature of American fire apparatus is the swinging harness, which is too well known to need description. There are several kinds in use, and much conflicting testimony uttered in regard to their priority. In a decision rendered by the United States Circuit Court, sitting at Kansas City, Mo., it was stated that swinging harness was used as early as 1843 by Dr. B. F. Whitney, of Loudonville, Ohio; in 1871, by the fire departments of Allegheny City, Pa., and St. Joseph, Mo., and by the Hughes Brewery, Cleveland, Ohio; and in 1872, by the Louisville (Ky.) Fire Department. The writer is informed by Major Edward Hughes, chief of the Louisville department, that Mr. Thomas Pendegrast, a member of that department, invented the first harness used there. Mr. Edward O. Sullivan invented a swinging harness in 1875, which was first manufactured by the Worswick Manufacturing Company, and also by Isaac Kidd, of Cleveland. In 1880, Mr. Charles E. Berry, of Cambridge, Mass., invented a harness which he still manufactures; and in 1885, Chief George C. Hale, of the Kansas City Fire Department, invented a harness that is now manufactured by the Fire Department Supply Company of that city. The sliding pole, by which firemen facilitate their descent from the second story of the engine house, was invented by Captain B. F. Bache, of the Louisville Fire Department. In nearly all engine houses the steamers are kept connected with boilers, and an automatic lighter kindles the fire as the engine starts in response to an alarm.

When it was first found necessary to have some warning signals upon fire apparatus, tinkling bells were used, and in many cases a fireman would run ahead, blowing a bugle. The introduction of horse cars made bells so universal in our streets that clanging gongs were substituted in their place on apparatus. The cable and trolley cars of to-day being exclusively provided with gongs, in many instances the fire officials have returned to the use of tinkling bells, although the bugle is still used.

The use of sail cars, introduced in Salem, Mass., and vicinity in 1774, was continued as late as 1843. The Scientific American of 1857 illustrates a truck carrying a roll of sheet iron that can be raised to form a screen; and in 1872 another is pictured composed of plates that can be raised one above another. The modern high buildings make such apparatus useless at the present time.

The numerous hand pumps would not receive notice here, were it not for the fact that one of them has been incorporated into a regular fire department. The Johnson pump, made by the National Manufacturing Company of Boston, is composed of a vertical cylinder and piston, provided with an air chamber. A short piece of hose that can be held in the hand is attached near the top. The pump is placed in a pail of water, and an adjustable clamp enables the operator to steady both pail and pump. Mr. Joseph Bird, in his interesting book entitled Protection against Fire, emphatically advocates the extended use of this pump, in addition to the existing apparatus. The experiment has been tried in Wakefield, Mass., with gratifying results. Almost a hundred of these pumps are owned by the town authorities and distributed in easily accessible places over the town. Every year a majority of the fires are quenched in their incipiency by some citizen with the aid of one of the pumps, and the steam fire engine is therefore seldom called upon to answer an alarm where a moment's delay might result in a large fire. The United States Government uses these pumps for the same purpose in armories, etc.

Some experiments have been made in the way of running an electric wire with each line of hose, that a fireman with a telegraph key or push-button at the nozzle may notify the engineer by telegraph or prearranged bell signals when to turn the water on and off, when help is needed, etc. The idea is a good one, but as yet has not been entirely perfected, as in dragging a line of hose through a burning building the wire may become broken at a critical moment when it is most needed.

Bicycles are being introduced in some European departments to enable the men to reach the fires as soon as possible. In some cases small chemical extinguishers are attached. As yet very little has been done in this line in America. The hose wagons and ladder trucks so well accommodate the men that the need of bicycles has not been greatly felt.

It does not come within the scope of this article to mention the fire-alarm telegraph, the stationary fire equipment of buildings, fire escapes, etc. It is also hardly necessary to mention the numerous lanterns, trumpets, uniforms, and other objects of like nature. The historical data at the beginning of the article are doubtless incomplete, for historians generally give very little attention to the primitive methods that were so long in use in every city. The American fireman is to-day equipped with the finest apparatus in the world for extinguishing fires and saving life, but he is badly handicapped by the town and city governments on every hand, who will not modify loose building laws or strengthen slight fire restrictions.*

VARIATION IN THE HABITS OF ANIMALS.

By GERTRUDE CROTTY DAVENPORT.

IN the introduction to his Animal Life as Affected by the Natural Conditions of Existence, Carl Semper wrote, in 1879: "It appears to me that of all the properties of the animal organism, Variability is that which may first and most easily be traced by exact investigation to its efficient causes; and, as it is beyond a doubt the subject around which at the present moment the strife of opinion is most violent, it is that which will be most likely to repay the trouble of closer research."

Among other sorts of variability discussed by Semper, that which concerns the change of food habits of animals receives consideration, and several examples illustrating such changes—polyphagy—are cited. For instance, on page 62 the story of the New Zealand parrot (*Nestor mirabilis*) is told. This parrot, which formerly fed upon the juices of plants and flowers, has acquired the habit of sipping the blood of newly slaughtered sheep, and thereby has come to develop such a love for the taste of blood that it will now alight upon living sheep and peck at the "most minute wounds." Another case is told of two horses in Chili which had developed the habit of eating young pigeons and chickens.

A great many other interesting cases of variability in food habits might be collected by a little observation and by compilation. Two such cases at least have come under my own observation. On a farm in Coffey County, Kansas, a few years ago, there

* In compiling the data for this article the writer wishes to acknowledge the services rendered by all the manufacturers of fire apparatus, especially the American Fire Engine Company, the La France Fire Engine Company, S. F. Hayward & Company, and the Gleason & Bailey Manufacturing Company. Also the personal assistance of the chiefs of the Bangor, Boston, Hartford, New York, and Louisville Fire Departments; Mr. James R. Newhall, the Lynn historian; Mr. Arthur W. Brayley, author of the History of the Boston Fire Department; Mr. Albert C. Winsor, Secretary of the Providence Veteran Fire Association; Mr. Amos Perry, Secretary of the Rhode Island Historical Society; Mr. A. D. Nickerson, Pawtucket; Mr. William Cowles, of the Cowles Engineering Company; Mr. Talcott Williams, of the Philadelphia Press; Mr. Abner Greenleaf, of Baltimore; and Mr. E. Steck, Superintendent of the Fire Extinguisher Manufacturing Company, of Chicago.

were several horses and mules which greedily devoured the eggs laid in their mangers by improvident hens. I believe that this habit is not uncommon. At any rate, I have been told of several instances in which this same practice has been acquired by other horses. Also upon this farm, during the winter of 1887, a milch cow and a fully grown pig were shut up together in the same lot. This cow, which had been furnishing milk bountifully, suddenly, about a month after her confinement in the lot with the pig, ceased to supply milk at all. At first she was accused of "stubbornly holding her milk," but after several days it was decided that some one was stealing her milk. A careful watch was then kept, and the thief proved to be the pig.

Another kind of variability which is displayed by wild birds has received not a little attention from ornithologists—namely, that which they exhibit in their nesting habits. From the observations of Coues, Ridgway, and Allen, we learn that not only in regard to the place, but also in regard to the manner of building their nests, do birds display considerable variation. Also we know that among wild birds the male aids much more in the rearing of broods than do the males of our various domestic fowls. The wild male often takes turns with the female in sitting on the incubating eggs, and in some instances the male assumes the entire responsibility of rearing a hatched brood while his mate builds a new nest and lays another set of eggs. Domestication seems to have obliterated much of this parental instinct in our male fowls. When, perhaps by reversion, we find such instinct to be developed in our domestic male fowls, we are at once impressed by the unusualness of the occurrence. I know of no instance recorded in which parental instinct seemed to be so fully developed in the male of any of our domestic fowls as in the following case. In the poultry yard upon a farm in La Salle County, Illinois, there was but one pair of turkeys. The hen, one spring, stole away, made her a nest in some hiding place, and in due time began to incubate her eggs. After her disappearance the male became exceedingly lonely. Sometimes he would follow her in her tortuous retreat to the nest after a visit to the house for food; but he returned later, more disconsolate than ever. He strove to make friends with the other fowls, but found none which seemed to realize his loneliness and give him sympathy or affection. After ten days or so of this dreary neglect he gave up in despair and began to sit upon a deserted nest of hen's eggs which he discovered under some shrubbery in a corner of the lawn. From that time on he seemed as contented, important, and preoccupied as any sitting hen. He would not leave the nest until driven by absolute need of food and water. Then he would run to the feeding-pans, greedily swallow a few grains of corn and a gulp of water, and dive again for his nest. As soon as his owners felt convinced that he wished to rear a brood of his own, he was supplied with fresh hen's eggs. He continued thus to persist in his conduct for more than two weeks. Then the turkey hen appeared in the poultry yard with her brood. During that day the male turkey was observed to take food frequently. His visits to the poultry yard became more and more prolonged, while the intervals spent upon the eggs grew shorter and shorter, until finally, after the elapse of two or possibly three days, the nest of hen's eggs was abandoned altogether. From that time on he shared with the turkey hen the care of the brood of his own kind. The abandoned eggs were placed under a hen and hatched in a few days. This instance is not without interest as it stands, but it is much to be regretted that the eggs did not hatch while the male turkey sat upon them. Would he have abandoned his living brood with the same or with more reluctance than he showed in deserting the eggs, or would he have reared his adopted offspring?

One other most remarkable instance of a change of habit came under my observation also in Coffey County, Kansas. The individuals which showed a change of habit in this instance were birds in the wild state—namely, blue jays (*Cyanocitta cristata*). I say *individuals*, for a score or even scores of blue jays were concerned. These all adopted the same peculiar practice in their warfare with the so-called English sparrow (*Passer domesticus*), and, moreover, have preserved this habit for at least three successive years.

Since the arrival of the aggressive English sparrow much apprehension has been felt by bird-loving Americans regarding the fate of native American birds. As the area of distribution of the English sparrow rapidly widened, just so rapidly our native birds seemed to be brought into violent conflict with the garrulous stranger, or else they were driven to abandon to the newcomer their nesting sites and retire into the forests or prairies. The question arose as to whether the English sparrow itself on account of numbers would be driven from the cities and towns to take up nesting sites about country barns and farmhouses. The Report of the United States Department of Agriculture for the year 1889 on The English Sparrow (*Passer domesticus*) in North America, especially in its Relation to Agriculture, contains communications from many parts of the country testifying, not only to the destruction wrought by this sparrow in gardens and upon ripening grain fields, but also to the fact that few American birds seem to be able to resist the aggressions of this sparrow, and many therefore are compelled to abandon their nests to the intruders, even after their eggs have been deposited or are in process of incubation.

But the relations of our native birds to the English sparrow seem now to be undergoing a change. F. H. Kimcoll (Auk, vol. vi, July, 1894, p. 261) has stated that in many localities in Illinois the English sparrow and native birds are now found nesting side by side, where only a few years ago the English sparrow occupied all the desirable nesting sites, and assumed so aggressive an attitude toward native birds that one rarely saw a native bird nesting in the regions inhabited by the English sparrow. "Either," he writes, "our native birds have unexpectedly developed powers of resistance at first unsuspected, or the pugnacity of the English sparrow has diminished, for certainly our own songsters have not been driven away, but, on the contrary, seem as numerous as they were twenty years ago. For the past two or three years, since my attention was first called to the matter, I have seen but little if any persecution of our native birds by the foreign sparrows; on the contrary, our own birds are now often the aggressors, and if they do not indulge in persecution themselves are adepts at defense. Very commonly a jay, robin, or catbird will from pure mischief hustle a flock of sparrows into desperate flight."

I find, on referring to the Government report of 1889, that the English sparrow has been present in the town of Burlington, Kansas, for ten or twelve years. My own attention was not attracted particularly to these birds until after they had been there for several years. Upon returning to Burlington in 1889, I began to look about upon the lawn for my old bird friends, and found none of them. Upon inquiry, I was told that they had all been driven away by the English sparrow. The wren house was occupied by sparrows. The martins, robins, bluebirds, and catbirds had all resisted according to their various strengths, and had been worsted in the conflict. The lawn under consideration is one peculiarly attractive to birds on account of its bountiful supply of shade trees. There is a long walk upon it completely shaded by apple and pear trees, of which the ripening fruit proves attractive to insects all summer long, while the fruit itself is no less enticing to bird than insect. On one side of the lawn there are cherry trees with their tempting fruit, and on the adjoining lots a large kitchen garden with its ripening seeds, berries, and freshly turned loam. Altogether this place furnishes a paradise for parent birds. The house itself was covered with vines of the Virginia and trumpet creepers. Within these vines the English sparrow took up its abode and soon so increased in numbers as to be able to mob any other bird that ventured on the premises. Only one pair of blue jays stubbornly clung to their nest in an apple tree. With this pair was throughout the summer waged one long and bitter warfare.

Upon my return the following summer the number of jays had increased and the conflict was much less one-sided. In June, 1891, early the first morning after my return again to Burlington, I heard on the lawn the screeching of a hen hawk. The English sparrows shot in terror into the verandas and among the vines upon the house. Upon inquiry, I was told that the hawks had been chasing the sparrows all spring, and was assured by our colored cook that "dis country am comin' to 'struction suh, when de hawks come to town." I had never known of an instance where hawks had entered a town several miles in area, and supposed that they were made so bold on account of the attraction such an abundance of sparrow food afforded. The cry of the hawk, however, seemed shriller and more satanic than any hawk cry I had ever heard before. Indeed, there was a suggestion of a mocking laugh in these hawk screams. I wondered if this change in tone was due to the new environment of the hawk, to the fact that it was dealing with such helpless prey, or whether the cry came from a hawk new to me.

With these questions in mind I watched carefully for days, without even catching a glimpse of the hawks, although they screamed at intervals all day long among the trees. Each time the demonic scream began the sparrows seemed almost paralyzed with terror, and the hens would hustle their broods into the barn or under the shrubbery. One day, while lying in a hammock watching some sparrows devour a fallen apple, I was startled by the screams of a hawk in the tree just above me. Upon looking upward I discovered that my elusive bird was no other than a blue jay. The fallen apple was abandoned by the sparrows in their fright and the jay sought its nest in a tree near by. For several weeks longer the blue jays always concealed themselves in the trees before they gave their adopted yell, but later in the summer they did not even take the precaution of alighting in the trees before screaming, but sat boldly in view upon the fence, screamed while in flight, and even followed the sparrows into their retreat among the vines. In a few instances they destroyed the sparrows' eggs or young.

For a time the ability thus to imitate the hawk seemed to be confined to the blue jays nesting upon this one lawn. Ofttimes these blue jays would rush to the rescue of other blue jays on neighboring lawns. Eventually, however, other blue jays learned the cry, and in the following summer I heard it on the other side of the town some two miles or more away. The second summer after this imitation of the hawk began, other native birds returned in small numbers. The blue jays often made themselves champions of these returned exiles. The other birds, however, soon learned to resist the English sparrow on their own account.

About a year ago the vines were almost entirely torn away from the house, and in consequence the English sparrow, having no place of refuge from the blue jays, has deserted this lawn. The blue jays now seem to take greater pleasure in routing a venturesome sparrow by means of their own natural call, and have recourse to the imitation of the hawk only as a last resort.

The catbird and robin seem to have learned from the blue jay the efficacy of a vigorous, angry call, and now fight successfully their own battles. Last summer a bluebird nested and sang freely in the trees. Even the wrens ventured to build on a beam in the carriage shed, although they seemed very shy and were rarely heard to sing.

In Ornithological Notes from the West, by J. A. Allen (American Naturalist, vol. vi, p. 18), I find the following references to the blue jays which were observed by him at Leavenworth, Kansas: "The blue jay (*Cyanura cristatus*) was equally at home and as vivacious and even more gayly colored than at the north. While he seemed to have forgotten none of the droll notes and fantastic ways one always expects from him, he has here added to his manners the familiarity that usually characterizes him in the more newly settled parts of the country, and anon surprised us with some new expression of his feelings or sentiments—some unexpected eccentricity in his varied notes, perhaps developed by his southern surroundings."

Robert Ridgway, in Volume VIII of The American Naturalist, refers to the above instance and others cited by Mr. Allen. "Mr. Allen," he writes, "has called attention to the variation in the notes of different birds at remote localities; and in this I am able to corroborate him, though I think that cases of such variation are very rare, and do not occur in more than perhaps five per cent of the species. I have only detected it in two or three species after the most careful observation, and in very many cases noticed that there was not in the minutest particular any difference between individuals of one species on opposite sides of the continent. Such is undoubtedly the case in a very great majority of the species, any seeming variation that may be observed being more probably the peculiarity of an individual rather than the manifestation of any regional impress."

The conduct of the blue jays instanced above may be used in confirmation of the three quotations made in this article, for the blue jay has certainly in this instance "developed powers of resistance at first unsuspected," which certainly aid it in its warfare with the English sparrow. Moreover, it would confirm Mr. Allen's observation in regard to the variability of the jay's note—his "unexpected eccentricity" in Kansas—if indeed Mr. Allen's observations needed other confirmation than that afforded by

Ridgway for certain other birds in southern Illinois and by Dr. Elliott Coues. The latter has observed that the note of Nuttall's whip-poor-will differs from that of the eastern whip-poor-will in that the western species "does not cry 'Whip-poor-will,' like" the eastern species, but "drops a syllable, saying 'Whip-poor,' or 'Poor-will,' as the fancy of the hearer may interpret." Moreover, the practice of mocking the hawk is, at present at least, confined, so far as I know, to the individuals of such a limited area—this one town—that with Mr. Ridgway we must believe this peculiarity exhibited by the blue jay to be scarcely the "manifestation of a regional impress."

DR. DANIEL HACK TUKE.

DR. DANIEL HACK TUKE, the distinguished English alienist and editor of the Journal of Mental Science, who died early in March, 1895, was a grandson of William Tuke, the founder of the York Retreat, and one of the earliest English workers in the humane treatment of the insane, and was born in York, April 19, 1827. He was a delicate child, of high spirit, and with a turn for investigating; pertinently to which the story is told of him that he once carried the family cat to the woods and left it there, expecting to find it again some day a wild cat. His father being a member of the Society of Friends, he was sent to their school, and afterward to Bradford to study law. Three months' experience in this occupation showed that he had no taste for the law, and he was allowed to gratify his own inclination and study medicine. He held the post of steward at the York Retreat; entered St. Bartholomew's Hospital, London, in 1849; became a member of the Royal College of Surgeons in 1852; was graduated M. D. at Heidelberg in 1853; visited the asylums of Holland, Germany, and France; and in 1857 published his first book, an account of these visits. He was next appointed

visiting physician to the York Retreat and the York Dispensary; became Lecturer on Psychology at the York School of Medicine; was prevented by an attack of hæmorrhage from converting the old family house in York into a private asylum for ladies; recovered in a year, and settled in Falmouth for fifteen years. Here he took active interest in the library, schools, workingmen's clubs, etc., and did much literary work. He settled for practice in London in 1879, and eventually became a governor of Bethlem Hospital. He had great power of continued intellectual work, and a corresponding indifference to mere physical comforts; and possessed an extraordinary memory for details. His work in the study of lunacy and advocacy of the humane treatment for the insane was known all over the world. He visited most of the asylums in Europe and America, never, says the Lancet, "losing a chance of picking up the threads which connected the present with the past. He knew the city of the simple (Gheel) in Belgium and the secluded valley in Ireland where priest healing had held sway. He was one of the originators of the After-care Association for patients who, having left asylums, were not fit for full work. His holidays were combinations of the study of asylums with (insufficient) complete relaxation." He gave much thought and attention to the study of moral insanity. His earliest established literary work was prepared in collaboration with Dr. Charles Bucknill, and is known as "Bucknill and Tuke on Insanity." He set great value on his book on the Influence of Mind on the Body, which has now been "left behind." He was for eighteen years editor of the Journal of Medical Science; prepared an Index Medicus; and undertook and carried out the Dictionary of Psychological Medicine.

A BODY of the English engaged in the Chitral Expedition suffered severely at the river Panjkora, in consequence of the enemy's launching heavy logs of wood down stream, which destroyed the bridge the men were constructing. One of the enemy who was captured in the subsequent fight described in vivid language how their attempt at a night surprise was frustrated by the magnesium light of a star-shell fired from the English camp. "There were two thousand hillmen who set forth that night to crawl up to the soldiers' camp. We lay for hours in the wet fields, with the rain falling steadily, waiting for our chiefs to give the signal for the great rush. Word came round from chief to chief to be ready, and every man crouched, grasping his weapon, to run forward. But at that very moment a devil's gun boomed forth, and lo! instead of bullets and balls coming out, there burst over us a mighty light, so great that we thought the night had suddenly become day. And we cried aloud to Allah to abate his wrath against us, and when the great light faded we all hurried away, and even our mullahs had no word to say."

TRADES AND FACES.

By Dr. LOUIS ROBINSON.

IT is to be feared that any present attempt on the part of the physiognomist to analyze trade expressions must be somewhat unsatisfactory to the lovers of exact science. Our proved knowledge concerning the laws which govern facial expression is very slight: we are still stumbling among the elements of feature language, and it may seem presumptuous to attempt to criticise the text when the very alphabet is still doubtful.

But as the digger-out of a cryptogram finds it profitable to take a general survey of the script before attacking details, so it may perhaps be found that a somewhat speculative excursion, such as the present, will not be altogether without value in helping on more precise methods of research. At any rate, such a discussion can hardly fail to interest those among the readers of Maga who have observed the remarkable facial likeness often found among people who follow the same calling, without being able to see why a butcher should resemble his trade brethren more than he resembles the other sons of his father who have become bakers of bread or makers of candlesticks.

When we seek to analyze the forces which are continually at work on the human face, the complexity of the problem as to the interpretation of any prevalent trade expression at once becomes apparent. A few examples will bring this fact home to every reader, and will also help us in taking the first step toward classifying the numerous factors which contribute to the result in any single instance.

In a previous article on facial expression,* attention was drawn to the distinctive cast of countenance exhibited by men who have much to do with horses. No great acuteness of observation is necessary to make it clear that, in the various branches of such professions, a corresponding diversity of type is visible.

Regarding Environment as a portrait painter (if we may venture to personify, in classic fashion, the abstractions of the newer philosophers), we find that she has, after boldly laying on a general groundwork of horseyness, touched the faces with different pigments which greatly affect the final result.

If, for example, we place side by side a gentleman's groom and a horse-dealer's groom, both of whom, when seen in a crowd of ordinary mortals, strike us as typically horsey, these supplementary touches are at once brought into prominence. The one

* See Popular Science Monthly, vol. xlv, p. 380.

face reveals something of the superfine genteelness of the flunkey, the other a shifty truculence acquired among the chafferers of Barnet or Ballinasloe. In like manner we may distinguish between the many sections of the great tribe of Jehu. In the expression of the 'bus-driver, still more in that of the driver of a tradesman's or carrier's cart, but most of all in that of the brewer's drayman, the extra coats are so numerous as to obscure the original grounding. In the two former, traffic with humankind, and other circumstances, such as constant exposure to the weather, have entered into competition with the feature-molding power of the horse; in the last, all equine traces have been dissolved clean away by malt liquor. Should a certain popular belief, to the effect that contact with horses has a malign effect upon the character, be borne out by more exact researches in moral pathology, the phenomena observable in the drayman's face might suggest a powerful antidote, and one which would readily be taken by the afflicted—although (as is often the case with new remedial measures) it would, without doubt, be denounced by a considerable section of the public as ten times worse than the disease.

One would have thought that the riders and ringmaster at a circus would exhibit a marked degree of facial horseyness; but, strangely enough, this is not so. The reason seems to be that in a circus the achievement of certain difficult feats to the satisfaction of the audience wholly occupies the minds of the performers, and the horses, large as they loom in the eyes of the public, are regarded by the circus folk as mere "properties."

Now it is plain that, in the cases given, numerous agencies of a widely diverse character are responsible for the total results. Association with horses can only change a man's facial aspect by first influencing his mind, and hence the general common groundwork alluded to is essentially psychic in origin.

On the other hand, certain of the supplementary touches in the cases brought forward seem at first sight to be purely accidental, and to have no mental significance whatever. Hence it might seem that those who study the human face as an index of the mind might safely ignore such physiognomical items as are due, let us say, to exposure, to heat, or cold, or to other purely direct causes. This, however, is only partly true, if it is true at all. Every student of the psychology of expression must be extremely cautious in neglecting any particular trait because it seems due to some accident of environment which has no apparent effect on the central nervous system.

That there is a continual stream of influence passing from the brain to the muscles of expression, which tends to give a permanent cast to the features, has been shown; but it is not so generally recognized that there are also reverse currents from the organs of expression to the inner nerve centers, and that in many cases these are sufficient (even when induced by agencies which must be called external and fortuitous) to give a bias to the mind. When Mr. Du Maurier depicted a small child forcibly wagging the tail of a big St. Bernard in order to put it in a good humor, most people who laughed at the conceit probably thought that the child's plan was as illogical as that of moving the pointer of a barometer in order to bring about a change in the weather. But it will be seen, when we come to discuss these curious centripetal currents, that this is by no means the case. Indeed, in all probability, some of the mental peculiarities which mark the members of certain professions may be owing to changes which originated primarily in the features.

Leaving this subject for the present, let us pay attention to some of the face-making forces which act from within. In my previous article a good deal was said about the facial muscles, and the nervous mechanism which controls them. It was explained how a constant succession of stimuli to one set of muscles would, in the course of time, give them a predominant influence, and so bring about a general change of expression. Nowhere can such a result be seen better than in the horsey type above alluded to. Speaking generally, the expression of all men of action is attributable to like causes. In such people the chief motive force is the will, which is continually exerting authority over the man himself, or over other men or things. Hence we find that the expression mechanism which is under the control of the will (consisting chiefly of muscles of the striped variety) is mainly responsible for the result.

But a little reflection will show that the salient points of many of the typical faces which we constantly see are under but little obligation to these agents of the will. It is beyond the power of the facial muscles shown in works on anatomy to give a man a shiny nose or a double chin, or to affect the tint and general tone of the integument.

Such changes must be attributed to the influence of the *sympathetic nervous system*, which is practically independent of the will, and which profoundly influences growth and nutrition in all parts of the body. Any one who has looked into a treatise on physiology will have seen diagrams of the sympathetic nervous system, and will have learned that nearly all unconscious organic processes, such as the digestion and assimilation of food, the movements of the heart, the alteration in the caliber of the arteries, and the special functions of innumerable glands, are carried on under its management. He will also have learned that fibers from the sympathetic ganglia frequently join the nerve trunks derived from the brain and spinal cord; and that this is very markedly so in the case of those cranial nerves which supply the face with common sensation. Probably he will have observed that in the neighborhood of the heart, stomach, and liver, as well as in certain other parts, there are extraordinary aggregations of sympathetic fibers. Each of these dense networks of nerves and ganglia is called a *plexus*, and primarily, no doubt, each *plexus* is busily engaged in superintending the purely organic duties of the viscera in its neighborhood. But this is not its only function. It is a very curious fact that when we try to localize any deeply felt emotion, it seems to appeal to the consciousness from one or other of these very regions. The least analytical mind is aware that we do not love, or hate, or fear, with our heads, but that, in each case, the feeling takes its rise somewhere in the body cavity. Hence the conventional phrases, "warm-hearted," "bowels of compassion," and many others of like nature, which are only approximately correct from an anatomical point of view, since it is demonstrable that the organs named are only affected secondarily, and do not indicate the exact spot where the emotion is felt.

It is not possible to discuss this subject fully on the present occasion; but enough has been said to show that, in their inception as well as in their expression, the feelings which accompany the passions are referable to parts of the sympathetic nervous system.

Now the question might very naturally be asked, What has all this to do with physiognomy? I hope to show, if my readers will follow me in an argument involving a few more technical details, that in these complex functions of the sympathetic nervous system we may find an explanation of certain curious points of facial resemblance among people whose pursuits and mental habits, at first sight, put them as far as the poles asunder.

We will take, as examples, the common facial traits seen in professional musicians, religious devotees, of the priestly class, and sensual "men about town."

To show how the fibers from the sympathetic ganglia affect growth and nutrition in certain localities, let me instance the different results which follow the division of the fifth cranial nerve in two different parts of its course from the brain to the face. If it is cut *after* it has received its accessory fibers from the sympathetic system, a destructive inflammation at once arises in the eye, owing to defective or perverted nutrition; but if the division takes place on the cranial side of the ganglion through which the nerve passes, so as to leave the sympathetic fibers intact, no such consequences follow, although the part supplied by the nerves is entirely cut off from the brain.

Redness or pallor of the skin is the direct result of the influence of the sympathetic nerves upon the muscular coats of the smaller blood-vessels, and such visible changes are often confined to a small area. When, owing to some wave of emotion, the cheeks flush or turn pale, the same stimulus which effects such an alteration in outward expression *will also disturb the existing conditions of nutrition in the regions affected.* And it appears exceedingly probable that just as the faint currents continually flowing along the motor nerves are to a great extent responsible for the prevailing "muscular" expression of the countenance, so also slight but continuous emotional stimulation of the sympathetic fibers which supply any part of the face may influence its growth in a marked degree in the long run, although at any given moment the vascular consequences may be imperceptible.

Now it is within the knowledge of every one who has turned a curious inward eye upon his feelings that certain emotions which deeply stir the inner man, and which may make us glow or shudder to the finger tips, do not cause any facial changes, except, perhaps, a slight difference in the hue of the brow or cheeks, and a glistening or darkening of the eye. This is often the case when we are under the control of the deeper feelings. We do not laugh when filled with the most exalted joy, or distort our faces when overwhelmed with grief. The fierce emotion which seizes on man and beast alike when the grosser appetites hold full sway often produces many profound changes of an organic nature without provoking any activity in the expression muscles.

Even when certain forms of emotion tend to distort the features if provoked in a natural and direct manner, they fail to react upon the facial muscles when produced artificially, as they may be by a play, a novel, or a strain of music. During the silent perusal of a pathetic story many people confess to a "lump in the throat," but it is very seldom that the corners of the mouth are twitched downward.

These deliberately induced or artificial emotions offer an interesting field to the psychologist. They evidently differ from their elementary prototypes as much as polarized light differs from direct light. They tint what would else be both hideous and prosaic with all the colors of the rainbow, so that we are able to take pleasure in tragedy,

> "And with an eager and suspended soul
> Woo terror, to delight us."

If we survey the faces of a crowd of people at a concert, we find that they offer scarcely a hint of the emotion evoked by the music. The features of the listeners remain as placid as if they were asleep, and as if the inward excitement which thrills them, and which makes their pulses throb and their flesh "creep," were but the sham excitement of dreamland. As a rule, the same may be said of the ecstatic feelings which accompany devotional exercises. I do not allude to public prayers from the pulpit—where an earthly audience has to be borne in mind—but to the silent communings of private worship, when the soul feels that it has entered the holy of holies, and stands naked before the Eternal Powers.

If it were possible to set apart certain individuals in whom all emotional impulses reacted upon the features *via* the sympathetic, to the exclusion of the motor nerves, we should expect to find among them many strong points of resemblance in facial expression. Although, happily, no such creatures exist among healthy human beings, it is by no means difficult to indicate whole classes of people whose pursuits, or mental habits, give the sympathetic system a preponderating influence.

Professional musicians, priests, and sensualists, all, as a rule, bear distinct certificates on their countenances that they belong to such a category.

But before we are in a position to discuss the special points of resemblance among these very distinct classes, it will be necessary to clear the ground of certain stumbling blocks.

Since the facial changes in question are brought about by means of the machinery of nutrition, it must be taken for granted that this machinery is in good working order in every case, and that it is reasonably well supplied with raw material in the shape of victuals and drink. If one of our subjects should chance to be an ascetic or a dyspeptic, it is plain that all trophic processes, whether direct or indirect, will be so profoundly affected that it would be unfair to compare him with people who live well and have sound stomachs. Again, the possession of an exceptionally alert intellect would vitiate results in any individual, since this tends, as is well known, to develop a distinct type of face. The candidate for sympathetic facial marks must also maintain an aloofness from the turmoil and traffic of the world about him; although it does not much matter whether the wall which shuts him off from his fellows consists of substantial bricks and mortar, or of professional enthusiasm, or of mere selfishness.

It will be well, for the present, to confine our attention to subjects of the male sex who are past their first youth, since women and young people exhibit but few conspicuous traces of emotional influence upon facial nutrition as compared with men of mature age. Probably the reason of this difference is found in the fact that both women and youths are normally more under the sway of the feelings than are men, and therefore special emotional stimuli do not cause any deviation from the type of face which usually characterizes them. If we were to take two individuals, one a trained gymnast and the other a clerk with flabby muscles, and were to make them exercise one arm, so as to develop it to the fullest extent, there can be no doubt that, when this end was attained, the latter would deviate more noticeably from his usual state than the former.

From the fact that women are more governed by their emotions than men, one might be tempted to jump to the conclusion that constant emotional stimulation of the kind we are discussing would tend to produce an effeminate type of face. But, as a matter of fact, this is only true to a very limited extent. It must be remembered (and this is a point upon which I wish to lay special stress) that artificial emotion—such as is evoked by music—has to make use of nervous machinery *belonging primarily to the body rather than to the soul*, and which remains indissolubly connected with certain organic processes common to man and beast.

Now there can be no question that any deep stirring of the emotional side of our nature tends to throw us back upon the bestial substratum derived from our remote ancestors which we generally keep covered up. In a strong gust of passion the "vital spark," which crowns our material being like a nimbus, is extinguished, and the ancient and half-quenched embers of animality beneath are fanned into fierce life. A man, excited or enraged (in common with other mammals of the combative and covetous sex), becomes emphatically a savage male. Hence habitual stimulation of the emotional side of our nature will tend to enhance, rather than to diminish, certain sexual differences in expression.

It is extremely important that we should bear in mind that passion prints on the face are often quite useless in enabling us to form an opinion as to the moral character (as distinct from the moral *tendencies*) of any individual. For the inhibitory centers of the mental apparatus, upon which depend our powers of self-restraint, do not exercise their veto beyond the frontier line which separates the rational from the organic side of human nature. And, let us recollect, it is the latter region which is governed by the sympathetic system, with its complex emotional and trophic functions. Thus, although a man may feel illicit passion, or unrighteous rage, without deviating in act from the path of rectitude, yet his heart, his skin, and other parts under the sympathetic *régime*, will ignore both the moral code and any voluntary decision to obey it.

Not only may the organic part of a man show every sign of guilt when there is no guilt, but only temptation; but it may even go further in attaching a false and slanderous label to the countenance, owing to the interlocking mechanism of emotion, passion, and nutrition, above alluded to.

Doubtless some of my readers have chanced to contract a black eye in a perfectly innocent and unpugnacious manner. Let us suppose, for the sake of argument, that it resulted from a sharp return across the tennis net. Until the last of the dismal tints fades away, such a one bears about with him one of the most generally accepted proofs of a hasty disposition and of a blackguardly encounter. Yet the victim himself—and each of his friends who will believe his statement—knows that not only is he innocent of a breach of the peace, but that, when he received the ugly mark, he was engaged in one of the most amiable of recreations.

Now in like manner, certain popularly received evidences of a bad moral record may be printed accidentally *from within*. For the molecular impulses welling forth from a disturbed emotional center may chance to flow along channels usually occupied by less innocent currents, and may produce an expression nearly identical with that which accompanies some form of vice. And yet, all the time, the said emotion may be as essentially distinct from the travelers which usually follow the track, as were Bunyan's Pilgrims when they walked the streets of Vanity. In such a case it will be seen that, in spite of outward appearance, not only is there no guilt, but there may be also a complete absence of evil inclination.

To return from what I fear may be regarded by some as a rather arid and metaphysical region, let us take stock of the typical characteristics of the musician, the priest, and the sensualist, who have so oddly foregathered in the interests of science. Physiognomy, it will be seen, like misfortune, makes strange bedfellows.

To get our typical musician, we must, to some extent, follow the example of the society caricaturist. That is, we must generalize, after the fashion of a composite photograph, and then slightly magnify the traits which are found to be common to most members of the class. Probably professional singers approach our ideal most nearly, because the mastery of the *technique* of voice music involves fewer disturbing influences (from our point of view) than does the mastery of any complex external instrument.

The average musician's face shows but little trace of muscular activity, but evidences of trophic changes due to sympathetic disturbance are abundant. The skin, especially beneath the eyes and about the throat, tends to be full and baggy, and is often filled out with local accumulations of fat. As a rule, the eyes are prominent and dreamy, the cornea is bright and the conjunctiva glistening, but the natural blue-white of the sclerotic has given place to a duller tint. The nose is characterless (as far as acquired qualities are concerned), and differs essentially from the clear-cut nose of the man of active will or intellect. The mouth is the least constant feature, but it generally is characterized by a lax and flabby set of the lips. It is the sensuous mouth belonging to the artistic temperament, with certain specific characters superadded, which result from the same causes as are responsible for the fullness beneath the eye and chin.

Now, why does the mouth, which commonly accompanies the artistic temperament, suggest habits of self-indulgence? It is an essential, with every true artist, that he should follow certain spontaneous impulses. He is born, not made. He can not, like the student or the man of business, hope to excel by toiling against the tide of inclination. In his art he therefore achieves most through a species of self-indulgence; and it is too often characteristic of the artist that this drifting tendency widens and embraces other departments of life. Yet, although it may be confined to artistic matters alone, any habitual yielding to natural impulse will tend to tell its tale on the mouth.

Although the subcutaneous tissues of certain parts of the musician's face are plainly increased in bulk through sympathetic influence, one does not find that the skin itself is much altered in texture. It is, however, usually pallid, and does not exhibit the full-blooded coarseness observable in the other types which we are considering. I am inclined to think that the peculiarities which are generally so obvious in the hair among professional musicians are not altogether dependent upon fashion, but that here again we have evidence of trophic changes which result from mental habits. Almost every fashion of this kind, when carefully analyzed, is found to be based upon some natural physical peculiarity. All who have to do with the treatment of mental disease know how profoundly the growth and vitality of the hair is influenced by emotion; and it seems very probable that local trophic stimulation, similar to that which gives a fullness to the throat, etc., may effect typical changes of this kind also.

Passing on to the priestly class, we find many undoubted signs of special sympathetic influence upon the face. It should be understood, however, that the term "priestly" must be taken in a very broad sense. Any religious devotee with mystical tendencies, who makes much of the emotional and little of the intellectual side of religion, is liable to develop something of the characteristic priestly aspect. It is not unknown among those archenemies of priestcraft, the Quakers, although these good folk are generally too much in touch with the world to develop it to such an extent as do mystics who live in seclusion, or under the dwarfing shadow of ecclesiastical authority.

In this type of face we find not a few points similar to those already discussed. For some mysterious reason the subcutaneous tissue over the cheek bones and under the jaw gets an undue supply of nourishment. The skin, however, is less flabby and has more color than that of the musician, and in this respect the priest occupies an intermediate position between him and the last of our trio. Naturally, there is more evidence of mental activity in the priestly than in the musical face, and, especially where our reverend subject is conscious of a share in the apostolic legacy, his sense of authority gives a more muscular set to his lips. Habits of self-denial and self-command give him characteristics which make him, as a rule, compare favorably with his physiognomical associates; but when these, and marked intellectual traits, are absent, and no physical bars to nutritive processes intervene, he is capable of reaching an even lower level of ugliness than they.

Probably nowhere can one see the less prepossessing characteristics of the priestly type in so pronounced a form as among the humbler Catholic clergy in Ireland. Here we have most of the conditions (mentioned above) which are required for the full development of sympathetic facial traits. The Irish priest is generally drawn from a healthy and imaginative peasant class, readily given to emotion and superstition, and not overburdened with intelligence. His constitution is sound, his digestion is good, and he is not very rigidly abstemious either by rule or custom. I see no reason to doubt the testimony of impartial critics who declare that, taken as a whole, the Irish priests are the most chaste and devoted body of clerics upon earth. They are undoubtedly of good report, but they can not be classed among the "things that are lovely." Judged from the conventional rather than from the scientific standpoint, the expressions of these good men are indicative of anything but of spiritual purity or of intellectual refinement. In their jaws, lips, and eyes, those traits which are generally considered to be the marks of the grosser animal qualities are so apparent as to force themselves upon the attention of the spectator.

Now why does a clerical congress in the Isle of Saints appear —as far as outward facial aspect is concerned—like a parliament representing the interests of the world, the flesh, and the devil?

People of "the opposite religion," to use a convenient phrase which we owe to Lord Salisbury, have not been backward in suggesting explanations of the phenomena which are not very favorable to the doctrines and practices of the spiritual followers of St. Peter. And in like manner some of those "painefull and pious" Christians who regard all theatrical and similar amusements as sinful, find support for their views in the stodgy visages of musicians and public singers. In both cases science is on the side of the charity which thinketh no evil. For if the inferences here drawn from what we know as to the physiology of emotion are correct, the facts prove no more than that the ugly priest, or public entertainer, has good assimilative organs, deep feelings, a sluggish mind, and narrow interests. If in feature he tends to resemble certain moral offenders, the fact is owing to a mere unhappy accident, like the black eye of the tennis player aforesaid. Any such resemblances depend upon the fact that man's emotional machinery has not kept pace with civilization, but is still practically in the same state as when it was adapted for the very limited wants of our pristine ancestor, who had no inward feelings unassociated with animal appetite. Our complex modern life has revealed its deficiencies, just as the advent of a missionary among certain primitive races reveals the ludicrous poverty of languages, which can only express the idea of "heavenly bliss" by words meaning "a very full belly."

Into the distinguishing facial traits of the sensualist it is not necessary to enter. In his case the evil expression is honestly come by, and is due to no physiological accident. To any competent reader of facial records it tells its story with a frankness which out-Zolas Zola. What is chiefly of interest about it is the mechanical process by which the inner man is revealed upon the surface. Here, again, we find that the sympathetic nervous system is the agent chiefly responsible; for the changes which have occurred since the face lost its youthful innocence are owing to trophic rather than to muscular causes.

It is worth while noting that here, as in the other tpyes instanced, the exercise of the will and the intellect, or any interference with organic nutritive processes, will mask the facial results of yielding to emotion. Any man of the world will support me when I say that there are not a few grossly sensual men whose expressions do not readily betray them. An ascetic debauchee is an impossible being, but there are not a few instances of men who give free rein to their desires, who nevertheless, from some defect in the assimilative organs, or from the fact that they exercise their wills and minds in other directions, do not develop the bloated countenance and prominent lustful eye which typify the class generally.

In concluding my remarks on the three types we have been discussing, let me say that no abnormally acute powers of observation are required to enable one to distinguish the actual marks of vice from the marks of sensuous emotion which is innocent in character. But it is evident that the resemblance is quite suggestive enough to confuse the crowd, and to provide mud for the ever-ready hand of the religious controversialist. Let it be remembered, also, that we are not dealing here with any of the deeper results of the complications which arise owing to the diverse functions of the machinery of emotion. Dean Swift, in his ruffianly onslaught on the revivalists of his day, had enough truth on his side to give point to his parable. In *our* religious devotee the physical results of excitement do not break through the barrier set up by the inhibitory centers, and come into the region of conduct.

Having had occasion to make free use of the word "artist," it may be worth while to devote a few words to the class most generally known by that name. In the case of most painters, and all sculptors, another and most important expression factor comes into play. I allude to the effect of unconscious imitation.

This subject was touched upon in my previous article, when an explanation was attempted of the remarkable resemblance which often becomes apparent between persons who live together.

There appears good reason for believing that even an unsubstantial ideal face which is always before the mind's eye will influence the expression muscles in a like manner. Among the majority of artists who paint or model the human figure certain standards of perfection, generally founded upon the old Greek masterpieces, are ever present to the mind—more so, probably, than the face of any human companion. Now when we strive to realize a mental picture of another face, whether it be that of a god or a costermonger, we unconsciously imitate it. Careful observation of a considerable number of artists' faces has convinced me that such involuntary mimicry is a considerable factor in determining that classic cast of visage which is certainly more common among men of this profession than among those of any other. On the other hand, we find that caricaturists and all low comedians of the pencil tend to develop an eccentric expression. Those who have lived long enough to watch the development of certain well-known faces in the artistic world will, I think, agree with me that in most cases the acquired expressions are broadly reflections of those chosen ideals which have been occupying the thoughts and employing the hands of the artists.

Landscape and *genre* painters are of course free from this kind of influence. There is nothing in their work or in their ideals that can be reproduced by the mechanism of the body, and any reaction of the nervous system must be akin to that of ordinary sensuous impressions. These, as we have seen in the case of the musician, do not conduce to personal beauty. It seems probable that Turner might have been a much more presentable man, though possibly less famous, had he devoted himself to figure painting.

Actors' and actresses' faces are of great interest to the physiognomist. An actor's art must of necessity involve the stimulation of both the muscular and trophic factors of expression. Not only has he to emphasize the facial movements which are appropriate to his part, in order that his expression may be plainly seen by the pit and gallery, but he is as a rule obliged to change his rôle frequently, and to assume a succession of characters requiring very different facial renderings. As a result, all his expression muscles are exercised as thoroughly as are the body muscles of an athlete who is undergoing a systematic course in a gymnasium. Hence in a typical actor's face, when seen at rest, no one group of expression muscles outpulls the others, and as a consequence of this state of muscular balance there is about it a peculiar aspect suggestive of a mask. Moreover, this impassive and almost wooden look is enhanced in many cases by an even layer of subcutaneous fat—the result, probably, of emotional stimulation of a constantly varying character.

I am aware that many actors state that they do not consciously experience the emotions which they simulate; but from the very fact that they are able, without taking thought, to adapt their voices, gestures, and expressions to the sentiments they utter, it is clear that the organic (sympathetic) nerves are moved if the conscious ego is not, and, as we have seen, this is all that is required to influence trophic function whether in the face or elsewhere. Miss Ada Rehan, who was kind enough to assist me in clearing up this point, stated that, in rendering any particular expression, she is quite unconscious of any deliberate effort of the will.

One consequence of the full exercise of all the facial muscles, and of the trophic results of varying emotions, is a remarkable interference with the time records which are usually so visible on the human face. In fact, most actors maintain a somewhat boyish aspect until late in life, although the suggestion of callow immaturity is at times rather startlingly contradicted by the expression of the eye. In ladies who adopt the stage as a profession, a true youthful appearance is, as a rule, much better maintained. Until the physiological principles which account for the phenomenon are understood, it must remain a very puzzling fact that an actress's life should be more favorable to the preservation of good looks, and even of girlish freshness, than the life led by women who occupy their natural sphere, and who cultivate (as they think) all physical and moral virtues. A successful actress must work extremely hard, generally by artificial light, and in a gas-befouled atmosphere. Her hours for work, meals, and sleep are all utterly bad from the hygienic point of view; and not infrequently she makes bad worse by falling into those bohemian habits which are an immemorial tradition of her class. Her secret, apart from the laws regulating the expression and nutrition of the face above stated, consists chiefly of avoidance of monotony and petty worries—those archenemies of feminine good looks and good temper. Her work, if arduous, is generally performed both with earnestness and lightness of heart; and, above all, she gets a sufficiency of bodily exercise of the kind (although not under the conditions) most conducive to health—viz., exercise involving quick and general movements of the muscles, combined with a certain amount of mental excitement.

Any one who considers the preservation of female beauty worthy of serious attention can draw from the facts here stated some general principles, resting on a sound and scientific basis, upon which to found rules for the guidance of the sex. I see no reason why the average British matron should not be physically qualified to play Juliet at fifty if she will observe all the conditions favorable to the preservation of youthful good looks. Indeed, when we bear in mind the many adverse circumstances in a stage career, a lady who goes to bed at half past ten and rises at seven or eight, should be able to give an actress ten years, and beat her easily.

Descending from the realm of Venus to that of Vulcan, let us consider, while we stand among the smoke and sparks of the forge, the problem already alluded to as to the reaction of the expression on the mind. As the smith wields his hammer with an energy which has something fierce and vengeful about it, he automatically contracts his brow into a frown. He does this partly, no doubt, to protect his eyes from the flying flakes of metal; but if you watch the face of the man who holds the iron on the anvil, you will find that although he lowers his eyebrows somewhat as the sledges descend, he does not scowl as do the strikers. In most blacksmiths the constant exercise of the *corrugator supercilii* muscles causes a permanent frown, and gives the face a somewhat hard expression; but whether there is any inward and spiritual state corresponding with this outward and visible sign I am not quite sure. Certainly there is a popular belief that, as a rule, the blacksmith is a serious and downright person, who "looks the whole world in the face," and who does not take chaff kindly; but the popular mind is peculiarly liable to be biased by such obvious arguments as are presented by the smith's lowered brow and huge biceps, and does not stop to weigh their pertinence in deciding questions of character. I remember being a good deal impressed, when residing in a shipbuilding town, by the intent gaze and bent brows of the riveters and boilersmiths with whom I was brought in contact. One instinctively wondered at first what there was about a harmless hospital surgeon who ministered to them in times of dire trouble, to excite such an air of watchful hostility. I soon found, however, that no hostile sentiments were entertained, but that the frowning, falconlike expression was explained, partly by the "smith's scowl" above mentioned, and partly by the fact that all these men were rendered somewhat deaf by their noisy work, and in consequence had a habit of closely watching the face of any one who conversed with them. Whether their characters in any way corresponded with their acquired expressions I did not discover; there was a grave courtesy in their demeanor while in hospital which was singularly dignified and pleasing, although always slightly suggestive of the politeness of foes during an armistice.

It is easy for any one to satisfy himself by making a few experiments that the act of striking a forceful blow, even at the empty air, tends not only to bring a flush and a frown to the face, but also to awaken an inward glow of emotion which is the raw material of wrath. We all know how certain individuals, when they think it expedient to be angry, "work themselves up" by deliberately assuming a loud, harsh voice, violent gestures, and other choleric symptoms. Here there can be no doubt about centripetal currents which pass inward from the expression organs, and which influence the mind. Nor is it necessary that the will should be called into requisition in order to set such currents in motion, for persons much given to involuntary blushing, and who experience the distressing mental abasement and confusion which accompanies a general dilatation of the arterioles of the face and brain, find that any outward circumstance, such as the heat of a room, which tends to redden the face, also renders them liable to the psychic accompaniments of a blush. Moreover, it is well known that the assumption of an expression of dejection contributes to lowness of spirits, and that we find it easier to be brave with our chins up and our shoulders squared than when we cringe and look at our boots.

In religious services involving an elaborate ritual, posturing is made use of in all parts of the world as a remedy for mental inertia. Doubtless the general prevalence of the practice is a strong testimony in its usefulness, although such strategy, based upon the innate tendency of the mind to conform to the body, appears, from one point of view, a trifle undignified, in warfare where the spirit is endeavoring to assert its eternal supremacy over the flesh.

Moreover, occasionally, the laws upon which these and like ceremonials are founded seem to be reversed. Professional merry-men are proverbially grave and melancholy in private life, while undertakers, according to Oliver Wendell Holmes, are cheery beyond their fellows. The assumption, therefore, of devotional attitudes, and of a pious countenance, in the hope that the soul may follow suit, may not be so safe as has been generally supposed.

Even if space permitted, it would be impossible on the present occasion to analyze each of the many distinct trade expressions which must be familiar to all dwellers in towns. In the first place, our knowledge of the inner lives of most persons outside our own class or social circle is quite insufficient to justify us in theorizing concerning the forces which may have been instrumental in making them, facially, what they are. Until some enthusiastic naturalist will apply the methods of Lubbock and Huber to his fellow-men, we must be content to remain in comparative ignorance. But if the general principles which I have ventured to put forward in this paper are to be trusted, any new fact concerning the habits of any section of the great human swarm may at once be made available by those who are endeavoring to place physiognomy on a sound basis.—*Blackwood's Magazine.*

NATURAL RAIN-MAKERS.

By ALEXANDER McADIE.

THE efficiency of the clouds in lifting water will be brought home to us if we consider the rainfall over a garden fifty feet wide and one hundred feet in length. If one hundredth of an inch of rain occurs, about twenty-five gallons or two hundred and fifty pounds of water will have fallen. One inch of rain over the garden would mean twenty-five thousand pounds of water.

A rainfall of forty-five inches in a year is not an unusually large rainfall. New York city has a mean annual rainfall of 45·2 inches, the observations covering a period of twenty-two years. If this rain of a year fell in equal amounts each day, we would have for every acre of surface two thousand eight hundred gallons of water, or in avoirdupois nearly nine thousand tons of water to the square mile. Tipping Manhattan Island each evening and draining it would give two hundred thousand tons of water. In a year over seventy million tons of water are dropped on the roofs, sheds, and pavements of Manhattan Island.

It requires a powerful pump to lift water in such quantities and store it in reservoirs thousands of feet above us. And these reservoirs are remarkable; for they have no walls of rigid masonry, and they course across the sky at higher speed than man can travel. A locomotive can travel a mile in thirty-seven seconds, a fast yacht in about twice that time, and a swift torpedo boat in one hundred and ten seconds. The upper clouds move with an average velocity of a mile in thirty-six seconds, and have been observed moving as rapidly as a mile in eighteen seconds. Equally remarkable are the plastic walls of these aërial reservoirs. No courses of heavy stone and mortar are to be found; but in their stead drops of water so minute that a thousand of them side by side would not extend farther than one inch. If the temperature

ALTO-CUMULUS.

was low during the building of the cloud, the water drops are changed into ice spicules and snowflakes.

From such reservoirs the rain falls as a rule harmlessly. A collapse, which rarely occurs, is known as a cloud-burst. Then, the deluge destroys life and property, sweeping all before it.

If we were able to control the valves and vents of this tremendous pump-reservoir, we could cause rain at will and shut off the downpour at pleasure. But hardly yet may we hope to master the rain. Rain-makers of our time bang and thrash the air, hoping to cause rain by concussion. They may well be compared to impatient children hammering on reservoir walls in a vain endeavor to make the water flow. Rain-control is a scientific possibility. Successful rain engineers will come in time, we venture to predict, from the ranks of those who study and clearly understand the physical processes of cloud formation.

Cloudland, for a realm so near us and so closely associated with our welfare, has been sadly slighted by man's genius. The ancients were surprisingly stupid in their views and discussions of air, wind, and clouds. The wisdom of Aristotle, filtered through the mind of his favorite pupil Theophrastus of Eresus, does not show to advantage in these subjects. Nor have the moderns achieved much that is worthy of detailed mention until a comparatively recent period.

Our cloud names date from the beginning of the century. At a meeting of the Askesian Society in 1802, a young chemist of Tottenham read an essay in which he proposed the terms stratus or sheet, cumulus or heap, and cirrus or feather for cloud names. One attempt at cloud classification had been made previously, but Howard's scheme was so superior that it at once received recognition. The essay was reprinted, translated, and officially adopted in all the great countries of the world. While Howard's name is known to all meteorologists, little has been handed down concerning the man himself. He is quaintly described on the title-page of his three-volumed Climate of London, as a Citizen of London, Honorary Citizen of Magdeburg, and Honorary Associate of the Art Societies of Hamburg and Leipsic. No less a person than Goethe was among those who were charmed by Luke Howard's work. A friendship sprang up, a long correspondence was carried on, and the poet sings of Howard as one worthy of all honor.

Within the past few years the leading countries of the world through their representatives on the International Meteorological Committee have decided to depose the Howardian nomenclature. The proposal was made four years ago at the Munich Conference, and at Upsala last year a new classification was formally approved. Some of the more prominent sponsors for the new system are Hildebrandsson, Köppen, Neumayer, and Rotch. Modern meteorology demands more than a record of the appearance of the cloud. It seeks the meaning of each formation. The cloud is primarily valuable not on account of its beauty but because it makes manifest atmospheric motions and conditions not otherwise noticeable. A striking illustration of the use which modern meteorology makes of the clouds is found in the storm of August 26 to 29, 1893. This is the storm more familiarly known as the Sea Islands storm, in which eleven hundred lives were lost. At a critical moment the telegraph lines were blown down and all reports were missing south of Savannah. It is said that the storm center was accurately located by the forecasting officials by means of the clouds at distant stations.

Great progress has been made in the past five years in our knowledge of clouds. Two masters in physical science, von Helmholtz and Hertz, were brilliant cloud investigators. The former explained the formation of cloud billows; the latter devised a graphic method of following the adiabatic changes in moist air. The number of tiny solid particles in a cloud can even be counted. John Aitkin, of Edinburgh, has constructed a dust-counter delicate enough to do this. The dust nuclei in the smoky air of London, on the quiet shores of the Mediterranean, on Alpine peaks, or in the pure mists of the Scotch Highlands can be counted and

Fracto-nimbus. Advance Clouds of Thunderstorm.

their influence in the making of rain properly appreciated. Both in Europe and the United States meteorologists are studying clouds. At Berlin, Storlein, Upsala, and Blue Hill observers are daily determining cloud heights and velocities, and in the coming year forces will be massed and something akin to a systematic survey of cloudland attempted.

Poet, painter, and all of us have felt the keen delight of following the cloud transitions of a summer sky. All men in all lands are nephelolaters or cloud admirers—for the cloudscape gives all that the most varied landscape can offer. A generous sky knows no difference between the sons of earth, and spreads everywhere scenes of wondrous grace and color. Even the most commonplace cloud formation—fog—which on earth is often aggravating and trying to health and temper, becomes beautiful as soon as it leaves the earth.

A fog may be defined as a cloud viewed from within, and is therefore the first distinct cloud type. The next low type is the stratus or "raised fog," less than one thousand metres high. And here it may be noticed that in summer the earth pushes her cloud mantle away from her and draws it closer to her in winter. In other words, clouds are lower in winter than in summer. The highest cloud is the cirrus, with a mean elevation of nine thousand metres. The cirrus is a fine, featherlike cloud, and its neighbor, cirro-stratus, something like it, only more diffuse and lower. When a veil of cirro-stratus is drawn before the sun or moon, large halos forty-four and eighty degrees in diameter, with faint red on the inside or nearest the sun, and blue on the outside, appear. These are caused by the refraction of light by ice crystals. A lower cloud, alto-stratus, without causing halos may cause coronæ or smaller circles of prismatic colors, about one fourth the diameter of halos. In coronæ the red is on the outside. The Brockenspecter is a particular kind of coronal cloud shadow. Midway between high and low clouds are the cirro-cumuli and alto-cumuli. These give perhaps the most beautiful of all cloud effects. The fairest meadows of earth seldom show such flocks grazing so leisurely and scattered so harmoniously. Cirro-cumuli are small, white, fleecy clouds, often arranged in rows, while the alto-cumuli are denser, larger, and less regular. Both types are like tranquil fleets upon a serene sea. "Their very motion is rest," as John Wilson said of them long ago. Trailing in lustrous glory before the midnight moon, they turn into silver bars and "streak the darkness radiantly." Of the low clouds, the strato-cumuli and nimbi are most common: the former, large rolls of dark cloud, often covering the whole sky and of somewhat dreary aspect; the latter, nondescripts without definite form and with little gradation in color. The sky effects of both are as a rule somber and depressing, though there are times, especially if the sun be close to the horizon, when the nimbus gives the golden rain of Greek mythology, a downpour inexpressibly beautiful. The cumuli and cumulo-nimbi are the largest clouds in cloudland. The familiar "castles in air" are the turreted cumuli, thick clouds with domes and summits. The cumulo-nimbus, or towering thunder cloud, rises mountain high, and has peaks of snowy whiteness with a flat and frowning base. Its monstrous size can be better appreciated if we imagine Mont Blanc (14,134 feet high) lifted into the air and set down on top of Mount Washington (6,279 feet). This would make a medium-sized cumulo-nimbus. The thunder cloud is noteworthy in another respect, namely, that the water in it may be cooled below the freezing point and yet not frozen. A snowflake or ice crystal falling into it may suffice to start a sudden congelation, just as we may see ice needles dart in all directions when the chilled surface of a still pond is disturbed. We liken this monstrous cloud to a huge gun loaded and quiet, but with a trigger so delicately set that a falling snowflake would discharge it. The sudden puffs, gusts, and elongations of the thunder cloud may have their origin in this way. Again, there is every reason for believing that electricity plays an important part in the enlargement and subsequent history of this cloud. We have ourselves measured with sensitive quadrant electrometers the pull in volts experienced by the air between one of these clouds and the ground. The approach of the cloud can be foretold *without seeing it* and the sky mapped out roughly by the changes in the electrical potential caused by the passage of the cloud.

CUMULO-NIMBUS.

From what precedes it will be readily understood that cloud motion is not always a true exponent of air motion. Meteorologists know that it is not safe to obtain the motion of the air currents from the motion of the clouds, for the latter may move faster or more slowly, or even apparently stand still in the wind, as in the "table-cloth" cloud on Table Mountain at the Cape of

Good Hope. In reality the cloud is changing rapidly, forming and dissolving at one and the same time.

In forecasting weather, clouds have, as we all know, special significance. They are the true robes and garments of earth. The poet sings of hills clad in verdure, the mantle of tender green that the Earth puts on in the spring, and the splendid hues of her autumnal dress; but the garment which protects old Earth the year round from extreme temperatures is the cloud layer. Where there is little cloudiness the range of temperature is large, and where there is much cloudiness the temperature is very even.

So, while the clouds delight us, they are also active for our welfare. In never-ending procession they move—ragged ranks of fracto-nimbi jostled by frowning cumuli, tatterdemalion scud leading an army of mighty nimbi, the baleful funnel cloud, hovering and ill-omened, rolling strato-cumuli that lie far out on the flank; thus they pass, while in the calm above appear the cirri dainty and lacelike, or curling wisps of laughing cirro-stratus.

STUDIES OF CHILDHOOD.

X.—MATERIAL OF MORALITY.

By JAMES SULLY, M. A., LL. D.,
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(a) PRIMITIVE EGOISM AND ALTRUISM.

PERHAPS there has been more hasty theorizing about the child's moral characteristics than about any other of his attributes. The very fact that diametrically opposed views have been put forward is suggestive of this haste. By certain theologians and others, infancy has been painted in the blackest of moral colors. According to M. Compayré, it is a bachelor, La Bruyère, and a bishop, Dupanloup, who have said the worst things of children; and the parent or teacher who wants to see how bad this worst is may consult M. Compayré's account.* On the other hand, Rousseau and those who think with him have invested the child with moral purity. According to Rousseau, the child comes from the Creator's hand a perfect bit of workmanship, which blundering man at once begins to mar. Children's freedom from human vices has been a common theme of the poet: their innocence was likened by M. About to the spotless snow of the Jungfrau. Others, as Wordsworth, have gone further and attributed to the child positive moral excellences, glimpses of a higher mo-

* L'Evolution intell. et mor. de l'enfant, chap. xiv, ii.

rality than ours, divine intuitions brought from a loftier prenatal existence.

Such opposite views of the moral status and worth of a child must spring not out of careful observation, but out of prepossession, and the magnifying of the accidents of individual experience. A theologian who is concerned to maintain the doctrine of natural depravity, or a bachelor who happens to have known children chiefly in the character of little tormentors, may be expected to paint childhood with black pigments. On the other hand, the poet attracted by the charm of infancy may easily be led to idealize its moral aspects.

The first thing that strikes one in all such attempts to fix the moral worth of the child is that they are judging of things by wrong standards. The infant, though it has a nature capable of becoming moral or immoral, is not as yet a moral being; and there is a certain impertinence in trying to force it under our categories of good and bad, pure and corrupt.

If, then, we would know what the child's "moral" nature is like, we must be careful to distinguish. By "moral" we must understand that part of its nature, feelings, and impulses which have for us a moral significance; whether as furnishing raw material out of which education may develop virtuous dispositions, or, contrariwise, as constituting forces adverse to this development. It may be well to call the former tendencies favorable to virtue, pro-moral, the latter unfavorable tendencies, contra-moral. Our inquiry, then, must be: In what respects and to what extent does the child show itself by nature apart from all that is meant by education, pro-moral or contra-moral—that is, well or ill fitted to become a member of a good or virtuous community, and to exercise what we know as moral functions?

Our especial object here will be, if possible, to get at natural dispositions, to examine the child in his primitive nakedness, looking out for those instinctive tendencies which, according to modern science, are hardly less clearly marked in a child than in a puppy or a chick.

Now, there is clearly a difficulty here. How, it may be asked, can we expect to find in a child any traits having a moral significance which have not been developed by social influences and education? In the case of pro-moral dispositions more particularly, as kindness or truthfuluess, we can not expect to get rid of that molding effect of the combined personal influence and instruction of the mother which is of the essence of all moral training. And even with regard to contra-moral traits, as rudeness or lying, it is evident that example is frequently a co-operating influence.

The difficulty is, no doubt, a real one, and can not be wholly got rid of. We can not completely eliminate the influence of the common life in which the good and bad disposition alike may be said to grow up. Yet we may distinguish. Thus we may look out for the earliest spontaneous, and what we may call original, manifestations of such dispositions as affection and truthfulness, so as to eliminate the *direct* action of instruction and example, and thus reduce the influence of the social medium on the child to a minimum. Similarly, in the case of brutal and other unlovely propensities, we may, by taking pains, get rid of the influence of bad example.

Let us see, then, how far the indictment of the child is a just one. Do children tend spontaneously to manifest the germs of vicious dispositions, and, if so, to what extent? Here, as I have suggested, we must be particularly careful not to read wrong interpretations into what we see. It will not do, for example, to say that children are born thieves because they show themselves at first charmingly indifferent to the distinction of *meum* and *tuum*, and are inclined to help themselves to other children's toys, and so forth. To repeat, what we have to inquire is whether children by their instinctive inclinations are contra-moral—that is, predisposed to what, if persevered in with reflection, we call immorality or vice.

Here we can not do better than touch on that group of feelings and dispositions which can be best marked off as antisocial, since they tend to the injury of others, such as anger, envy, and cruelty.

The most distant acquaintance with the first years of human life tells us that young children have much in common with the lower animals. Their characteristic passions and impulses are centered in self and the satisfaction of its wants. What is better marked, for example, than the boundless greed of the child, his keen desire to appropriate and enjoy whatever presents itself, and to resent others' participation in such enjoyment? For some time after its birth the child is little more than an incarnation of appetite which knows no restraint, and only yields to the undermining force of satiety.

The child's entrance into social life through a growing consciousness of the existence of others is marked by much fierce opposition to their wishes. His greed, which at the outset was but the expression of a vigorous nutritive instinct, now takes on more of a contra-moral aspect. The removal of the bottle by another before full satisfaction has been attained is, as we know, the occasion for one of the most impressive utterances of the baby's "will to live," and of its resentment of all human checks to its native impulses. In this outburst we have the first rude germ of that defiance of control and of authority of which I shall have to say more by and by

In another way too the expansion of the infant's consciousness through the recognition of others widens the terrane of greedy impulse. For envy commonly has its rise in the perception of another child's consumption of appetite's dainties.

Here, it is evident, we are still at the level of the animal. A dog is passionately greedy, like the child, will fiercely resent any interference with the satisfaction of its appetite, and will be envious of another and more fortunately placed animal.

Much the same concern for self and opposition to others' having what the child himself desires shows itself in the matter of toys and other possessions of interest. A child is apt not only to make free with another child's toys, but to show the strongest objection to any imitation of this freedom, often displaying a dog-in-the-manger spirit by refusing to lend what he himself does not want. Not only so, he will be apt to resent another child's having toys of his own. The envy of other children's possessions by a child is apt to be impressive by reason not only of its passionate intensity, but of its far-reaching extent.

As the social interests come into play so far as to make caresses and other signs of affection sources of pleasure to the child, the field for envy and its "green-eyed" offspring, jealousy, is still more enlarged. As is well known, an infant will greatly resent the mother's taking another child into her arms.

Here, again, we are at the level of the lower animals. They, too, as our dogs and cats show us, can be envious not only in the matter of eatables, but in that of human caressings, and even of possessions—witness the behavior of two dogs when a stick is thrown into the water.

Full illustrations of these traits of the first years of childhood are not needed. We all know them. M. Perez and others have culled a sufficient collection of examples.*

Out of all this unrestrained pushing of appetite and desire whereby the child comes into rude collision with others' wants, wishes, and purposes there issue the well-known passionateness, the angry outburst, and the quarrelsomeness of the child. These fits of angry passion or temper are among the most curious manifestations of childhood, and deserve to be studied with much greater care than they have yet received.

The outburst of rage as the imperious little will feels itself suddenly pulled up has in spite of all its comicality something impressive. Hitting out right and left, throwing things down on the floor, breaking them, howling, and wild, agitated movement of the arms and whole body—these are the outward vents which the gust of fury is wont to take. Anything will do as object of

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* See, for example, The First Three Years of Childhood, p. 66 ff.

attack. A child of four, on being crossed, would bang his chair and then proceed to vent his displeasure on his unoffending toy lion, banging him, jumping on him, and threatening him with the loss of his dinner. Hitting is in some cases improved upon by biting. The boy C—— was for some time vigorously mordant in his angry fits. Another little boy would under similar circumstances bite the carpet.

Here we have expressive movements which are plainly brutal, which assimilate the aspect of an angry child to that of an angry savage and angry animal. The whole outward attitude is one of fierce, ruthless assault. The insane, I am told, manifest a like wildness of attack in fits of anger, smashing windows, etc., and striking anybody who happens to be at hand.

Yet these are not all the manifestations. Childish anger has its wretched aspect. There is keen suffering in these early experiences of thwarted will and purpose. A little boy rather more than a year old used, when crossed, to throw himself on the floor and bang the back of his head; and his brother, when fourteen months old, would similarly throw himself on the floor and bang the back of his head, biting the carpet as before mentioned. This act of throwing one's self on the floor, which is common during this early period, and is apparently quite instinctive, is the expression of the utter *dejection* of misery. C——'s attitude when crossed, gathered into a heap on the floor, was eloquent of this infantile despair. Such suffering is the immediate outcome of thwarted purpose, and must be distinguished from the moral feeling of shame which often accompanies it.

Such stormy outbursts vary, no doubt, from child to child. Thus, C——'s sister in her angry moments did not bite or roll on the floor, but would dance about and stamp. Some children show little if anything of this savage furiousness. Among those that do show it, it is often a temporary phenomenon only.

This anger, it is to be noted, is due to mere check of will by will, and would show itself to some extent even if there were no intervention of authority. Thus a child will show himself angry, resentful, and despairingly miserable if another child gets effective hold of something which he wants to have. Yet it is undoubtedly true, as we shall see, that these little storms are most frequently called up by the imposition of authority, and are a manifestation of what we call a defiant attitude.

This slight examination may suffice to show that with the child self—its appetites, its satisfactions—is the center of its existence, the pivot on which its action turns. I do not forget the real and striking differences here, the specially brutal form of boys' anger as compared with that of girls, the partial atrophy of some of these impulses—e. g., jealousy—in the more gentle and affectionate type of child. Yet there seems to me little doubt that these are common and among the most pronounced characters of the first years.

Evolution will, no doubt, help us to understand much of this. If the order of development of the child follows and summarizes that of the race, we should expect the child to show a germ at least of the passionateness, the quarrelsomeness of the brute and of the savage before he shows the moral qualities distinctive of civilized man. That he often shows so close a resemblance to the savage and to the brute suggests how little ages of civilized life, with its suppression of these furious impulses, have done to tone down the ancient and carefully transmitted instincts. The child at birth and for a long while after may then be said to be the representative of wild, untamed Nature, which it is for education to subdue and fashion into something softer and gentler.

At the same time the child is more than this. In this first clash of his will with another's he knows more than the brute's sensual fury. He suffers consciously, he realizes himself in his antagonism to a world outside him. It is probable, as I have pointed out before, that even a physical check bringing pain, as when the child runs his head against a wall, may develop this consciousness of self in its antagonism to a not-self. This consciousness reaches a higher phase when the opposing force is distinctly apprehended as another will. Self-feeling, a germ of the feeling of "my worth," enters into this early passionateness and differentiates it from a mere animal rage. The absolute prostration of infantile anger seems to be the expression of this keen consciousness of the self of its rebuff and injury.

While, then, these outbursts of savage instinct in children are, no doubt, ugly and in their direction contra-moral, they must not hastily be pronounced wholly bad and wicked. To call them wicked in the full sense of that term is indeed to forget that they are the swift reactions of instinct which have in them nothing of reflection or of deliberation. The angry child venting his spite in some wild act of violence is a long, long way from a man who knowingly and with the consent of his will retaliates and hates. The very fleeting character of the outbreak, the rapid subsidence of passion, and transition to another mood show that there is here no real *malice prepense.* These instincts will, no doubt, if they are not tamed, develop later into truly wicked dispositions; yet it is by no means a small matter to recognize that they do not amount to full moral depravity.

On the other hand, we have seen that we do not render complete justice to these early manifestations of angry passion if we class them with those of the brute. The child in these first years, though not yet human in the sense of having rational insight into his wrongdoing, is human in the sense of suffering through consciousness of an injured self. This reflective element is not yet moral; the sense of injury may turn by and by into lasting hatred. Yet it holds within itself possibilities of something higher. But of this more when we come to envisage the child in his relation to authority.

The same predominance of self, the same kinship with the unsocial brute which shows itself in these germinal animosities, is said to reappear in the insensibility or unfeelingness of children. The commonest charge against children from those who are not on intimate terms with them, and sometimes, alas! from those who are, is that they are heartless and cruel.

That children often appear to the adult as unfeeling as a stone is, I suppose, incontestable. The troubles which harass and oppress the mother leave her small companion quite unconcerned. He either goes on playing with undisturbed cheerfulness, or he betrays a momentary curiosity about some irrelevant circumstances connected with the affliction which is worse than the absorption in play through its tantalizing want of any genuine feeling. Brothers and sisters may be ill; but if the vigorous little player is affected at all, it is only through loss of companions, if this is not more than made up for by certain advantages of the solitary situation. If the mother is ill, the situation is interesting merely as supplying him with new treats. A little boy of four, after spending half an hour in his mother's sickroom, coolly informed his nurse: "I have had a very nice time; mamma's ill!" The order of the two statements is significant of the child's mental attitude toward others' sufferings. If his faithful nurse has her face bandaged, his interest in her torments does not go beyond a remark on the "funniness" of her new appearance.

When it comes to the bigger human troubles this want of fellow-feeling is still more remarkable. Nothing is more shocking to the adult observer of children than their coldness and stolidity in presence of death. While a whole house is stricken with grief at the loss of a beloved inmate the child preserves his serenity, being affected at most by a feeling of awe before a great mystery. Even the sight of the dead body does not always excite grief. Mrs. Burnett, in her interesting reminiscences of childhood, has an excellent account of the feelings of a sensitive and refined child when first brought face to face with death. In one case she was taken with fearsome longing to touch the dead body so as to know what "as cold as death" meant; in another, that of a pretty girl of three with golden-brown eyes and neat, small brown curls, she was impressed by the loveliness of the whole scene, the nursery bedroom being hung with white and adorned with white flowers. In neither case was she sorry, and could not cry, though she had imagined beforehand that she would. Even in this case, then, where so much feeling was called forth, commiseration for the dead companion seemed to have been almost wholly wanting.

No one, I think, will doubt that, judged by our standards, children are often profoundly and shockingly callous. But the question arises here, too, whether we are right in applying our grown-up standards. It is one thing to be indifferent with full knowledge of suffering, another to be indifferent in the sense in which a cat might be said to be indifferent at the spectacle of your falling or burning your finger. We are apt to assume that children know our sufferings instinctively, or at least that they can always enter into them when they are openly expressed. But this assumption is highly unreasonable. A large part of the manifestation of human suffering is unintelligible to a little child. He is not oppressed by our anxieties, our griefs, because these are to a large extent beyond his sympathetic comprehension.

We must remember, too, that there are moods and attitudes of mind favorable and unfavorable to sympathy. None of us are uniformly and consistently compassionate. It is wonderful how insensible really kind-hearted people can show themselves on occasion, as, for example, toward the afflictions of those whose previous good fortune they have envied. Children are the subject of moods which are exclusive of sympathy. They are impelled by their superabundant nervous energy to wild, romping activity; they are passionately absorbed in their play; they are intensely curious about the many new things they see and hear of. These dominant impulses issue in mental attitudes which are indifferent to the spectacle of others' troubles.

Again, where an appeal to serious attention is given, a child is apt to see something besides the sadness. The little girl already spoken of saw the prettiness of the death-room rather than its mournfulness. A teacher once told her class of the death of a classmate. There was, of course, a strange stillness, which one little girl presently broke with a loud laugh. The child is said to have been by no means unemotional, the laugh not a "nervous" one. The odd situation—the sudden hush of a class—had affected childish risibilities more than the distressing announcement.

One other remark by way of saving clause here. It is by no means true that children are always unaffected by the sad and sorrowful things in life. The first acquaintance with death, as we know from a number of published reminiscences, has sometimes shaken a child's whole being with an infinite nameless sense of woe. But of this more, presently, after we have heard the rest of the indictment.

Children, says the misopædist, are not only unfeeling when we look for sympathy and kindness; they are positively unkind, their unkindness amounting to cruelty. What we mean by the brute in the child is emphatically this cruelty. By cruelty is here understood cold-blooded infliction of pain. "Cet âge," wrote La Fontaine of childhood, "est sans pitié." The idea that children, especially boys, are cruel in this sense is, I think, a common one.

This cruelty will now and again show itself in relation to other children. One of the trying situations of early life is to find one's self supplanted by the arrival of a new baby. Children, I have reason to think, are in such circumstances capable of coming shockingly near to a feeling of hatred. I have heard of one little girl who was taken with so violent an antipathy to a baby which she considered outrageously ugly as to make futile attempts to smash its head, much as she would, no doubt, have tried to destroy a doll which had become unsightly to her. The baby, I may as well add, was not really hurt by this shocking precocity of infanticidal impulse—perhaps the smashing was more than half a "pretense"—and the little girl grew up to be a kind-hearted woman.

Such cruel-looking handling of smaller infants is probably rare. More common is the exhibition of the signs of cruelty in the child's dealings with animals. It is of this, indeed, that we mostly think when we speak of a child's cruelty. Young children are not, I think, often charged, even by the harshest of their accusers, deliberately with inflicting pain on their human companions.

At first nothing seems clearer than the evidence of malicious intention in a child's treatment of animals. Look, for example, at a little girl trying to get the cat from some hiding place. She grabs at its tail, receives formidable scratches, yet perseveres with something of a soldier's indifference to her own pains. Do we not here see evidences of a determination to plague, and of a delight in plaguing? Or watch a child chasing a fly on the window pane, and note the hard, doglike pertinacity with which he follows it up and at length pins and crushes it with his fingers.

The question of the innermost nature of human cruelty is too difficult a one to be discussed here. I will only say that, whatever the cruelty of adults may be, children's so-called cruelty toward animals is very far from being a pure delight in the sight of suffering. The torments to which a child will subject a long-suffering cat are, I suspect, due not to a clear intention to inflict pain, but to the child's impulse to hold, possess, and completely dominate the pet animal. It is a manifestation of that odd mixture of sociability and love of power which makes up a child's attachment to the lower animals.

The case of destructive cruelty is somewhat different. Let me give a well-observed instance. A little boy of two years and two months, "after nearly killing a fly on the window pane, seemed surprised and disturbed, looking round for an explanation, then gave it himself: 'Mr. Fy dom (gone) to by by'; but he would not touch it or another fly again—a doubt evidently remained, and he continued uneasy about it." Here we have, I think, the instinctive attitude of a child toward the outcome of its destructive impulse. And this destructive impulse, which as we know becomes more clearly destructive when experience has taught what result follows, is not necessarily cruel in the sense of including an idea of the animal's suffering. Animal movement, especially that of tiny things, has something exciting and provoking about it. The child's own activity, and the love of power which is bound up with it, impel him to arrest the movement. This is the meaning, I suspect, of the fascination of the fly on the window pane, and other small capturable creatures, as later on of birds. The cat's prolonged chase of the mouse, into which something of a dramatic make-believe enters, owes its zest to a like delight in the realization of the captor's power.

Along with this love of power there goes often something of a child's fierce, untamable curiosity. A boy of four, finding that his mother was shocked at hearing him express a wish to see a pigeon which a dog had just killed, remarked: "Is it rude to look at a dead pigeon? I want to see where its blood is." I am disposed to think that the crushing of flies and moths and the pulling of worms to pieces, and so forth, are prompted by this curiosity. The child wants to see where the blood is, what the bones are like, how the wings are fastened in, and so forth.

A like combination of love of power and of curiosity seems to underlie other directions of childish destructiveness, as the breaking of toys and the pulling of flowers to pieces. In certain cases, as in C——'s destruction of a whole garden of peonies, the love of power or effect overtops and outlives the curiosity, becoming a sort of savage greed.*

I think, then, that we may give the little child the benefit of the doubt, and not assign its rough handling of sentient things to a wish to inflict pain, or even to an indifference to pain of which he is clearly aware. Wanton activity, the curiosity of the experimenter, and delight in realizing one's power and producing an effect, seem sufficient to explain most of the alleged cruelty of the

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* Ruskin tells us that when a child he pulled flowers to pieces "in no morbid curiosity, but in admiring wonder" (Præterita, 88). Goethe gives an amusing account of his wholesale throwing of crockery out of the window, inspired by the delight of watching the droll way in which it was smashed on the pavement.

first years. That later on cruelty becomes possible, that the school bully may find his satisfaction in tormenting the "little kids," this is but too certain. Yet even schoolboys with clearest example to guide them are by no means always bullies.

We have now looked at one of the dark sides of the child and have found that, though it is unpleasant, it is not so hideous as it has been painted. Children are, no doubt, apt to be passionate, ferocious in their anger, and sadly wanting in consideration for others; yet it is consolatory to reflect that their savageness is not quite that of brutes, and that their selfishness and cruelty are a long way removed from a deliberate and calculating egoism.

It now remains to point out that there is another and counterbalancing side. If a child has his outbursts of temper he has also his fits of tenderness. If he is now dead to others' sufferings, he is at another time taken with a most amiable, childish concern for their happiness. In order to be just to the child we must recognize both sides.

It must not be forgotten here that children are instinctively attachable and sociable, in so far as they show in the first weeks that they get used to and dependent on the human presence, and are miserable when this is taken from them. The stopping of a child's crying at night on hearing the familiar voice of its mother or nurse shows this.

In this instinct of companionship there is involved a vague inarticulate sympathy. Just as the attached dog may be said to have in a vague way a feeling of oneness with its master, so the child. The intenser realization of this oneness comes in the case of the dog and of the child alike after separation. The wild, caressing leaps of the quadruped are matched by the warm embracings of the little biped. Only that here, too, we see in the child traces of a deeper human consciousness. A girl of thirteen months was separated from her mother for six weeks. On the mother's return she was speechless, and for some time could not bear to leave her mother for a minute.

This sense of joining on one's existence to another's is not full imaginative sympathy—that is, a warm realizing representation of another's feelings—but it is a kind of sympathy, after all, and may grow into something better. This we may see in the return of the childish heart to its resting place after the estrangement introduced by "naughtiness." The relenting after passion, the reconciliation after punishment, are these not the experiences which help to raise the dumb-animal sympathy of the first months into a true human sense of fellowship? But this part of the development of sympathy belongs to another chapter.

Sympathy, it has been said, is a kind of imitation, and this is strikingly illustrated in its early forms. A dog will howl piteously in response to another dog's howl; similarly a child of nine and a half months has been known to cry violently when its mother or father pretends to cry.

One curious manifestation of this early imitative sympathy is the impulse to do what the mother does and to be what she is. Much of early imitative play shows this tendency. It is more than a cold, distant copying of another's doings; it is full of the warmth of attachment, and it is entered on as a way of getting nearer the object of attachment. Out of this, too, there springs the germ of a higher sympathy. It will be remembered that Laura Bridgman bound the eyes of her doll with a bandage similar to the one she herself wore. Through this sharing in her own experience the doll became more a part of herself. Conversely, a child, on finding that her mother's head ached, began imitatively to make believe that her own head was hurt. Imaginative sympathy rests on community of experience, and it is curious that a child, before he can fully sympathize with another's trouble and make it his own by the sympathetic process itself, should thus show the impulse to procure by a kind of childish acting this community of experience.

From this imitative acting of another's trouble so as to share in it, there is but a step to a direct sympathetic apprehension of it. How early a genuine manifestation of concern at another's misery begins to show itself, it is almost impossible to say. Children probably differ greatly in this respect. I have, however, one case which is so curious that I can not forbear to quote it. It reaches me, I may say, by a thoroughly trustworthy channel.

A baby, aged one year and two months, was crawling on the floor. An elder sister, Katherine, aged six, who was working at a wool mat, could not get on very well, and began to cry. Baby looked up and grunted, "On! on!" and kept drawing its fingers down its own cheeks. Here the aunt called Miss Katherine's attention to baby, a device which merely caused a fresh outburst of tears. Whereupon baby proceeded to hitch itself along to Katherine with many repetitions of the grunts and the finger gestures. Katherine, fairly overcome by this, took baby to her and smiled. At which baby began to clap its hands and to crow, tracing this time the course of the tears down its sister's cheeks.

This pretty nursery picture certainly seems to illustrate a rudiment of genuine fellow-feeling. Similarly, it is hard not to recognize the signs of a sincere concern when a child of two will run spontaneously and kiss the place that is hurt, even though it is not to be doubted that the graceful action was learned through imitation.

Very sweet and sacred to the mother are the child's first clear indications of concern for herself. These are sporadic, springing up rarely, and sometimes, as it looks to us, capriciously. Illness and temporary removal are a common occasion for the appearances of a deeper tenderness in the young heart. A little boy of three spontaneously brought his story book to his mother when she lay in bed ill; and the same child used to follow her about after her recovery with all the devotion of a little knight.

Very quaint and pretty, too, are the first attempts of the child at consolation. A little German girl, aged two and a half, had just lost her brother, and seemed very indifferent for some days. She then began to reflect and to ask about her playmate. On seeing her mother's distress she proceeded in truly childish fashion to comfort her: "Never, mind mamma, you will get a better boy. He *was* a ragamuffin" (*"Er war ein Lump"*). The coexistence of an almost barbarous indifference for the dead brother with practical sympathy for the living mother is characteristic here.

A deeper and more thoughtful sympathy comes with years and reflective power. Thought about the overhanging terror, death, is sometimes the awakener of this. "Are you old, mother?" asked a boy of five. "Why?" she answered. "Because," he continued, "the older you are the nearer you are to dying." This child had once before said he hoped his mother would not die before him, and this suggests that the thought of his own forlorn condition was in his mind here; yet we may hope that there was something of disinterested concern too.

This early consideration frequently takes the practical form of helpfulness. A child loves nothing better than to assist you in little household occupations; and though love of activity and the pleasure of imitating, no doubt, count for much in these cases we can, I think, safely set down something to the wish to be of use. This inference seems justified by the fact that such practical helpfulness is not always imitative. A little boy of two years and one month happened to overhear his nurse say to herself, "I wish that Anne would remember to fill the nursery boiler." "He listened and presently trotted off, found the said Anne doing a distant grate, pulled her by the apron, saying, 'Nanna, Nanna!' (come to nurse). She followed, surprised and puzzled, the child pulling all the way, till, having got her into the nursery, he pointed to the boiler, adding, 'Go dare, go dare,' so that the girl comprehended and did as he bade her."

With this practical "utilitarian" sympathy there goes a wish to please in other ways. Sometimes this shows itself in a dainty courtesy, as when a little girl, aged three and a quarter, petitioned her mother in this wise: "Please, mamma, will you pin this with the greatest pleasure?" Regard for another's feelings was surely never more charmingly expressed than in the prayer that in rendering this little service the helper should not only be willing but glad.

Just as there are these sporadic growths of affectionate concern and wish to please in relation to the mother and others, so there is ample evidence of kindness to animals. The charge of cruelty in the case of little children is indeed seen to be a gross libel as soon as we consider their whole behavior toward the animal world.

I have touched above on the vague alarms which this animal world has for tiny children. It is only fair to them to say that these alarms are for the most part transitory, giving place to interest, attachment, and fellow-feeling. In a sense a child may be said to belong to the animal community, as Mr. Rudyard Kipling's account of the Jungle prettily suggests. Has he not indeed at first more in common with the dog and cat, the pet rabbit or dormouse, than with that grown-up human community which is apt to be so preoccupied with things beyond his understanding, and in many cases at least to wear so unfriendly a mien? We must remember, too, that children as a rule know nothing of the prejudices, of the disgusts, which make grown people put animals so far from them. The boy C—— was nonplussed by his mother's horror of the caterpillar. A child has been known quite spontaneously to call a worm "beautiful."

As soon as the first fear of the strangeness is mastered a child will take to the animal. A little boy of fifteen months quickly overcame his fright at the barking of his grandfather's dog, and began to share his biscuits with him, to give him flowers to smell, and to throw stones for his amusement. This mastery of fear by attachment takes a higher form when later on the child will stick to his dumb companion after suffering from his occasional fits of temper. Ruskin gives in his reminiscences a striking example of this triumph of attachment over fear. When five years old, he tells us, he was taken by the serving man to see a favorite Newfoundland dog in the stable. The man rather foolishly humored the child's wish to kiss Leo (the dog), and lowered him so that his face came near the animal's. Hereupon the dog, who was dining, resenting the interruption of his meal, bit out a piece of the boy's lip. His only fear after this was lest Lion (the dog) should be sent away.*

Children will too at a quite early age betray the germ of a truly humane feeling toward animals. The same little boy that bravely got over his fear of the dog's barking would, when nineteen months old, begin to cry on seeing a horse fall in the street. More passionate outbursts of pity are seen at a later age. A boy

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* Præterita, pp. 105, 106.

of five years and nine months had a kitten of which he was very fond. One day, after two or three days' absence from the house, it came back with one foot much mutilated and the leg swollen, evidently not far from dying. "When" (writes the mother) "he saw it, he burst into uncontrollable tears, and was more affected than I have ever seen him. The kitten was taken away and drowned, and ever since (a month) he has shown great reluctance in speaking of it, and never mentions it to any one but those who saw the cat at the time. He says it is too sad to tell any one of it." The boy C——, when only four, was moved to passionate grief at the sight of a dead dog taken from a pond.

The righteous indignation of children at the doings of the butcher, the hunter, and others, which deserves a chapter to itself, shows how deeply pitiful consideration for animals is rooted in their hearts.

It is sometimes asked why children should take animals to their bosoms in this fashion, and lavish so much fellow-feeling on them. It seems easy to understand how they come to choose animals, especially young ones, as playmates, and now and again to be ruthlessly inconsiderate of their comfort in their boisterous gambols; but why should they be so affected by their sufferings and champion their rights so zealously? I think the answer is not hard to find. The sympathy and love which the child gives to animals grows out of a kind of blind, gregarious instinct, and this again seems to be rooted in a similarity of position and needs. As M. Compayré well says on this point: "He (the child) sympathizes naturally with creatures which resemble him on so many sides, in which he finds wants analogous to his own, the same appetite, the same impulses to movement, the same desire for caresses. To resemble is already to love." * I think, however, that a deeper feeling comes in from the first and gathers strength as the child hears about men's treatment of animals—I mean a sense of a common danger and helplessness face to face with the human "giants." The more passionate attachment of the child to the animal is the outcome of the widespread instinct of helpless things to band together. A mother once remarked to her boy, between five and six years old, "Why, R——, I believe you are kinder to the animals than to me!" "Perhaps I am" (he replied); "you see they are not so well off as you are." May there not be something of this sense of banding and mutual defense on the animals' side too? The idea does not look so absurd when we remember how responsive, how forbearing, how ready to defend a dog will often show itself toward a "wee mite" of a child.

The same outpourings of affection are seen in the dealings of

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* *Op. cit.*, p. 108.

children with their toy babies and animals. Allowing for occasional outbreaks of temper and acts of violence, the child's intercourse with his doll and his toy "gee gee" is on the whole a striking display of loving solicitude—a solicitude which is at once tender and corrective, and has the enduring constancy of a maternal instinct. No one can watch the care given to a doll, the wide-ranging efforts to provide for its comfort, keeping it warm, feeding it, bathing it, tending it while sick and so forth, to make it look pretty, to make it behave nicely, approving, scolding, as occasion arises, and note the misery of the child when parted from it, without acknowledging that in this plaything humanized by childish fancy we have the very focus of the rays of childish tenderness; that in the child's devotion to its wooden pet we have a striking example of the truth that daily companionship and the habit of caring for a thing make it an inseparable part of us.

Lastly, the reader may be reminded that childish kindness and pitifulness extend to what look to us still less deserving objects in the inanimate world. The expression of pity for the falling leaves and for the stones condemned to lie always in one place, referred to above, shows how quick childish feeling is to detect what is sad in the look of things. Children have even been known to apply the commiserating vocable "poor" to a torn paper figure and to a bent pin. It seems right to suppose that here too the tender heart of the child saw occasion for pity.

It is worth noting that childish sorrow at the sufferings of things is sometimes so keen that even artistic descriptions which contain a "cruel" element are shunned. A little boy under four "is indignant [writes his mother] at any picture where an animal suffers. He has even turned against several of his favorite pictures—German *Bilderbogen*—because they are 'cruel,' as the bear led home with a corkscrew in his nose." The extreme manifestation of this shrinking from the representation of animal or human suffering is dislike for "sad stories." The unsophisticated tender heart of the child can find no pleasure in horrors which appear to be the crowning delight of many an adult reader.

Here, however, it is evident we verge on the confines of sentimental pity. It is worth remarking that it is the highly imaginative children who shed most tears over these fictitious sufferings. Children with more matter-of-fact minds and a practical turn are not so affected. Thus a mother writes of her two girls: "M——, being the most imaginative, is and always has been much affected by sad stories, especially if read to her with dramatic inflections of voice. From two years old upward these have always affected her to tears, while P——, who is really the most tender-hearted and helpful, but has little imagination, never cries at sad stories, and when four years old explained to me that she did not mind them because she knew they didn't really happen."

It appears to me to be incontestable that in this spontaneous outgoing of fellow-feeling toward others, human and animal, the child manifests something of a truly moral quality. C——'s stout and persistent advocacy of the rights of London horses against the oppression of the bearing-rein had in it something of righteous indigation. The way in which his mind was at this period preoccupied with animal suffering suggests that his sympathies with animals were rousing the first fierce protest against the wicked injustice of the world. The boy De Quincey got this first feeling of moral evil in another way through his sympathy with a sister who, rumor said, had been brutally treated by a servant. He could not, he tells us, bear to look on the woman. It was not anger. "The feeling which fell upon me was a shuddering horror, as upon a first glimpse of the truth that I was in a world of evil and strife." *

THE STUDY OF BIRDS OUT-OF-DOORS.†

By FRANK M. CHAPMAN.

WHETHER your object be to study birds as a scientist or simply as a lover of Nature, the first step is the same—you must learn to know them. This problem of identification has been given up in despair by many would-be ornithologists. We can neither pick, press, net, nor impale birds; and here the botanist and the entomologist have a distinct advantage. Even if we have the desire to resort to a gun its use is not always possible. But with patience and practice the identification of birds is a comparatively easy matter, and in the end you will name them with surprising ease and certainty. There is generally more character in the flight of a bird than there is in the gait of a man. Both are frequently indescribable but perfectly diagnostic, and you learn to recognize bird friends as you do human ones—by experience.

If you confine your studies to one locality, probably not more than one third of the species described in this volume will come within the field of your observation. To aid you in learning which species should be included in this third, the paragraphs on *range* are followed by a statement of the bird's standing at Wash-

* Autobiographical Sketches, chap. i.

† Being part of a chapter from the author's illustrated Handbook of Birds of Eastern North America recently issued by Messrs. D. Appleton & Co.

ington, D. C., Sing Sing, N. Y., and Cambridge, Mass., while the water-birds of Long Island are treated specially. Take the list of birds from the point nearest your home as an index of those you may expect to find. This may be abridged for a given season by considering the times of the year at which a bird is present.

After this slight preparation you may take to the field with a much clearer understanding of the situation. Two quite different ways of identifying birds are open to you. Either you may shoot them, or study them through a field- or opera-glass. A "bird in the hand" is a definite object whose structure and color can be studied to such advantage that in most cases you will afterward recognize it at sight. After learning the names of its parts, its identity is simply a question of keys and descriptions.

If you would "name the birds without a gun," by all means first visit a museum, and, with text-book in hand, study those species which you have previously found are to be looked for near your home. This preliminary introduction will serve to ripen your acquaintance in the field. A good field- or opera-glass is absolutely indispensable. A strong opera-glass with a large eye-piece is most useful in the woods, while a field-glass is more serviceable in observing water-birds. Study your bird as closely as circumstances will permit, and write *on the spot* a comparative description of its size, the shape of its bill, tail, etc., and a detailed description of its colors. In describing form take a Robin, Chipping Sparrow, or any bird you know, which best serves the purpose, as a basis for comparison. A bird's bill is generally its most diagnostic external character. A sketch of it in your note-book will frequently give you a good clew to its owner's family. It is of the utmost importance that this description should be written in the field. Not only do our memories sometimes deceive us, but we really see nothing with exactness until we attempt to describe it. Haunts, actions, and notes should also be carefully recorded. This account is your "bird in the hand," and while you can not hope to identify it as easily as you could a specimen, you will rarely fail to learn its name, and experience will render each attempt less difficult than the preceding.

HEAD OF BARRED OWL.

The best times of the day in which to look for birds are early morning and late afternoon. After a night of fasting and resting, birds are active and hungry. When their appetites are satisfied they rest quietly until afternoon, hunger again sending them forth in search of food.

Experience will soon show you the places where birds are most abundant. The more varied the nature of the country the greater number of species you may expect to find inhabiting it. An ideal locality would be a bit of tree-dotted meadow with a

HAIRY WOODPECKER.
YELLOW-BELLIED SAPSUCKER.

reed-bordered pond or stream, surrounded by woods, rolling uplands, and orchards.

Common sense will tell you how to act in the field. Birds are generally shy creatures and must be approached with caution. You must not, therefore, go observing or collecting dressed in flaming red, but in some inconspicuous garb and as quietly as a cat. Furthermore, go alone and keep the sun at your back—two apparently unrelated but equally important bits of advice.

The collector generally has the instincts of a hunter, and practice will develop them. The "squeak" is one of his most valuable aids. It is made by placing the lips to the back of the hand or finger and kissing vigorously. The sound produced bears some resemblance to the cries of a wounded or young bird. In the nesting season its utterance frequently creates much excitement in the bird world, and at all times it is useful as a means of drawing bush- or reed-haunting species from their retreats. One may enter an apparently deserted thicket, and, after a few minutes' squeaking, find himself surrounded by an anxious or curious group of its feathered inhabitants.

Head of Cedar Waxwing.

The observer of birds will find that by far the best way to study their habits is to take a sheltered seat in some favored locality and become a part of the background. Your passage through the woods is generally attended by sufficient noise to warn birds of your coming long before you see them. They are then suspicious and ill at ease. But secrete yourself near some spot loved by birds, and it may be your privilege to learn the secrets of the forest.

During the year the bird life of temperate and boreal regions fluctuates with the changing seasons. Birds may thus be classed in the following groups according to the manner of their occurrence: Permanent residents are birds found in one locality throughout the year. Summer residents come from the south in the spring, rear their young, and leave in the fall. Winter visitants come from the north in the fall, pass the winter, and leave in the spring. Transient visitants pass through a given place in migrating to and from their summer homes north of it. Accidental visitants are birds which have lost their way. They are generally young and inexperienced, and are usually found in the fall.

Golden-crowned Kinglet.

The best time of the year to begin studying birds is in the winter, when the bird population of temperate regions is at the minimum. The problem of identification is thus reduced to its simplest terms, and should be mastered before spring introduces new elements.

The commoner permanent residents of the middle Eastern States are the following:

Bob-white,	Hairy Woodpecker,
Ruffed Grouse,	Flicker,
Red-shouldered Hawk,	Blue Jay,
Red-tailed Hawk,	Crow,
Sharp-shinned Hawk,	Meadowlark,
Barred Owl,	American Goldfinch,
Long-eared Owl,	Purple Finch,
Screech Owl,	Song Sparrow,
Great Horned Owl,	White-breasted Nuthatch,
Downy Woodpecker,	Chickadee,

and occasionally the Waxwing, Myrtle Warbler, Bluebird, and Robin. To these should be added the following more or less common winter visitant land-birds:

Saw-whet Owl,	Tree Sparrow,
Horned Lark,	Junco,
Snowflake,	Northern Shrike,
Lapland Longspur,	Winter Wren,
Redpoll,	Golden crowned Kinglet,
American Crossbill,	Brown Creeper,
White-throated Sparrow,	

Let us now begin with the opening of the spring migration and briefly review the ornithological year. In the vicinity of New York city the first birds arrive from the south late in February or early in March. There is much variation in the coming of these early birds. Later, when the weather is more settled, migrants arrive within a few days of a given date. In April most of our winter visitants leave for the north. The current of migration grows steadily stronger until about May 12th, when high-water mark is reached. Then it rapidly subsides, and the spring migration is practically over by June 1st. The winter visitants have gone, the great army of transients has passed us, and our bird population is now composed of permanent residents with the addition of about ninety summer residents.

Nesting time has arrived, and birds which for nearly a year have been free to go and come as inclination directed, now have homes where, day after day, they may be found in tireless attendance upon the nest and its treasures. Courtship, the construction of a dwelling, the task of incubation, and care of the young, all tend to stimulate the characteristic traits of the bird, and at no other time can its habits be studied to better advantage.

But resident birds begin building long before the migration is concluded. The Great Horned Owl lays in February, other birds in March and April; still, the height of the breeding season is not reached until June 1st.

Another period in the avian year closely connected with the spring migration and nesting time is the song season. Near New

Song Sparrow.
Swamp Sparrow.

York city it is inaugurated late in February by the Song Sparrow. Voice after voice is added to the choir, and in June our woods and fields ring with the chorus so dear to lovers of Nature. By the middle of July it is on the wane, and early in August it is practically over. Some birds have a brief second song season in the fall, but as a rule it lasts only a few days—it is a farewell to their summer homes.

August is a most discouraging month to the student of birds. Birds leave their accustomed haunts and retire to secluded places to renew their worn plumages. They are silent and inactive, and therefore difficult to find. Late in the month they reappear clad in traveling costumes and ready for their southern journey. One by one they leave us, and there are days late in August and early in September when the woods are almost deserted of birds. Later the fall migration becomes continuous, and each night brings a host of new arrivals.

The spring migration is scarcely concluded before the fall migration begins. July 1st, Tree Swallows, which rarely nest near New York city, appear in numbers from the north and gather in immense flocks in our marshes. Later in the month they are joined by Bobolinks. Early in August the careful observer will detect occasional small flights of Warblers passing southward, and by September 10th the great southern march of the birds is well under way; it reaches its height between the 20th and last of the month, when most of the winter residents arrive, and from this time our bird life rapidly decreases. Some of the seed- and berry-eaters remain until driven southward by the cold weather in December. When they have gone our bird population is again reduced to the ever-present permanent residents and hardy winter visitants.

In a careful study of the great divine's works, the Rev. J. A. Zahm finds that St. Augustine clearly distinguishes between creation, properly so called, and the work of formation and development. The former was direct and simultaneous, while the latter, he contends, was gradual and progressive. "As there is invisibly in the seed," he affirms, "all that which in the course of time constitutes the tree, so also are we to view the world, when it was created by God, as containing all that which was subsequently manifested, not only the heavens with the sun and moon and stars, but also those things which he produced potentially and causally, from the waters and the earth, before they appeared as we now know them." The formless matter, which God created from nothing, was first called heaven and earth, and it is written that "in the beginning God created heaven and earth," not because it was forthwith heaven and earth, but because it was destined to become heaven and earth. When we consider the seed of a tree, we say that it contains the roots, the trunk, the branches, the fruits, and the leaves, not because they are already there, but because they shall be produced from it. "Verily," says Mr. Zahm, "in reading these words, we can fancy that we are perusing some modern scientific treatise on cosmogony instead of an exposition of Genesis written by a father of the Church fifteen hundred years ago."

ANCESTOR-WORSHIP AMONG THE FIJIANS.*

By BASIL H. THOMSON.

THERE are more gods than tribes among the Fijians, and it is manifestly impossible to give an account of the religions of them all within reasonable limits; hence I take as a type the tribes inhabiting the northern and eastern portions of the island of Viti-Levu, the part of the group first colonized by Fijians. Like the Greeks, the Fijians made their gods as beings of like passions with themselves; but whatever may have been the fountain head of Greek mythology, it is clear that the Fijians humanized their gods, because they had once existed on earth in human form. Their mythology was traditional history. Like other primitive peoples, the Fijians deified their ancestors. The father ruled the family. Each member of it turned to him for the ordering of his daily life. No scheme entered the head of the young man that did not depend upon the consent or prohibition of the head of his family. Suddenly the father died. How were his sons to rid themselves of the idea of his controlling influence that had guided them ever since they were born, even though they had buried his body? He had been wont to threaten them with punishment for disobedience, and even now, when they did the things of which he disapproved in life, punishment was sure to follow—the crops failed, a hurricane unroofed the hut, floods swept away the canoe.

If they won a victory over their enemies, it was he who had strengthened their arms in response to their prayers and offerings. Then each son of the dead father founded his own family, but still owed allegiance to their eldest brother, who represented their father as the head of the joint family. Generations came and went; the tribe even increased its tens to hundreds, but still the eldest son of the eldest, who carried in his veins the blood of the common ancestor in its purest form, was venerated as the head of the tribe. The name of the ancestor was not forgotten. He was now a god, and had his temple and his priests, who had themselves come to be hereditary and had the strong motive of self-interest for keeping his memory green. My belief is that the extra-tribal mythology of the Fijians is in fact legendary history, that the gods that peopled their Olympus had been the men who were the founders of their race. The story of their origin, history, and beliefs is contained in a poem, the Saga of Nakauvadra, by an unknown author, a specimen of which follows:

* Abridged from an address delivered before the Anthropological Institute of Great Britain and Ireland, and published in the Journal of the Anthropological Institute.

"Ko Degei sa tagi lagalaga,
Bogi Dua, bogi rua ka'u yadra,
Bogi tolu, bogi va ka'u yadra,
Sa tubu dugu dina ko Turukawa."

In a distant land to the far westward were three chiefs, Lutunasobasoba, Degei, and Waicalanavanua. For some cause, long since forgotten, they resolved to leave this land with their wives and children, and they sent a messenger to the head craftsman Rokola, bidding him build them a great canoe, which they called the *kaunitoni*. In her they set sail, and with them went a number of other canoes, all seeking a new land. They found many lands, and at each some of the people stayed to make it their adopted home; but none of them pleased Lutunasobasoba. At last the *kaunitoni* was left alone, and for many days she sailed and found no land. And then a great storm came up from the westward and struck her, and the waves swept her deck, carrying overboard all their goods, and among them a basket of inscriptions. So for many days she drove before the western gale, and all hope of gaining land left them. But at last they saw high land, and knew that they were saved; and they beached their canoe on a sandy shore, and built themselves huts and called the place *Vuda* (Our Origin). This is the *Vuda* on the northwest corner of *Viti-Levu*. The saga goes on to relate the distress of Lutunasobasoba at losing his basket of inscribed stones. I have not succeeded in finding any contemporary tradition that throws light on this very important passage. The Fijians, when we Europeans first came into contact with them, had no knowledge of any kind of writing, nor even of making rude representations of natural objects in their carving. But the poem says:

"Lutunasobasoba wept bitterly:
'My descendants will be in pitiable plight,
My basket of stones is overset,
My writings (vola) have fallen out.'"

It goes on to relate how he sent out the canoe to look for the lost inscriptions (which, if they really were of stone, was a somewhat futile proceeding), and how the crew of the canoe discovered the Yasawa Islands, but came back without the lost records.

They stayed at Vuda until Lutunasobasoba became very old and infirm, and then they decided to move him to higher ground. Degei, who had now taken the lead of the party, ordered Rokola to build some new canoes to carry them to the eastward. The tribe had become too large for the *kaunitoni*. When these were ready the fleet crept along the coast to the eastward, and landed in what is now the bay of Rakiraki. Thence the dying Lutunasobasoba was carried up the mountain, and a hut was built of which the posts and walls and thatch were all made of the vadra or pandanus tree, and from this hut or the profusion of this tree the mountain took its name of Nakauvadra. Here Lutunasobasoba lived several years, and when at last he felt his end to be near he summoned his children around him and gave them his dying commands, ordering them to separate and settle in different parts of the wide land he had discovered. Under these conditions Fiji was peopled, and the greater part of the saga is taken up with the wanderings of these children. Besides being the dwelling place of their gods, Nakauvadra Mountain was the first circle of the Fijian inferno, the point of departure for the unseen world that lay to the westward. Nearly all South Sea islanders point to some spot on their island where the spirits of the dead leap into the ocean to be ferried over to the world of shades. These "jumping-off places" (thombothombo) are generally steep cliffs facing the place whence tradition says the race originally came. Whatever may become of the soul hereafter, to Nakauvadra it must first betake itself before leaping into the ocean. From the populous district of the Lower Rewa there is but one path to the Nakauvadra Mountain, called the "Sala ni Yalo" (Path of the Shades). Chance led to its discovery, or rediscovery, if it is true that Europeans had before noticed it. Last year a surveyor was sent to traverse the boundaries of lands claimed by the tribe of Namata. His native guides led him along a high ridge, the watershed between the river Rewa and the eastern coast of the island. As they cut their way through the undergrowth that clothed the hilltop, he noticed that the path was almost level, and seldom more than two feet wide, and that the ridge joined hilltop to hilltop in an almost horizontal line. The surveyor had a patch of the undergrowth cleared away and found that without doubt the embankments were artificial. Following the line of the ridge, the valleys had been bridged with banks thirty or forty feet high. The level path thus made extended, so the natives said, clear to Nakauvadra, fifty miles away. For a people destitute of implements this was a remarkable work. I thought at first that this was a fortification on a gigantic scale, for Fijians never undertake any great work except for defense, under the spur of a pressing necessity. It could not be a road, because the ancient Fijians preferred to go straight over obstacles, like the soldier ants in Africa, that climb trees rather than go round them. The old men at Bau, whom I questioned, knew nothing of its history except that it was called "The Path of the Shades," and that it was an extension of one of the spurs of the Kauvadra Mountain. I asked for guides to take me over it, and they chose three gray-headed elders of the Namata tribe. We started in heavy rain. My guides were reticent at first, but as we went on the spirit of the place seemed to possess them, and at each turn of the path they stopped to describe to me the particular danger that there beset the passing shade. The eldest of the three became at times positively uncanny, for he stopped here and there in the driving rain to execute a sort of weird gamboling dance, whether out of pure excess of spirits or a praiseworthy intention of exorcising the gods of the place I do not know. Little by little I wormed out of them the whole tradition, with fragments of the sagas in which it was preserved. After I got home I set two of my native collectors to write it all down. It is far too long to give here in its entirety, but I will try to condense it.

Long ago—so long ago that the tradition has become dim—the ghosts of the dead used to annoy the living. They whistled in the houses, turned the yams rotten in the ground, filled the cooking pots with live snakes, or played some other of the pranks in which the Fijian ghost delights. And the living reasoned with themselves, and found that it was because of the bad state of the road to Nakauvadra that the shades could not find their way to the sacred mountain, and so they stayed about their old haunts. So the tribes banded together and built a road for the ghosts of their dead to travel over, and thenceforward they did not stay to annoy the living.

When a man died, his body was washed and laid in its shroud, and a whale's tooth was put upon his breast to be his stone to throw at the pandanus tree; and while his friends were still weeping, his spirit left the body and went and stood on the bank of the "Water of the Shades" (Wainiyalo), at the place called Lelele—the ferry—and cried to Ceba, the ghostly ferryman, who brought the end of his canoe which was of hard *vesi* if it was for a chief, but the end that was of breadfruit wood for a vulgar shade.

Across the stream the shade climbed the hill of Nathegani, where grew the pandanus tree. And he threw his whale's tooth at it, and if he hit it he sat down to await the coming of his wife, who, he now knew, was being strangled to his manes; but if he missed the pandanus tree he went on, weeping aloud, for he knew that his wife had been unfaithful to him in life, and that she cared not to be strangled to accompany him. Then he came to the ghost scatterer, Droydroyalo, who strode toward him and pounded his neck with a great stone, scattering the *ndawa* fruit he was carrying to eat on his journey. Thence he journeyed to Drekei, where dwell the twin goddesses Nino, who crept on him, peering at him, and gnashing their terrible teeth; and the shade shrieked in terror and fled away. As he fled up the path he came to a spring and stopped to drink; and as soon as he tasted the water he ceased weeping, and his friends also ceased weeping in his home, for they straightway forgot their sorrows and were consoled. Therefore this spring is called the Wai-ni-dula—Water of Solace. And when he stood erect from drinking, he looked afar off, and saw the white *buli* shells gleaming on the roofs of the great dwellings of Nakauvadra; and he threw away the *via* roots he was carrying, for he knew that he was near his resting place and would want no more provisions for the journey. So he flung away his *via*, to travel unencumbered, and to this day you may see the *via* sprouting where the shades threw it. Going on, the shade had many adventures. He was crippled by Tatovu's axe; he was wounded by Motoduruka's reed spear; he crawled forward on his belly; he bowed ten times; he fainted away, and was dragged onward as corpses are dragged to the cannibal ovens; he had to pinch the "pinching stone" to see whether his nails are long, for if the stone is indented, it is a sign that he was lazy in his lifetime, and that his nails are not worn away by scooping up the yam hills in his plantation. From the "pinching stone" he went onward, dancing and jesting, till he came to Taleya, the Dismisser, who asked him how he died—whether by the club, or the strangling cord, or the water, or naturally of disease or old age. And if he said he died of violence, the Dismisser let him journey onward, but if he said that he died naturally, he was commanded to re-enter his body; but not all of these obey, so anxious are they to reach Nakauvadra. Thus the Fijians explained recoveries from trances and epileptic seizures. He goes on through myriad adventures and dangers, and it is entirely out of the question to give them all. One of the most curious is that of the vasa tree at Naililili—the "hanging place." From the branches of this tree are hanging the souls of little children, like bats, waiting for their mothers to come and lead them onward, and they cry to the passing shades, "How are my father and my mother?" If the shade answers, "The cooking fire of your mother is set upright," the child ghost wails aloud, knowing that it must still wait, for its mother is still in her prime; but if the shade answers, "Their hair is gray, and the smoke of their cooking fire hangs along the ground," the child laughs with joy, crying: "It is well! my mother will soon be here. Oh, let her hasten, for I am weary of waiting for her!"

I wish that space permitted me to follow the journey of the Fijian shade to its end. The folklore of a people spontaneously developed and uninfluenced from without will always have an interest of its own, because of the light it throws upon the genesis of religions. Many of us have heard of the Fijians as the most striking example of the success of missionary enterprise. Their conversion, however, was in most cases a political move. The chief found it convenient to "*lotu*," and his people of course followed him. In one of these cases the missionary attended a meeting of the tribe to receive their conversion to Christianity. The heathen priest took his seat near the piled-up feast, and thus addressed the ancestor gods: "O ye, our fathers! be not angry with us. We, your children, bring you this miserably inadequate feast from our impoverished gardens, this wretched root of yagona for you to drink. We are poor, we are miserable. And another thing —be not angry with us if, for a while, we give up worshiping you. It is our mind to worship the foreigner's God for a while, yet, nevertheless, be not angry with us." Then the ancestor gods ate the spiritual essence of the yams, and the missionary lunched on its grosser material fiber, and enjoyed it greatly.

In 1876 the natives of Fiji had all nominally embraced Christianity—outwardly they conformed to the new faith—but at the end of 1885 strange rumors were brought to the coast by native travelers from the mountains. A prophet had arisen, who was passing through the villages, saying to the people, "Leave all and follow me." His teachings were an ingenious compound of Christianity and heathenism. He said that when Nacirikaumoli and Nakausabaria (two of the ancestral chiefs, described in their Saga) sailed away after their defeat by Degei, they went to the land of the white men, who wrote a book about them, which is the Bible; only they lied about their names, falsely calling them Jehovah and Jesus. They were about to appear and bring with them all the ancestors of the Fijians. The millennium would come, the missionaries and the Government would be driven into the sea, and every one of the faithful would have shopfuls of English goods. Those who believed that he was sent before to prepare their way would have immortality, but the unbelieving would perish. The white men who came in the men-of-war, looking through glass instruments, who falsely said that they were surveying, were really looking for the coming of the divine twins. In the meantime the faithful were to drill as soldiers and the women to minister in the temples. Temples were secretly built at Drau-ni-ivi and other places, and behind the curtain, where the priest and the women sat, the god might be heard to descend with a low, whistling sound. There was some controversy between the faithful whether Degei was God or the devil. Many inclined to the latter belief, because Satan took serpent form, and the traditions describe Degei as a gigantic serpent lying coiled in his cave in Uakauvadra, and causing thunder when he turns his huge bulk. The new prophet fixed the day for the resurrection of the ancestors, but he was arrested and deported to Rotuma, and the outbreak was stamped out for a time; but in 1892 it reappeared, and the Government then decided to remove the village of Drau-ni-ivi, the fount of all these superstitions, and the houses were removed and the site leveled to the ground. We have by no means, however, heard the last of Fijian mythology. There was another outbreak about a year ago.

FRUIT AS A FOOD AND MEDICINE.*

By HARRY BENJAFIELD, M. B.

And Eve saw that the tree was good for food, and that it was a delight to the eyes.—*Genesis.*

Stay me with raisins, comfort me with apples.—*Solomon.*

SUCH was the opinion of people who lived six thousand years ago, and all down through the succeeding ages poets have sung the praises of the luscious grape and peach, and painters have sought to outvie each other in depicting the attractions of the apple and plum, and away deep down below all this we see throughout the whole animal creation a developed instinct which teaches all to long after these beautiful fruits. Is this instinct wrong? Is Nature a fool thus to make her creatures voice their needs? When you see the whole insect family swarming over and voraciously devouring our choicest fruits, shall we say that they do not know what is good for them? When we see pigs, horses, cows, and sheep breaking down our fences, need we ask how they learned to love fruit? Ay, more, note the baby in arms who screams for the rosy apple, and bites away at it even with toothless gums, and as the baby grows into the boy how he will defy canes, and even police, so that he can get what he loves and longs for. The Creator is so anxious that this very necessary food shall be eaten by his creatures that he makes it beautiful to look upon, sweet and attractive in smell, and gives to it such varieties of flavors that the most fastidious can be satisfied. And yet in spite of all this the great mass of the people look upon fruit as a luxury upon which they can only spend odd pennies for the amusement of their children. Many parents will more readily spend money on injurious or even poisonous sweets than they will on good healthy fruit, and fashionable society will spend pounds on cakes, wines, and brandies, while they spend as many shillings on the very thing they need to keep them healthy —fruit. And as for the amount of drugs swallowed which should be replaced in great measure by fruit it is beyond my powers to calculate. Millions upon millions of pounds are spent annually upon mercurial and other purgatives, most of which would be quite unnecessary if the people would but look upon fruit as a necessary article of diet. The fruit grower of the future must try to so educate the public mind that this state of things will be

* From advance sheets of a lecture delivered before the Australasian Federated Fruit-growers' Association at the Tasmanian Exhibition Building, Queen's Domain, Hobart, April 26, 1895.

altered. The man who makes sweets does not just make them and do nothing to induce the public to buy. No; first he puts them up in all sorts of tempting boxes or packages, then he pushes the sale in various ways. The men who make beers, brandies, etc., not only do this, but they go further, they provide all kinds of places where they shall be taken, they provide the gin palace with all its attractions of club rooms, billiards, daily papers, besides plenty of pretty girls to wait on their customers. Why should we not have fruit palaces where, at reasonable prices, people could get the choicest fruit at any hour of the day?

Eve is said to have seen that fruit was good for food. Every generation since has indorsed her opinion, and now perhaps more than ever before the world is waking up to see how good a food it really is. Good ripe fruits contain a large amount of sugar in a very easily digestible form. This sugar forms a light nourishment, which, in conjunction with bread, rice, etc., form a food especially suitable for these warm colonies;* and when eaten with, say, milk or milk and eggs, the whole forms the most perfect and easily digestible food imaginable. For stomachs capable of digesting it fruit eaten with pastry forms a very perfect nourishment, but I prefer my cooked fruit covered with rice and milk or custard. I received a book lately written by a medical man advising people to live entirely on fruits and nuts. I am not prepared to go so far—by the way, he allowed some meat to be taken with it—for, although I look upon fruit as an excellent food, yet I look upon it more as a necessary adjunct than as a perfect food of itself. Why for ages have people eaten apple sauce with their roast goose and sucking pig? Simply because the acids and pectones in the fruit assist in digesting the fats so abundant in this kind of food. For the same reason at the end of a heavy dinner we eat our cooked fruits, and when we want their digestive action even more developed we take them after dinner in their natural, uncooked state as dessert. In the past ages instinct has taught men to do this; to-day science tells them why they did it, and this same science tell us that fruit should be eaten as an aid to digestion of other foods much more than it is now. Cultivated fruits such as apples, pears, cherries, strawberries, grapes, etc., contain on analysis very similar proportions of the same ingredients, which are about eight per cent of grape sugar, three per cent of pectones, one per cent of malic and other acids, and one per cent of flesh-forming albuminoids, with over eighty per cent of water. Digestion depends upon the action of pepsin in the stomach upon the food, which is greatly aided by the acids of the stomach. Fats are digested by these acids and the bile from

* Australia.

the liver. Now, the acids and pectones in fruit peculiarly assist the acids of the stomach. Only lately even royalty has been taking lemon juice in tea instead of sugar, and lemon juice has been prescribed largely by physicians to help weak digestion, simply because these acids exist very abundantly in the lemon.

Another great action of fruit in the body is its—shall I call it—antiscorbutic action. It keeps the body in a healthy condition. When out on a long voyage where fruit is scarce how one longs for it! Those who have been without it for an extended time long for it until even in their dreams they picture the fruit their system so badly needs. The following case will illustrate my meaning: A ship's crew had any amount of fresh meat, new bread, tea, coffee, etc., aboard, but no fruit nor vegetables. As days went by the men grew haggard, breathless, and weak, with violent, tearing rheumatic pains in the joints. Then the gums grew spongy, the blood broke through its veins, and the whole system was demoralized and dying. In short, they were dying of scurvy. A fruit ship passing sent aboard a good supply of oranges and lemons, which were greedily eaten by the sufferers. Mark the the result: though they still went on eating the same food the addition of fruit to their diet made all the difference between life and death. In a few days their gums began to heal, the blood became healthy, natural color came in their faces, and strength came to the limbs so lately racked with pain. This is, perhaps, an extreme illustration, but I am satisfied that in a lesser degree the want of fruit is responsible for much of the illness in the world. When a student I remember sitting beside a leading London surgeon as an unhealthy child was brought in suffering from a scrofulous-looking rash over the face. Turning to us he exclaimed, "That is a rash from eating lollies." And many times since have I had occasion to remember his teaching, as I have seen it verified. Good fruit clears the blood and prevents this sort of thing. This lemon-juice cure for rheumatism is founded on scientific facts, and having suffered myself from acute gout for the last fifteen years, I have proved over and over again the advantages which are obtained from eating fruit. Garrod, the great London authority on gout, advises his patients to take oranges, lemons, strawberries, grapes, apples, pears, etc. Tardieu, the great French authority, maintains that the salts of potash found so plentifully in fruits are the chief agents in purifying the blood from these rheumatic and gouty poisons.

Perhaps in our unnatural, civilized society, sluggish action of the bowels and liver is responsible for more actual misery than any other ailment. Headache, indigestion, constipation, hæmorrhoids, and a generally miserable condition, are but too often the experience of the sufferer, and to overcome it about half the drugs in the world are given in all sorts of compounds. Let the man of drugs go aboard that ship in mid ocean, with its crew suffering from all these ailments; let the man with his artificially made fruit salts have his trial at their bowels and liver; let the man of mercury and podophyllum, and all the so-called liver doctors try their best; call in the tribes of tonics, and give iron, quinine, arsenic, strychnia, and all the rest of the family; then try your stomachics for his digestion, but in spite of all these the scurvy fiend will sit aloft and laugh you to scorn. In fact, all these drugs have been tried over and over again, and Dr. Buzzard, perhaps the greatest authority in the world, tells us they have all proved miserable failures. But bring in your fruit and the whole scene changes. Can not we show the world that what is applicable to these men in their extreme condition is more or less applicable to the millions of sufferers on land who now persist in looking upon fruit as a thing they can very well do without? Dr. Buzzard advises the scorbutic to take fruit morning, noon, and night. "Fresh lemon juice in the form of lemonade is to be his ordinary drink; the existence of diarrhœa should be no reason for withholding it. Give oranges, lemons, apples, potatoes, cabbage, salads," and if this advice is good for those aboard, and there is no doubt about that, it is equally good for the millions who are spending millions annually in drugs which will never cure them. The first symptoms of scurvy are a change in the color of the skin, which becomes sallow or of a greenish tint. Then follows an aversion for all exercise. Bloodshot eyes, weak heart, bad digestion, and constipation follow on. Dr. Ballard says many of the most serious and fatal cases of scurvy he has seen have only presented as symptoms the pallid face, general listlessness, and bloodshot eyes. If we go through the back streets of our large towns how many pallid faced, listless-looking people and children swarm around us, and they have, as a rule, plenty of food! Within the last few weeks two of my own children have given me a good example of what fruit will do. Two months ago I decided to let these two boys, aged six and eight, go to my farm among the apple-packers. They were not actually ill when they went out, neither had they been at all shut up, but they were pale-looking, would not eat their food, etc. During the last two months they make their boast they eat a dozen apples a day each, and as soon as they began eating these apples their appetite for other foods about doubled, and during the eight weeks they have grown stout and robust, skin clear and healthy, with the glow of health on their cheeks, and bodily strength equal to any amount of exertion.

As a medicine, I look upon fruit as a most valuable ally. As previously shown, when the body is in that breaking-up condition known as scurvy, the whole medical profession look upon fruit and fresh vegetables as the one and only known remedy. I believe the day will come when science will use it very much more largely than it does now in the treatment of many of the everyday ailments. I have shown how it aids digestion. Observations in scurvy prove that it exerts a very powerful influence on the blood. But "the blood is the life": poor blood means poor spirits, poor strength, poor breath, and poor circulation. Impure blood means gout, rheumatism, skin diseases, rickets, and other troubles. As it is proved that fruit will purify and improve the quality of the blood, it must follow that fruit is both food and medicine combined. In fevers I use grapes and strawberries, giving them to my patients in small but frequent doses—oranges and baked apples, if the others are not obtainable. For rheumatism, plenty of lemons are invaluable. White girls with miserable, pallid complexions want a quart of strawberries a day; where these are not obtainable, bananas, which contain much iron, are a good substitute. Probably, of all fruits, the apple stands unrivaled for general purposes in the household; either raw or cooked it can be taken by nearly everybody, and it contains similar properties to the other more delicate fruits. To my mind the pear is more easily digested than the apple, and for eating uncooked is superior to it. In our climate we can have good dessert pears nine months in the year, and their culture should be much increased.

Dried fruits are now occupying more attention than perhaps they have ever done before. It has been proved in a large way by giving troops dried vegetables and fruits that the attack of scurvy could be warded off, but in curing scurvy they were nowhere alongside green. Still it teaches us that dried fruits should be used when green can not be obtained. If soaked for a few hours before cooking they make a capital substitute for fresh fruit, and they come cheaper to the consumer. I wonder that miners, sailors, and others do not use dried fruits very largely.

For preserving fruit I look upon bottling in glass bottles as the coming thing. Not by the use of chemicals, such as salicylic and boracic acids, and the various preservatives made from them, but simply by protecting it after cooking from the fermentative germs in the atmosphere. It keeps for years, turns out even more palatable than green fruit, is equally digestible, and contains all the virtues of freshly cooked fruit. When bottles are made in Australia at a cheap rate this will be a great industry. Canned fruit is not so good; the acid of the fruit dissolves up tin and lead from the tin, and I have seen very serious cases of illness as a result. Besides, fruit should be sold much cheaper in bottles than in tins, as the bottle can be returned and used again.

Jams made from nice fresh fruit, and put up in glass or ware, make a very good article of diet, but much of the jams of commerce should be used as food for pigs. Jams act on tin and lead very much like tart fruits, but the acid in them is greatly neutralized by the sugar. Still, I have seen the outside of the jam in a tin quite discolored.

Solomon said, "Stay me with raisins, comfort me with apples," so great and wise kings six thousand years ago wished to be fed with dried fruit and apples. In this highly enlightened age it is nothing to our credit that we pay less attention to our diet than these old patriarchs did. They thought more of their vineyards than they did of their cattle. When Moses sent the spies into Canaan they were told to bring back samples of the fruit it bore, and they brought back not a fat bullock but a very fat bunch of grapes. A medical writer has recently been maintaining that bread and other starchy food, containing as they do large quantities of lime, are responsible, especially in aged people, for many of the diseases from which we suffer, such as apoplexy, rheumatic gout, etc., and urged that fruit should be taken freely instead, to counteract these limy effects. One of the first symptoms, when people are deprived of fruit and vegetables, is very severe pain in the joints like rheumatism, and death from failure of the heart's action. Whether he is right about this lime may not be proved, but there is no doubt but lime exists too largely in the blood vessels in these diseases, and if fruit were eaten regularly it would do much to prevent it. Science to-day tells us that we may live under the most beautiful conditions, we may feast on bread, meat, eggs, rice, cocoa, oatmeal, and such like foods for a short time, but unless we take fruits or fresh vegetables—fruits being the best—we shall get listless, with leaden face, etc., until we die in a few months at the longest; and it follows that if we would keep ourselves and our children with clear skins, bright intellects, good digestion, rich colored, healthy blood and strength for work, we must regularly take fruit and vegetables, and look upon them as actually more necessary for the support of good health than any other article of diet.

While among the Mongols of the borders of Tibet, Mr. W. W. Rockhill heard a story, said to be widespread among the people, that some five hundred years ago a foreign emperor, desirous of knowing what was in the sun, took fifty Mongol men and as many women, and, shutting them up in a crystal casket that had the power of flying, started them on a voyage of discovery to that star. Nothing has been heard of the explorers since then, and the Mongols bear a grudge against the emperor, whoever he may have been, who served their people so ill.

ONLY A MATCH.

By C. FALKENHORST.

IF one should count the matches that are used daily he would arrive at an immense sum—in the *milliards*, at least. To supply the immense demand for the little sticks which so quickly go out in fire and flame, a great number of factories on either side of the ocean are busy with steam and noisy machines; while we have become so indifferent that we see nothing special in the fire-bearing splinters, and are vexed when one of them fails, or the hissing head breaks off, or the flame goes out, leaving the wood to glimmer.

We shall really have to go among savages to learn to admire the match. Take the white traveler in darkest Africa, in the midst of naked negroes, who see a civilized man for the first time. He carelessly brings out his matchbox to light his cigar. A slight movement of the hand, and the blaze flickers; the crowd of black spectators, frightened, fall back and run away, crying, "Witch! witch!" These negroes are really not savages. They possess fire, by which they warm themselves, and with the help of which they work metals, produce iron and forge it; but they still obtain fire in the primitive way, either by striking steel against flint or in the tedious method of a ruder antiquity by rubbing pieces of dry wood together, and not always with success. But the white man produces his flame as if by magic in an instant.

In the beginning of this century chemists discovered a number of substances which took fire more easily than dry wood or punk, and, as modern naturalists are mostly practical men, the thought occurred to them to make these substances available for the quicker production of fire. They found, for example, that chlorate of potash, now much used as a gargle in throat diseases, was decomposed and set fire to combustible substances as soon as it came in contact with concentrated sulphuric acid. The first practicable match was based upon this observation; a stick was covered at the end with a coating of sulphur, and over this was spread a mass of gum and chlorate of potash. When the head of the match was dipped in concentrated sulphuric acid, the chlorate of potash detonated and set fire to the inflammable sulphur, which imparted its flame to the wood. These were the dip matches, which were introduced in 1812, and were very popular. The sulphuric acid was kept in vials, from the stoppers of which asbestus threads hung down in the inside, and were thereby wet with the acid. If one wanted fire, he drew out the asbestus thread and pressed the head of the match upon it when the fire appeared.

Another property of chlorate of potash was discovered shortly afterward. Mixed with various substances—sulphuret of antimony, for example—a combination was produced which exploded, with issue of flame, on being rubbed. This mixture was first applied to matches by Johann Friedrich Kammerer in 1832. Having sulphured the end of the stick, he prepared an adhesive mixture of gum arabic, chlorate of potash, and sulphuret of antimony, dipped the stick in it, and let the whole dry. This new match was lighted by rubbing it, under pressure of the fingers, in a folded piece of sandpaper.

The use of phosphorus was the next improvement. That substance inflames readily when warmed to 50° C., or 122° F.—a temperature easily obtained by lightly scratching the match on a rough surface. Experiments had been made with this substance at the beginning of the century; but the first phosphorus matches were crude and unsafe. Pure phosphorus was kept under water in bottles, whence small bits of it were taken out and lighted by rubbing on leather. Kammerer, not being fully satisfied with his first composition, tried a new one containing phosphorus as well as chlorate of potash. After this there were no more failures of the matches to light, for the phosphorus took fire under the slightest friction and decomposed the chlorate of potash, which gave out the oxygen required to inflame the sulphur, and made a lively combustion possible. The idea found favor, and the first large factory of phosphorus matches was erected in Vienna by Stephan Römer and J. Preschel. This match, too, had its defects. The mixture of phosphorus and chlorate of potash exploded with such force as to be available for filling bombs. Some serious accidents occurred in the shops, and the transportation of the material was forbidden in several countries. The new matches were wild comrades that needed taming. At last the Vienna makers succeeded in replacing the chlorate of potash by other substances—such as minium, peroxide of lead, and manganese oxide—which gave out oxygen more slowly.

Objections were still brought against these matches. The burning sulphur emitted an offensive odor: to obviate this, paraffin was introduced in the place of sulphur as the substance in which the sticks should be dipped before finishing their heads. A more serious objection was founded on the poisonous nature of the vapor of phosphorus, by reason of which the use of even only a few matches at a time was attended with peril, and the workmen in the factories became subject to dangerous diseases. Yet the manufacturers would not give up phosphorus, and the public, having become accustomed to the new matches, demanded them, so that it was not feasible to prohibit the making of them, and the attention of the Government was rather directed to devising the best provisions practicable for the safety of the workmen.

A curious coincidence occurred in 1845, when the attention of Lorinser in Vienna was first directed to phosphorus poisoning, and Römer, of the same city, discovered the amorphous or red form of phosphorus and the method of converting white phosphorus into it. This form of the element, taking fire at 250° C., is not poisonous. Römer and Preschel were engaged in experiments to find whether the new form of phosphorus might not be used in matches instead of white phosphorus. They found that a mixture of chlorate of potash, sulphuret of antimony, and amorphous phosphorus would take fire readily through friction on a rough body, but the same result followed which Kammerer had experienced with his first mixture. The mass exploded with a violence that sent burning bits of the stuff hissing all over the room. About 1850 the German chemist Böttger introduced a novelty which marked the beginning of a new era in the match manufacture. He made the substance of the head of the match of a mixture of chlorate of potash and sulphuret of antimony, using gum to bind them, and prepared a special friction surface consisting of a coating that contained amorphous phosphorus. When the head of the match was drawn over this substance bits of the amorphous phosphorus were kindled here and there by the friction, which ignited parts of the match-head, producing the explosion of the whole mixture.

The "Swedish safety matches" were made in many German shops from Böttger's recipes about 1850, but they could not compete with the phosphorus matches. People had become accustomed to the last; they were easily lighted, and if the sandpaper was lost, fire could be got by drawing them on the wall or the trousers; while with the new matches one had always to carry his rough card phosphorized with amorphous phosphorus, without which his match was useless. The great value of the German discovery, however, became known abroad about 1860, when the Swedish engineer Lundstrom founded the famous factory in Jönköping. The material of the match-head and the friction surface remained as before, but the Swedes devised a practicable method of boxing, putting the matches in the little convenient slide-boxes, and the chief hindrance to the spread of the invention was removed. The "Swedish matches," as they are now generally called, do not light of themselves so easily as the phosphorus matches, and are therefore safer; and they are, further, unpoisonous. It is therefore no wonder that the "Swedes" have enjoyed a triumphal march through the world, have found a home in Europe and America, and have even made their way into dark Africa. During its most prosperous period, the Jönköping factory produced annually four million marks' worth of matches. Rivals soon rose to it in different parts of the world, and several shops in Germany are sending out excellent Böttger safety matches in Swedish dress. They have so far naturalized themselves as to make the condition of the phosphorus match trade a hard one, and in some states the prohibition of the use of the poisonous white phosphorus in matches has been contemplated.

Still the match has not yet reached its highest stage of perfection. A third period of development looms before it. The safety matches can still be lighted only on the prepared surface of the box. An unpoisonous match which will light as readily as a phosphorus match is not yet found.

Not less important than the chemical constitution is the mechanical preparation of the little fire-bearers. The times have passed when a man could make matches profitably with a simple apparatus at home or in a little shop. Machines have gained the victory over hand labor in this field, and they only are competent to turn out the thousands of thousands of sticks that are burned yearly. The favorite wood for matches is the poplar; but as this can not supply all the demand, pine and fir woods are also used. In the early days of the manufacture, the work of cutting the blocks and forming the sticks was performed by hand; but now the machines are so perfected that a single one can turn out as many as 6,000,000 sticks in a day of ten hours.

The ordinary cut stick is not adapted to matches the heads of which contain no sulphur, and the Swedish matches are prepared by a new method, in which the sticks are obtained by a peeling process. The logs are barked and sawed into blocks about eighteen inches long. These are steamed, then drawn out of the tubs and placed while still hot into the peeling machine, where they are turned upon a pivot and cut by a sharp knife into a continuous band of the right thickness, which is also cut into strips as broad as the length of a match. One of these machines, of only two horse power, operated by a man, can in one working day turn out 4,000 square metres of shavings, from which 15,000,000 matches may be made. The narrow ribbons of wood next go into a machine the operation of which is something like that of a common straw chopper. By a simple mechanism from fifty to seventy thicknesses of the ribbons are pushed slowly forward under a sharp knife, which cuts them into sticks of the desired thickness. These fall upon an endless belt and are carried by it into the drying room. There are machines which, worked by a man and a boy, will turn out 28,000,000 sticks a day. The boxes for the Swedish matches are likewise made by the aid of machines, a description of which involves too many technicalities to be given here; so we only mention a few facts concerning their performance.

The first machine prepares daily 3,000 square metres of board, out of which 200,000 boxes can be made. The second machine cuts up the board into strips affording material for between 300,000 and 400,000 boxes. Another machine sticks these boxes together. The outside box is held together with blue paper. This paper is introduced in endless strips about fifty-six centimetres broad from a roller adjusted sidewise to it; and the cutting, turning, and parting are all done automatically. With one girl to serve it the machine completes daily 36,000 outer boxes. Another machine makes the drawers of the boxes, turning out 25,000 of them in a ten hours' day. Next the boxes are smeared on the narrow sides with the preparation on which the matches are rubbed. A machine does this for between 120,000 and 150,000 boxes a day, more neatly and correctly than can be done by a man's hand. Finally, there is the machine for pasting on the name of the firm, which tickets from 40,000 to 50,000 boxes a day, using less paste in the operation than a workman would. If we reflect now that there are thousands of these machines in different parts of the world, we may be able to comprehend the importance which the match industry has reached in our time.

We return to our sticks, which we left in the drying room, and which are yet to be furnished with the inflammable heads. Before this is done, the tips of the sticks are smeared with some substance that will take fire readily—sulphur, paraffin, or stearin. For this purpose they are dipped in the matter while it is warm. It was discovered at the beginning of the manufacture that no progress could be made if single matches were to be dipped by hand, and frames were devised for the purpose; they were made of thin boards, in which rows of parallel grooves were cut. The sticks were laid in these grooves, and they being short, the matches projected from them. The boards, having been filled up, are tightly packed in larger frames, and the whole, containing hundreds of thousands of matches, is immersed in the bath. The sticks were formerly deposited in the grooves by girls, who became so dexterous in the business that they could handle as many as 200,000 of the splinters in a working day. More recently machines have been substituted for this tedious labor, with which 1,500,000 matches can be handled in a day. But no one has succeeded in inventing a machine for coating the heads with the inflammable matter. That has still to be done by hand.

When the heads are fixed, the matches are returned to the drying room, where they remain till they have parted with all their moisture; then they are taken out of the frames, laid together, and packed in boxes. This part of the work, which is attended with danger of fire, was likewise till only a short time ago performed by hand; but machines have now been devised which take the matches from the opened frames and drop them all in order into large cases, from which they are then repacked in small boxes. One of these machines of the latest construction is capable of extracting from the frames from two to three millions of the sticks a day, with far less danger of fire than when the work is done by men.

Still more recently the Swedish Lundgren, who is famous for his box-making machines, has devised another machine, which fills the boxes and delivers them closed. Nothing more needs to be done than to fill the receiver of the machine with matches and boxes, and to draw from it 25,000 well-filled boxes in a working day.

Thus we see that the little match, which passes away so quickly, has a famous history, and is really one of the most wonderful achievements of the human race. An immense amount of most sagacious ingenuity is concealed in it. The negro is right when, seeing light and fire spurt out as he looks at the curious thing, he cries out that "it is an enchantment," for the little piece of wood certainly surpasses the most marvelous art of the old magicians. —*Translated for The Popular Science Monthly from Die Gartenlaube.*

The Challenger Report, recording the work of the greatest scientific voyage ever undertaken, is now completed, in fifty large volumes containing 29,500 pages of letterpress, with 3.000 plates and maps, and innumerable blocks in the text. The Challenger Expedition left England in December, 1872, charged with the scientific exploration of the physical, chemical, geological, and biological conditions of the great ocean basins, with Captain George S. Nares as naval commander, and Prof. Wyville Thomson and five other gentlemen as the scientific corps. A very complete study was made of the Atlantic Ocean, which was crossed and recrossed in many different directions. From Cape Town the Challenger proceeded to Australia by a southerly course, and was the first steam vessel to cross the Antarctic Circle. She then passed through the western Pacific and its island groups to Hong Kong and Japan, crossed to the middle of the Pacific in 40° north and sailed south to 40° south; then visited Juan Fernandez and Valparaiso; passed through the Strait of Magellan; and returned along the central line of the Atlantic to England in May, 1876. More than five hundred deep-sea soundings were made, with deep-sea dredge and trawl. Besides the vast collection of marine animals, specimens of water from different depths, and of the deposit in the sea-bed were obtained. Tow-nettings for the collection of surface-living organisms were taken continually, magnetic observations whenever it was pos sible, and meteorological and surface temperatures every two hours. The results of the exploration have furnished food for several years' study by many naturalists besides those concerned in the preparation of the report.

EDWARD HITCHCOCK.

BORN at Deerfield, Mass., May 23, 1793; died at Amherst, Mass., February 27, 1864.

The first of this family emigrated to this country in 1635, coming probably from Warwickshire in England. He was one of the original members of the New Haven, Conn., Colony. Two or three generations of the family resided in New Haven; the fourth in the line emigrated to western Massachusetts, and was an officer in the Revolutionary War. His son, Justin, the father of Edward, was a soldier in the army of General Gates when Burgoyne's army was captured. Justin married one of the Hoyts, who was descended from the sufferers at Deerfield at the French-Indian raid of 1704. He settled at Deerfield, and was a hatter. Becoming embarrassed financially by obligations incurred in the continental currency, he suffered from poverty all his life, and was unable to give his children more education than was afforded by the common school and the local academy. Edward was therefore compelled to educate himself, and that under the drawback of ill health, caused by overwork and carelessness. Six particulars may be mentioned, going to show that by improving his opportunities he was well educated in many respects: 1. For several years he was a leading member of a debating society. This afforded the opportunity to practice extempore speaking, composition, and acquire facility in philosophical reasoning. A few short poems showed that he essayed the higher type of composition. One of these was a tragedy entitled The Downfall of Bonaparte, written at the age of twenty-two, just after the battle of Waterloo, and acted by himself and friends before the people of the village. 2. For four years—from twenty-two to twenty-six—he was the principal of the academy in his native town. As there were always in this school a number who were fitting for college, he found it necessary to review all his classical studies—not once merely, but several times. The same was true of scientific studies also, so that quite a large number of subjects were gone over very thoroughly, and the details were fixed in his memory. It was a better discipline than if he had simply taken these studies as a college student. The academy owned a very good philosophical apparatus, and young Hitchcock prepared a number of lectures on physics, which were delivered with experiments both before his classes and in the evening to people of the village. 3. Perhaps the best mental discipline came from the use of the astronomical instruments belonging to the academy. He observed first the comet of 1811. From September 7th to December 17th, during the presence of the celestial visitor, he noted the distance of the comet from various stars, determined the latitude and longitude by lunar distances and eclipses of the sun and moon, occurring about the same time, and the variation of the magnetic needle. Several months of study were required to reduce these observations; and as tables were wanting, he was compelled to calculate elements that the modern astronomer finds ready to his hand. The results of this work were published by the American Academy of Arts and Sciences in a paper by General Epaphras Hoyt, the conclusions of the uncle and nephew being combined in a longitude determination. 4. In making these calculations use was made of the Nautical Almanac, then published by Edmund M. Blunt, of New York (reprinted from the standard English publication). Errors would hardly be looked for in such a work, but beneath the opening page for every month was this sentence: "Ten dollars will be paid on the discovery of an error in the figures." Young Hitchcock soon discovered a long list of errors, both in the figures and the text, and sent it to Mr. Blunt, who answered evasively. The list was then published in the American Monthly Magazine, which called out Mr. Blunt in a statement commencing, "Noticing an attack on my Nautical Almanac from one Edward Hitchcock, a few remarks only are necessary to explain the man's drift." He represented the errors as occurring in a part of the work used chiefly by astronomers, and added, "I would rather ten errors should escape me *there* than one by which the mariner should be deceived." Before this answer had been seen, Hitchcock had forwarded to the magazine a list of twenty errors in the tables of lunar distances, which were serious, because of their magnitude and their use by sailors. Six months later another list of thirty-five errors from these almanacs for 1815, 1816, 1817, and 1818 made its appearance. This led Mr. Blunt to employ a mathematician to recalculate the almanac for 1819, and in his preface to state that "it will afford much satisfaction and promote commercial advantages if, on discovery of an error in any nautical work, publicity should immediately be made." A copy was sent to Hitchcock, who soon made out a list of thirty-five errors, and forwarded them to the magazine. Mr. Blunt did not send the pecuniary reward promised, but published the statement that "the communication of Mr. Hitchcock deserves notice, and he is entitled to much credit for his perseverance." It was a great triumph for a young man to sustain himself against these standard astronomical tables. The most rigid accuracy was indispensable, and the discipline fully equal to that acquired by years of scholastic training. 5. A related discipline came from the publication of a Country Almanac from 1814 to 1818, whose calculations were original. Here also accuracy was essential to success. No complaint was ever made, except in the assignment of Easter to an unusual date. Both clergymen and people denounced the almanac because of this supposed misstatement. Defense was made that the ordinary rules for determining this festival were useless for that year, as it was a peculiar case, occurring only once in several hundred years. Soon afterward the bishop of the diocese issued a circular sustaining the almanac. 6. Classical training came in connection with teaching. First came the ordinary labor of making translations and grammatical construction. Then he kept a note-book for putting down the most striking sentiments of an author, such as would answer for mottoes and quotations. To obtain the choicest sentiments he carefully looked up all the references made from rare authors. Thus he became familiar with the best thoughts of the classical authors, and by fixing them in his memory obtained a fair substitute for the more extended college training.

During his connection with Deerfield Academy, Hitchcock became interested in botany and mineralogy, through the influence of Prof. Amos Eaton. With two associates, the list of plants and minerals of the neighborhood was soon made exhaustive. He had correspondence with the elder Prof. Silliman, of Yale College, respecting difficult questions, and the two maintained for each other a lifelong friendship. It was probably this correspondence which led Hitchcock to join the newly opened theological department at New Haven. He furnished contributions to the first volume of Silliman's American Journal of Science and Art, and to many later issues. In all, his name is prefixed to fifty-two papers, notices, and reviews on topics relating to geology, mineralogy, ichnology, surface geology, physics, meteorology, and botany, in this journal.

Hitchcock chose the ministry for his profession. He was settled as a pastor over the Congregational Church in Conway, Mass., from 1821 to 1825. While in this office he studied natural history to some extent, for the benefit of his health. It was at this time that he discovered and described that small but widely distributed fern, *Botrychium simplex*. In 1825 he was appointed Professor of Chemistry and Natural History in Amherst College. Twenty years afterward he became president of the same institution, and continued in the office for nearly ten years. For the remainder of his life—nearly ten years—he taught geology and natural theology in the same institution.

Like scientific men of his time, Dr. Hitchcock was familiar with several departments of learning—being an author, educator, theologian, and explorer. His career as a geologist is the best known. Starting as a student of the rocks of the Connecticut Valley, his home, he is soon found at both extremities of the State—at Martha's Vineyard and Berkshire County. With larger opportunities for travel, he was impressed with the importance of interesting legislatures in geological surveys, and he took measures to enlist the government of Massachusetts in such work. With this aim in mind he published a lengthy review of Olmsted's survey of North Carolina in the American Journal of Science, in 1828. Near the close he says: "We wish now to ask the intelligent legislator whether such a development of internal resources as this report exhibits does not amply remunerate the State of North Carolina for the comparatively trifling expense of this survey; and whether so great success . . . does not strongly recommend that this example be followed by other States of the Union."

As the result of this and other efforts, the State of Massachusetts commissioned him to make a geological survey of her territory in 1830. Three years were spent in the explorations, and the work was of such a high character that other States were induced to follow the example of Massachusetts, and similar surveys were organized in Tennessee, Maryland, New Jersey, New York, Virginia, Maine, Rhode Island, New Hampshire, Connecticut, Pennsylvania, Ohio, Delaware, Michigan, Indiana, Kentucky, and Georgia. The State of New York sought his advice in the organization of a survey, and followed his suggestions, particularly in the division of the territory into four parts, and appointed him as the geologist of the first district. He entered upon the work, but after a few days of labor he found that he must necessarily be separated from his family, much to his disinclination. He also conceived the idea of urging a more thorough survey of his own State; hence he resigned his commission and returned home. The effort for a resurvey of Massachusetts was successful, and he was recommissioned to do the work. The results appeared in 1841 and 1844—the first a quarto report and the last the geological coloration of a map based upon Borden's Trigonometrical Survey.

Independently of the survey came the discovery of fossil footmarks. As far back as 1800 Pliny Moody had observed trifid markings upon sandstone which he called the tracks of birds. In 1835 Mr. W. W. Draper, of Greenfield, Mass., noticed similar impressions, and drew the same conclusions. Mr. Draper remarked upon them to Dexter Marsh and Colonel William Wilson, who in turn consulted Dr. James Deane, who wrote to Professors Silliman and Hitchcock. All agreed to refer the investigation to Prof. Hitchcock, who propounded the fundamental principles of ichnology in the January number of the American Journal of Sciences for 1836. The announcement was not favorably received by many geologists, while the general public gave expression to their views by the employment of ridicule. The subject was referred to a committee of the American Association of Geologists, consisting of H. D. Rogers, L. Vanuxem, R. C. Taylor, E. Emmons, and T. A. Conrad, in order, if possible, to produce a unanimity of opinion. Those who had most earnestly opposed the new doctrine were upon the committee, but all were convinced; as their report, issued in 1841, states, "From a comparative examination of the facts on both sides, your committee unanimously believe that the evidence entirely favors the views of Prof. Hitchcock, and should regret that a difference had existed, if they did not feel assured it would lead to greater stability of opinion."

The publications upon the subject of these triassic footmarks by Prof. Hitchcock have been quite numerous. The most important were that in the final report upon the geology of Massachusetts in 1841, a paper in the Transactions of the American Academy of Arts and Sciences in 1848, in the Ichnology of New England, published by the State of Massachusetts in 1859 and its supplement in 1865. The total number of species described, as finally revised, amounted to one hundred and fifty. They were referred to several groups: a few marsupialoids, thick and narrow-toed birds, ornithoid lizards or batrachians, lizards, batrachians, chelonians, fish, crustacea, myriapods, insects, and worms. At first the trifid impressions were referred to birds; and it was considered a remarkable confirmation of this view that in 1838 or 1839 there should have been found in New Zealand the bones of true birds having the same dimensions as the largest *Brontozoum*. Prof. Owen has stated that his belief in the ornithic character of the *Deinornis* was strongly fortified by the fact of the existence of the *Brontozoum*. Very soon after the earliest publications about these ornithichnites specimens were exhumed which became very puzzling because of the presence of quadrupedal characters. It became very clear that there must be an intermediate class of beings between birds and reptiles, and accordingly this conclusion was embodied in the assignment of a large number of these *Ichnozoa* to the designation of "ornithoid lizards or batrachians." As time has progressed the order of *Deinosaur* has been proposed, to include such animals as have been made known to us by their bones; and now it is doubtful whether any of the impressions were made by birds. Prof. O. C. Marsh has obtained entire skeletons of *Deinosaurs* from the Connecticut sandstones, which he calls *Anchisaurus*. They seem to be allied to the *Plesiornis* rather than the *Anomœpus* or *Brontozoum* of Hitchcock.

The specimens from which the opinions and descriptions of the ichnology were derived are preserved in the Hitchcock Ichnological Cabinet at Amherst College, and completely fill a room one hundred by forty feet, besides two smaller apartments. The number of distinct impressions studied and labeled exceeds twenty thousand. It is likely that some of the suggestions of the Ichnology may not be verified. It would be strange if the following thirty years of discovery should not enable paleontologists to declare positively whether the *Batrachoides* impressions are really the mud nests of tadpoles, or whether the "insects" are properly larval or adult hexapods, or simply crustacea, as urged by Dana and Agassiz.

In 1857 Prof. Hitchcock accepted the appointment of State Geologist of Vermont. Though the appropriation was very small the work was energetically prosecuted, and conclusions presented in five years' time in two quarto volumes of nearly one thousand pages. Not many speculations were indulged in, though opportunity was afforded for propounding new and startling theories of the metamorphosis of rocks. The report was issued just at the time when Barrande had discharged his artillery at the opponents of the Taconic system, and compelled American paleontologists to assign the *Olenellus* to the primordial zone instead of the Hudson River slates. The report had been written to accord with the American view, but the authors were enabled to omit everything that did not illustrate the reference of the slates to the Cambrian terrane. The Vermont report suggested two general principles which have been of great service in the further discussion of the nature of metamorphism and the age of the New England rocks. The first point relates to the distortion and alteration of pebbles in conglomerates. As far back as 1832 Prof. Hitchcock had noticed the singular alterations in the shapes of pebbles constituting conglomerates in Rhode Island. Not till 1861 was he able to present satisfactory considerations concerning their distortion and alteration. He argued that pressure and metamorphism could totally obliterate the shapes of pebbly constituents and convert them into crystalline schists. Very few of his contemporaries followed him in this generalization. The large geological manuals of Dana and Le Conte conspicuously avoided any mention of this view. To-day the skilled petrographers of the country unanimously indorse the doctrine of the distortion and alteration of the fragmental constituents of sediments.

So long as our paleontologists referred the Cambrian fossils to the Hudson River group, their associates, as represented by Sir William E. Logan, insisted that the quartzite in western Vermont overlaid the slates, and was of Medina age. Logan also claimed a synclinal structure for the Green Mountains. Before accepting any conclusion as to their structure, Prof. Hitchcock directed that this mountain range should be carefully studied stratigraphically. A dozen sections were made at equal distances apart across the State, and it was discovered that the structure was anticlinal when not monoclinal; and hence comes the certainty that the axis of the Green Mountain chain is older than lower Cambrian. The latest workers in this field accept this conclusion.

Perhaps the favorite subject of Prof. Hitchcock was the study of the "Drift." He began to study the ice-marks even before the discovery of the footprints, and soon found himself far beyond the comprehension of his literary and scientific associates. Neither the iceberg nor glacier theory was original with him; but no one up to the time of his death had published so much upon the subject. His views are developed in the treatise on Surface Geology published by the Smithsonian Institution in 1857. His general theory refers the phenomena to both icebergs and glaciers; and their setting forth was generically like the most recent deliverances of Sir William Dawson, who acknowledges the presence of glaciers upon the mountains from which the icebergs were derived that flooded the submerged valleys. His papers are of special interest concerning river terraces, local glaciers in western New England, trains of bowlders, and frozen deposits of drift gravel. It is an interesting fact that he argued against the admissibility of Agassiz's glacial theory because of the absence of a grand terminal moraine at the outer margin of the ice sheet. It was less than five years after his death that geologists began to appreciate the true significance of the backbone of Long Island—that it was part of a gigantic moraine more than a thousand miles long. It is easy to see where Hitchcock would have stood had these facts been known in his day.

The first written suggestion in regard to the formation of the American Association of Geologists came from Prof. Hitchcock, and he was chosen its first president in 1840. This was the parent of the later organization known as the American Association for the Advancement of Science. He was present at nearly every meeting of both organizations until the gap in the later history induced by the war.

As President of Amherst College he was called upon to exercise unwonted judgment. The institution had almost broken down because of heavy indebtedness. The historian of the college declares that the institution was saved from destruction by the skill and wisdom of President Hitchcock. As an instructor and guide no one was more loved and honored. The number of students doubled during his administration. It was while he was president that his Religion of Geology appeared, in which he expounded the applications of science to theology. Most of the positions there maintained are accepted by the advanced Christian thinkers of to-day. The work appeared before the advent of Darwinism, but its principle was discussed as creation by law. While not accepting any development hypothesis, Prof. Hitchcock took pains to insist that its adoption would not be at variance with any fundamental principle of theology. During his lifetime the doctrine of creation was the prevalent fashion of thought, just as now everybody is an evolutionist, and as in the Mesozoic age every vertebrate animal assumed some reptilian feature.

Prof. Hitchcock devoted much thought to the relations between science and theology. He believed that his suggestions—original with him—would tend to bring together truths often divorced, but which only man puts asunder. The following are topics upon which he made important suggestions: 1. Proof of the general benevolence of God from geology. 2. Evidence from the same, of special divine interpositions in Nature. 3. Evidence from the same, of special providence. 4. Mode of answering objections to the doctrine of the resurrection of the body by the nature of bodily identity. 5. The religious bearing of man's creation. 6. The adaptedness of the world for the redemptive work. 7. The Mosaic days properly interpreted by symbolism. These and related truths were taught by him to his classes under the title of natural theology. Through his efforts the chair of Geology and Natural Theology was endowed in Amherst College, with the understanding that the science should always be taught from a religious standpoint.

A list of Prof. Hitchcock's published writings shows a total of twenty-six distinct volumes, thirty-five separate pamphlets, ninety-four papers in periodicals, and eighty newspaper articles—a total of 8,453 pages, with 256 plates and 1,134 woodcuts. Half of these were scientific papers; of the others, most were religious books, essays, sermons, and tracts. He published also biographies, reviews, poetry, and temperance documents.

In 1821 Mr. Hitchcock married Miss Orra White, daughter of Jarib White, of Amherst, Mass., and they lived together for forty-two years. Mrs. Hitchcock was an artist, and prepared many of the illustrations of her husband's reports. Six of their children, two sons and four daughters, reached maturity. The oldest son is the Professor of Hygiene and Physical Education at Amherst College; the youngest is the Professor of Geology at Dartmouth College. Three of the daughters were married—the first to Rev. Dr. H. M. Storrs, lately of Orange, N. J.; the second to G. B. Putnam, of the Franklin Grammar School, Boston, Mass.; the third to the late Rev. C. M. Terry, of Minneapolis, Minn. The oldest daughter is known as an amateur botanist, residing at Hanover, N. H.

EDITOR'S TABLE.

THE PROSPECTS OF SOCIALISM.

THE result of the recent elections in Great Britain has given no little discouragement to the hopes of those who were looking to see a great increase in the socialistic element in the British House of Commons. It is clear that up to this date the British public is more interested in the definite and limited questions of so-called "practical politics" than in the vague and general schemes put forward for the improvement of the world on the lines of socialism. What the British public feels in regard to this matter is felt, we believe, by the great mass of every advanced community in the present day. When socialistic writers or orators descant on the evils of the existing condition of things, striking as they frequently do a true and generous note, the sympathy of many goes out to them; but it is a different thing when society is asked to commit its legislation to the hands of these eloquent declaimers. Even those who acknowledge that such men *feel* right, entertain very often grave doubts as to whether they *see* right—whether their views are practical, whether they have truly forecasted the results of the changes they would introduce, and whether their benevolent efforts, if power were intrusted to them, might not prove the ruin rather than the salvation of the state.

It would be a great mistake to suppose that all who can not see their way to support socialistic schemes, and who can not even share to the full socialistic sentiments, are either insensible to the evils, such as they are, of our social state, or unwilling to do all in their power to have those evils remedied. There is abroad in the world to-day a very general desire to see things made right and fair for the average of mankind and for all men, to have the general conditions of life improved, to have an abatement, on the one hand, of the senseless luxury of the wealthy class, and, on the other hand, a dignifying of the lot of the ordinary citizen. Things are to-day perceptibly moving in the direction of giving better conditions to the average man; but they might move more quickly if the average man would only stand more firmly on his rights, and prosecute them in a more intelligent manner. Whenever the state grants a public franchise, then is the time to make the best bargain possible for the citizens at large. But on what does the possibility of protecting the rights of the citizen in such matters depend? Manifestly, on there being in our legislative bodies men who will not traffic with rich corporations in the citizens' rights. Then on what does the presence of such men in the legislature depend? Now we come to it: the citizen has the composition of the legislature in his own hands, and it depends on him whether the making of the laws shall be intrusted to honorable or to dishonorable, to trustworthy or untrustworthy, men. One of two things: either representative institutions are a mockery and a fraud, or the mass of the citizens have it now in their power to protect their own interests so far as the whole public life of the state is concerned. How they have betrayed their own rights and privileges into the hands of tricksters, gulled by some party cry or swayed by yet baser motives, is the story of nineteenth-century politics.

In spite, however, of such self-betrayal, things have improved even for the self-betrayed—not, of course, as they might have done, but still they have improved. If we compare the beauty of our modern cities and the multiplied conveniencies and decencies of modern life with the condition of things existing fifty years ago, we shall see that the average citizen lives in a world that is a much pleasanter and more desirable abode than that in which his grandfather's years were passed. At very small expense he can do a hundred things and share a hundred pleasures and advantages that either were totally inaccessible to his grandfather, or were only to be obtained at almost prohibitive cost. Whether the man of to-day is on that account happier than was his ancestor is another question; all we maintain is that he has at least the means of enjoyment and self-improvement placed within his reach in much more liberal measure. It is needless to say that all such changes for the better have been due, in the first place, to the great advance that has been made during the present century in scientific knowledge, and, in the second, to a certain enlargement of view and increased liberality of sentiment that have been the accompaniments of that advance. To say that the benefits of scientific discovery and invention have been monopolized by the rich would be to fly in the face of the most obvious facts. To the rich have doubtless been opened up new channels for extravagant expenditure; but the most substantial benefits of increased knowledge have been reaped by those of average means and by the poor.

The true road to that improved condition of human society which socialists are so desirous of bringing about lies, we have always held, through a heightened and strengthened individualism. One great advantage of approaching the problem from this side is that individualism does not imply a call for any form of state action. It means an awakened sense of individual worth, a consciousness of individual rights, the exercise of individual self-control, the elevation of individual aims and ambitions. The socialist wants to make men other than they now are by legislation. The individualist says that men might be other than they now are without legislation; at the same time he makes no objection to any legislation which springs from an actual necessity of the body politic, and which, without taking a needlessly wide sweep, holds out a remedy for a specific evil. He objects on principle to legislation which, for example, undertakes to repress drunkenness by forcing all men to be total abstainers. The sweep here is too wide, the law undertaking, not only to repress a specific evil, but to interfere on a vast scale with the liberties of persons who have in no way merited such interference. The cardinal doctrine of individualism is that each man is primarily responsible for making the best conditions of life he can for himself, and that he is the better for being held to this responsibility. Some writers declaim on the injustice of demanding a degree of virtue in the poor which is never practiced by the rich. It is not a case of demand, however; it is a case of counsel. If there are practices injurious to health, if there are useless modes of expenditure and degrading forms of amusement, he surely is neither an enemy nor an unsympathizing critic of the laboring classes who would urge them to avoid these things, and, by doing so, to stand forth in a nobler than any merely political liberty—in the liberty of men masters of themselves and already the partakers of a far higher life than that of the self-pampering sons and daughters of luxury. The more we reflect upon it, the more we are impressed with the amount of good which might be done in the world, independently of any and all legislation, simply by the substitution of higher aims for the lower ones which now rule so largely all classes of society. How many pass their lives in a miserable attempt to imitate the bad taste and generally foolish proceedings of the class next above them in point of means! If to-day Shoddy is king, it is simply because men and women are silly enough to make him so; not because there is anything in our laws to authorize or constitute his royalty. We can dethrone him whenever we like, without passing even the smallest municipal by-law, by simply resolving to throw off the yoke of false pretense, and live our lives in a simple, honest, and reasonable manner, studying what is excellent and not what is fashionable, the things that make for inward peace and outward dignity, rather than those which make for outward show and inward unrest.

It is truly the folly of mankind that is chiefly responsible for the evils which have called socialist agitation into existence; and it is doubtless a deep-lying instinct that such is the case which causes society as a whole to look coldly upon proposed socialistic remedies. It is desirable that discussion of this subject should be as free as possible, and our belief is that the more the subject is discussed the more clearly it will appear that a higher individualism is the key to the solution of our social problems. What the world wants is an extension of those liberties which a man can create for himself, rather than of the privileges and protections which are created by statute. The highest service, therefore, which any one can render to society is to awaken men in general to those possibilities of life which simple individual initiative and determination can realize; for thus, more than in any other way, would the unjust power of capital be broken, and the way be opened for the healthiest and happiest development of the social organism.

SHAM EDUCATION.

One of the leading writers of fiction of the present day has, in a quite recent work, attempted to set forth the miserable results of the pretentious modes of life and, above all, the pretentious systems of education which, according to his view, are characteristic of the time. The scene of his story is laid in England in the year of the Queen's Jubilee (1887), and the local color, as the expression is, is strongly English; nevertheless, there is much in the descriptions given and the lessons drawn which is capable of application far beyond the limits of the society the novelist had in view. He introduces us to a young woman who is overstraining all the resources of a very indifferent constitution in a desperate struggle to prepare for the matriculation examination of the London University, but whose mind is meantime in even a more feeble condition than her body, her judgment in practical matters wholly unexercised, her temper and disposition a compound of vanity, jealousy, and spite. We read of another who, having passed through an expensive course at schools reputed to be of a very superior grade, had emerged with an equipment of undigested knowledge which simply developed in her a morbid self-consciousness and a futile ambition to shine in some higher sphere than that in which her lot was cast. So far did the spirit of rebellion against circumstances carry this young woman that she abandoned herself to a young Oxford graduate of good birth who charmed and dazzled her by the superiority of his culture and bearing. We get a glimpse of another family in which a young wife and mother, also brought up in a pretentious fashion, neglects every duty of her position and leads her husband such a life that, taking his child with him, he turns his back upon her, leaving her, with such an allowance as he can afford, to her own devices.

It may be said, and has been said, that this author draws with too dark a pencil; but this need not prevent us from discerning the truth to which he calls attention. We learn from his pages, not that a "little knowledge is a dangerous thing," but that superficial knowledge, all unconscious of its superficiality, is a dangerous thing. We learn that a mind clogged with undigested information may lose the power of spontaneous judgment and become the sport of accidental influences. We learn that education may be so bestowed as to minister to vanity rather than to self-respect, to a spirit of reckless and selfish ambition rather than to a sense of responsibility, to habits of weak self-indulgence rather than to any strengthening of the moral powers. The question may then be asked, How are these dangers to be avoided? We answer, by making the building up of character the constant aim of educational work, and the guiding principle in the selection of courses of study. The forcing of uncongenial studies upon unwilling minds is a process that can not be too strongly deprecated, inasmuch as it inevitably tends to the creation of an unnatural atmosphere for the individual, to the confusing of his intellectual perceptions and the destruction of that sense for reality which it is above all things important to preserve. We are strongly of opinion that very serious dangers of the nature already indicated will attend our systems of education until the secret has been found of making all education contribute not less to the right development of character than to the sharpening of the intellectual faculties. That the thing can be done we have not the shadow of a doubt; and to say that it can be done is to say that it must be done.

The author to whom we have referred seems to be of the opinion that an unwise education shows its worst results upon the female sex. In this we think he is right. Contact with the world of which most men have early experience tends to correct the errors, repair the omissions, and cancel the superfluities of their scholastic training; whereas women whose minds have been injured by their school training do not, to anything like an equal extent, enjoy the means of throwing off the faults they have imbibed. It is, therefore, of special importance that young women should not be made the victims of false systems of education. Their intellectual food should be of the purest and most nutritious, so that the effects of their education may be seen, not in a blaze of evanescent accomplishments, but in a steady glow of rational thought and generous emotion. We have not yet learned to make the best of life, and many are the evils we suffer in consequence; but if once it can sink into the consciousness of the community that education for both sexes should be regarded not as a preparation for a career of mere self-seeking, but as an introduction to all the possibilities of higher mental and moral life, a most important step in the progress of the race will have been won.

LITERARY NOTICES.

Handbook of Psychology. Senses and Intellect. 1890. Pp. 343. $1.80. Handbook of Psychology. Feeling and Will. 1894. Pp. 339. $2. Elements of Psychology. 1892. Pp. $1.50. By James Mark Baldwin, Stuart Professor of Psychology in Princeton University. New York: Henry Holt & Co.

Prof. Baldwin expresses the hope in the preface to *Senses and Intellect* that no book upon psychology will hereafter satisfy the requirements of higher education for more than a generation. He says that the philosophical conception of the sphere and function of psychology now prevalent is widely different from that of twenty years ago, when many of the works were written which are yet used as introduction and strong support to the philosophy taught in the universities—"the new conception, namely, that psychology is a science of fact, its questions are questions of fact, and that the treatment of hypotheses must be as rigorous and critical as competent scientists are accustomed to demand in other departments of research." It is no new complaint that outworn and effete ideas continue to drag through school books long after they have been exploded in the world of living science. The hypothesis of caloric was still taught to the young when the doctrine of the correlation and conservation of forces had become firmly established in the minds of scientific men. The old dual chemistry held on in education, though all out of harmony with well-known facts, and though discussion and speculation were rife concerning the chemical constitution of bodies. When at last the compilers of text-books could no longer ignore the new state of things and seriously undertook to keep their works abreast of discovery, the advance was so rapid that new books and new editions were needed every eight or ten years at most. It is the same now in psychology. The accumulation of facts in this field and the activity of speculation about them are quite as remarkable. Since the appearance of Prof. Bain's great work on the Senses and Intellect forty years ago, wherein the physical basis of mind for the first time received adequate treatment in a book of instruction, there has been a most productive activity of observation, experiment, inquiry, and speculation, and several new divisions of psychological science have taken distinct form. Not to speak of psychiatry, or abnormal psychology, we have psychometry, psychophysics, and neurology pursued independently and with promising results. An excellent feature also is his "Further Problems for Study," given at the end of each chapter, indicating partially unexplored fields in which students may engage themselves in an original way. It is thus that tastes are strengthened in early life, that character is formed, and philosophers are made. When, therefore, the attempt is made to give such a presentation of the science as will meet the needs of our higher education and of an intelligent reading public, great judgment is required in choosing and rejecting material lest the work overrun all practical bounds, like that of Prof. James's, or for the most part omit the discussion of unsettled questions, like Sully's. A judicial quality is also needed to enable the author to deal fairly and in proper proportion with all branches of his vast subject. Prof. Baldwin's handbook may be commended in both these directions. He not only gives the facts, but he discusses theories and presents the important aspects of disputed questions. He does not burden the text with difficult points that are unsettled, but puts them in smaller print for students who like to know all sides and to go to the bottom of the case.

The first volume of the handbook, *Senses and Intellect*, opens with a short introduction, of which Chapter I is on the nature of psychology, Chapter II on method, and Chapter III on classification. Part I, containing two chapters, deals with the general characteristics of consciousness and attention. Part II, on the intellect, has nine chapters, and the book concludes with a short chapter on The Rational Function.

Oddly enough, we have to wait till the second volume, *On Feeling and Will*, before we are given an account of the structure and functions of the nervous system. Why this is so does not appear, although it is evidently by design. Prof. Baldwin states the truth about the connection between mind and body plainly enough, but does not emphasize it or enlarge upon it. Perhaps he had some jealousy of physiology, for he says in the preface to the second edition of *Senses and Intellect* that the object of the work was "largely, to demonstrate the independence of psychology," and a parade of pictures from the physiologies at the very outset might prejudice the case. His metaphysical training would be apt to generate such a feeling. However, in *The Emotions and Will* full consideration is given to the physiological side of the subject in three chapters: Chapter I, The Nervous System; Chapter II, The Nervous System and Consciousness; Chapter III, Nature and Divisions of Sensibility. Four chapters follow upon the Feelings and four upon the Emotions before we reach the division of the Will, to which a hundred pages are given. The headings of the chapters and of the paragraphs look very attractive, and we have dipped into the work sufficiently to perceive the thoroughness of Prof. Baldwin's preparation for his undertaking, his deep earnestness and abounding enthusiasm. He must have looked upon his first venture as an experiment, and we can imagine his delight when within a year of its publication the unexpected demand was made upon him for a new edition of *Senses and Intellect*. This alone is a proof of its adaptation to present needs, while the interest aroused by it in the author's "philosophical point of departure" is another guarantee of its quality. Still another, were it needed, may be found in the request made by a number of teachers of psychology in the universities that a single, compact volume should be made of the larger work, such as could be furnished at reasonable cost. This request has been complied with in the *Elements of Psychology*, wherein the exposition of the larger work is simplified, whole sections having been rewritten and chapters recast, while more illustrative facts and illustrations are furnished than are given in the large work. The treatment of the nervous system has been put at the beginning, as "a concession," and references to the corresponding fuller treatment of subjects in the larger work are given at the beginning of each chapter. And so, by slightly reduced type, we have the newest essentials of the science put within reach of everybody. We may add that Prof. Baldwin's large work has been welcomed and strongly commended abroad as well as at home. Fault may doubtless be found with details of its execution, but the spirit in which it is written, its power to awaken interest, enthusiasm, and a thirst for inquiry, are matters of greater importance, and in these respects the work is admirable.

Actual Africa; or, The Coming Continent. By Frank Vincent. With Map and over 100 Illustrations. New York: D. Appleton & Co. Pp. 541. Price $5.

Mr. Vincent's tour of Africa began in Morocco, where customs, institutions, and public affairs are dominated by the despotic Mohammedan religion. He describes the cities, bazaars, roads, and open country, tells how the Jews and Moors live, and gives us an idea of the architecture and wonderful arabesques of the mosques. Tangier, Mequinez, Fez, Wezzan, and a number of smaller Moroccan towns were visited, and our traveler then proceeded to Algeria. While in this country, now a French colony, he made a trip to an oasis in the edge of the Sahara and saw several Roman ruins. In Tunis other Roman remains and the ruins of Carthage were visited. There is naturally more or less sameness in the cities of the Barbary states, but with the ascent of the Nile we enter upon new scenes. Mr. Vincent takes us to the sphinx and the pyramids, and in succession to the temples and tombs at Memphis, Sakhara, Beni Hassan, Assiout, Denderah, Luxor, Karnak, Edfou, Kom Ombo, Kalabshah, Aboo Simbel, and Abydos, penetrating into Nubia as far as Sarras. While describing these monuments of severe grandeur he does not neglect to give us a realistic panorama of the river banks and landing places, showing the native boats and fishermen, style of agriculture, devices for irrigation, crocodiles, donkey-boys, relic peddlers, fields of sugar cane, sugar mills, etc., etc. From Egypt he takes us through the Red Sea and southward to Mauritius and Réunion. Before returning to the mainland an extended tour is made through Madagascar, where the French are now carrying on a war with the natives. Any one who would understand the condition and resources of the country, and the character and relations of its three races of inhabitants, should study Mr. Vincent's account. He next crosses to Zanzibar, sees Tippoo Tib, and has an audience with the Sultan, who "decorates" him. Proceeding down the coast to Natal, our traveler turns inland to Johannesburg—the city of Gold—and Kimberley, going thence to the Cape Colony. In coming up the west coast the first district visited is Angola, where the habits of the natives and the arrangements for trading with them furnish much material of interest. Mr. Vincent made an extended exploration of the Congo Free State, having an opportunity to accompany the managing director of the Upper Congo Company in an expedition to explore branches of the Congo where no settlements of whites existed, and establish posts upon them. The Cameroons, the Niger Territory, the Guinea Coast, the Cape Verde, Madeira, and Canary Islands are visited in turn, and the circumnavigation of the continent is completed when Gibraltar is passed once more. The illustrations, all full-page plates from photographs, are a valuable feature of the book. They include views of cities and native villages, portraits of prominent personages, pictures of natives showing their characteristic dress (or lack of it), dancing girls, scenery, industrial operations, etc., etc. The author's descriptions are eminently satisfying, and they are so because, in addition to the main facts, he is not too dignified to put in those characteristic details which fill the gaps between the outlines and give continuity to his word-pictures.

Handbook of Birds of Eastern North America. By Frank M. Chapman. Illustrated. New York: D. Appleton & Co. Pp. 421. Price, $3.

This is one of the most attractive and, at the same time, useful books that has come to our notice on this subject. Mr. Chapman is particularly well qualified, by long and enthusiastic study, to teach us about birds; and he has adopted an arrangement in this work which makes the subject extremely interesting, and the book a very easy one to use.

It is unfortunate that many of us are so entirely ignorant of bird life that one of the most varied and beautiful of Nature's creatures has no place in our landscape pictures; and as for their language, we are in even a worse plight. During a recent walk through the woods with a city friend, a wood thrush suddenly gave voice some little distance ahead of us. The friend immediately remarked that he didn't know crows lived in the woods. Such absolute ignorance as this is of course rather rare, but some of us are little better off. For many, a knowledge of bird lore is simply an addition to the pleasure obtained from out-of-door life; but to the large agricultural class it has an important economic value, and to the scientific philosopher the bird fills an important place in the evolutionary scheme. Mr. Chapman divides the science of ornithology into three branches—systematic, philosophic, and economic. The systematist classifies birds according to what are apparently their true relationships. "He is the ornithological storekeeper, and, having taken an account of stock, it is his duty to keep the books of the firm in order." The philosophic ornithologist, with the aid of these books, attempts to explain the reasons for and the effects of what he finds existing. "He is a seeker of causes." The economist, essentially practical, is impressed by the important part which birds play in the economics of Nature, and the value to the agriculturist of a knowledge as to whether their influence is, in a particular case, for good or evil. He says: "Few persons realize the value of birds to man. They are the natural check upon the increase of insect life; . . . indeed, it is not too much to say that without birds the earth would not long be habitable." On the last page of the introductory chapter is a heading, The Sentiment of Ornithology, under which the æsthetics of the science are considered. What impresses one most strongly in these few paragraphs is the enthusiasm of Mr. Chapman over his science. A perusal of simply this portion of the book assures one that the author's "whole heart is in his work," and that of course implies the very best results of which he is capable. In the next chapter he tells us how to study birds out of doors. How and when to find them requires a study of their haunts and migratory habits; how to identify them in the field, a consideration of the necessary outfit, such as gun, field-glasses, etc. This chapter is closed with some hints on keeping note-books and journals. Chapter III deals with collecting and preparing birds, nests, and eggs for museum specimens, and the care necessary to keep them in good condition after their installation in the museum. A few pages are then given to an explanation of the plan of the work. One of the many valuable features of the book is a color chart containing thirty different color combinations.

The remaining three hundred and sixty pages are occupied by the descriptive matter. The distinguishing characteristics of each order are first considered, including cuts of both bill and foot when necessary. Then the families and their individuals are studied. The technical description is, in most cases, followed by some observations on the origin of the bird's common name, on a curious habit which it may have, or other interesting facts, from the pen of some careful observer in the regions where this particular specimen abounds. There are a number of very pretty full-page illustrations. The book is tastefully and strongly bound, and may readily be carried in the pocket of a fishing or hunting coat.

Thinking, Feeling, Doing. By E. W. Scripture, Ph. D. (Leipsic). Meadville, Pa.: Flood & Vincent. Pp. 304. Price, $1.50.

In this volume the director of the psychological laboratory in Yale University sets forth the methods of what may be called the new psychology—"a psychology of fact," as he terms it, "a science of direct investigation of our thinking, feeling, and doing." He gives twenty chapters of directions for laboratory tests of reaction time and thinking-time, steadiness, attention, power of discrimination by the senses, emotion, memory, etc., most of them requiring apparatus of more or less complex construction. The author affects no occult profundity in this work. His style is popular and the illustrations that he uses to bring home the nature of the several faculties to the student or reader are drawn from everyday life or well-known occurrences. Thus he begins the chapter on attention by declaring frankly that he can not tell what attention is. He proceeds to illustrate the process by describing the image thrown by a camera, in which the object in focus is distinctly seen while surrounding objects appear in successively greater degrees of dimness according to their distances from the focus. He then describes experiments which consist in showing pictures, letters, words, etc., to the observer for a brief time, and from which it has been learned that four or five such objects can be grasped at the same time. The following extract from his statement of the methods of forcing attention to an object will serve as a sample of his mode of treatment:

> The first law I shall state is: *Bigness regulates the force of attention.* Young children are attracted to objects by their bigness. Advertisers make it a business to study the laws of attention. American advertisers in the past and also largely in the present rely chiefly on the law of bigness. They know that one large advertisement is worth a multitude of small ones. A certain New York life-insurance company puts up the biggest building, the New York World builds the highest tower. Churches frequently vie in building not the most beautiful but the largest house of worship. . . . Bigness, however, costs. The art of successfully applying this law of bigness lies in finding the point at which any increase or any decrease in size lessens the profit.

Four other laws are stated and exemplified in similar manner, and the discussions of other topics and directions for experiments are quite as lively and simple in language as the foregoing. In the two concluding chapters the ways in which the new psychology differs from both materialism and spiritualism are pointed out and some account is given of the labors that have most contributed to its rise, with portraits of Herbart, Fechner, Helmholtz, and Wundt. There are over two hundred other illustrations showing apparatus, persons, and animals being experimented upon, diagrammatic records, etc.

The Source and Mode of Solar Energy. By I. W. Heysinger, M. A., M. D. Philadelphia: J. B. Lippincott Company. Pp. 363.

The author takes as his guiding principle the theory that the true source of solar energy is not to be found in the sun itself, but in the potential energy of space, and that this energy is transmitted to the sun in the shape of electric currents of inconceivably high potential generated by the movements of the planetary system, which is really a huge induction machine. "All planetary space," he says, "is pervaded with attenuated vapors or gases, among which aqueous vapor occupies a leading place. The planets and all planetary bodies having opposite electrical polarity from the central and relatively fixed sun, by their orbital motions around and constant subjection thereto act as enormous induction machines which generate electricity from the ocean of attenuated aqueous vapor, each planet being surrounded by an enormous electrosphere carried with the planet in its axial and orbital movements, the successive atmospheric envelopes gradually diminishing in rotational velocity until merged into the outer ocean of space. As the planets advance in their orbits they plunge into new and fresh fields, and as the whole solar system gradually moves onward through space these fields are never reoccupied. These electrospheres by their rotation generate enormous quantities of electricity at an extremely high potential —so high that we can scarcely even conceive it—and this electricity flows in a constant current to the sun, where it disappears as electricity to reappear in the form of solar light and heat." A chapter is given pointing out the difficulties in the way of accepting present theories. The book is readable and interesting, contains numerous extracts from astronomical authorities, and some well-executed cuts.

The Story of "Primitive" Man. By Edward Clodd. With Illustrations. New York: D. Appleton & Co. Pp. 190. Price 40 cents.

The second of the little books in the Library of Useful Stories deals with the fascinating science of man, and with that division of it concerning which Dr. Johnson said but little more than a century ago, "We *can* know no more than what the old writers have told us." A great deal that seemed unknowable in Johnson's time, however, is now known, and Mr. Clodd here gives the general reader a comprehensive view of what we are told by the old river beds, lake bottoms, caverns, sepulchres, and refuse heaps concerning man's doings before there were any writers. Mr. Clodd is well known as the author of The Story of Creation, A Primer of Evolution, and The Childhood of Religions, and is thoroughly acquainted with the subject which he here epitomizes. After discussing the place of man in the earth's life history and the earth's time-history, he describes the implements and other remains of primitive man that have been found, and tells what may reasonably be inferred from them concerning human life at the time they were laid down. He divides this ancient period into the customary ages, but records his conviction that no hard-and-fast line can be drawn between the two stone ages. "The revolution wrought by metals," he says, "is the greatest that the world has yet seen or that it will ever see." Mr. Clodd has fully attained the ideal of the series to which he contributes this little volume. He has succeeded in telling his story in an eminently readable style, explaining all uncommon words that he was obliged to use and avoiding hosts that he might have used. He takes frequent occasion to call attention to the workings of evolution in human affairs, thus showing his emancipation from the sentiment that man is not really a part of Nature, which still hampers some men of science. There are an abundance of instructive illustrations, and for frontispiece the author has chosen the clever picture by Gabriel Max showing the probable appearance of the "ancestors of man."

Principles and Practice of Agricultural Analysis. By Harvey W. Wiley. Volume I, Soils. Easton, Pa.: Chemical Publishing Co. Pp. 607.

The chemist of the United States Department of Agriculture has undertaken the task of preparing a comprehensive manual for the estimation of soils, fertilizers, and agricultural products, and the first volume of the work is now before us. After some account of the origin of soils the author describes a variety of methods of taking samples for analysis and the preliminary treatment of the samples. Proceeding to the analysis, he takes up first the determination of physical properties, including behavior to heat, cohesion, adhesion, absorption of salts, and porosity. Another division of the work relates to the flocculation of soil particles and the separation of soil particles by a liquid, together with some miscellaneous determinations, and a chapter is given to estimations of gases. Coming to the chemical examination, methods are given for the determination of potash, lime, magnesia, manganese, iron, phosphoric and sulphuric acids, chlorine, silica, kaolin, and nitrogen. Some forty pages are devoted to determinations of oxidized nitrogen, and a few matters of less general application are grouped at the end. Following each of the eight parts into which the volume is divided is a list of authorities cited in that part. There are ninety-three figures, mostly of apparatus. Prof. Wiley uses the new spelling of bromin, bromid, sulfur, and similar words adopted by the Chemical Section of the American Association. In gathering the material for this work he states that he has drawn freely upon the results of experience in all countries, though paying more particular attention to what has been accomplished in the United States.

Introduction to the Pedagogy of Herbart. By Chr. Ufer. Translated by J. C. Zinser. Edited by Charles de Garmo. Boston: D. C. Heath & Co. Pp. 123. Price, 90 cents.

It is not possible to use an elementary text-book to the best advantage unless one has some conception of the point of view and ends which the author has in mind. This work attempts to give in simple, concrete manner a bird's-eye view of the ends and means of education as seen by Herbart, and serves as a guide not only to the works of Herbart himself, but also to the writings of his school. Although it has been impossible to make all the hard things easy, yet the author has certainly rendered it possible for the thoughtful teacher to make a profitable beginning.

Animal Rights. By H. S. Salt, with an Essay on Vivisection by Albert Leffingwell, M. D. New York: Macmillan & Co. Pp. 176. Price, 75 cents.

It is unfortunate that the reformer so generally overstates and misapplies his views that the people are often misled as to their real value. His zeal for his one reform obscures all other considerations, thus leading him to make impracticable and ridiculous applications of it. This has been a feature in the "prevention of cruelty to animals" movement, and the book before us is no exception. There is nothing in it especially worthy of mention; it rehearses all the old arguments, insists that we are trespassing on the animal's rights in using it for food or by catching it in a trap to protect our granaries and chicken houses, and says that we are parties in a crime when we allow our students, after the utmost precaution has been taken to avoid giving pain, to examine the workings of the vital machine in the animal. The first few paragraphs of the introductory chapter are rather deceptive, their tone leading one to expect a thoughtful and moderate discussion of the question.

Geology. By Charles Bird, F. G. S. London and New York: Longmans, Green & Co. Pp. 429. Price, $2.25.

Although described on the title-page as "a manual for students in advanced classes and for general readers," this may properly be called an elementary book. It is written in a simple and readable style, and, so far as a necessarily brief examination shows, it omits no topic needed by one who is beginning his acquaintance with geology. Moreover, it does not go into any of the abstruse questions of the science. To facilitate the use of the book in teaching, a summary and a list of questions are given at the end of each chapter, and to enhance its worth for general readers matter has been inserted to illustrate the various points of contact which geology has with practical life, including its application to such questions as water supply, agriculture, mining, and building material. There are three hundred cuts in the text, and at the end of the volume are examination papers, a classification of the fossils, and an index.

Edward Knobel has hit upon an idea for the study of Nature that ought to prove popular. He has made *A Guide to Find the Names of all Wild-growing Trees and Shrubs of New England by their Leaves*, consisting of fifteen plates, on which are tastefully grouped leaves of two hundred and fifteen trees and shrubs, a key occupying the pages facing the plates. The whole is printed on heavy glazed paper in the form of an oblong booklet with a cardboard cover. He has undertaken a series of such guides, the second, already issued, being devoted to *Ferns and Evergreens of New England*. In this the plates are printed in white on black, which brings out the delicate tracery of the ferns very effectively. The subjects of other booklets in preparation are: Day Butterflies and Dusk-fliers, Beetles of New England, Moths of New England, Fresh-Water Fishes, and Frogs, Turtles, and Snakes (Whidden, 50 cents each).

An introduction to the subject of *Electrical Measurements*, by *Edward Trevert* (Bubier Company, $1), is a neatly arranged little book, of convenient size for the pocket. For an amateur who is attempting practical work the book ought to be a very handy one. Its four chapters, Electrical Units, The Measurement of Resistance, Current Measurements, and Potential Measurements, occupy 117 16mo pages. There are numerous illustrations.

A condensed and convenient *Handbook of Practical Mechanics* comes to us in the shape of a 16mo from *Charles H. Saunders*, of Hartford, its author and publisher. It is intended for use in the shop and draughting room, and contains rules and formulæ for the solution of practical problems. There are numerous tables and illustrations where necessary. The last few pages contain a collection of "workshop receipts."

In *Robinson's New Intellectual Arithmetic* (American Book Company, 35 cents) we have a carefully arranged system of mental arithmetic; a science, the study of which is of great value in developing the thinking and reasoning powers, and which has a direct utility for the business man. The general divisions of the subject—addition, subtraction, etc.—are treated in the same order as in an ordinary arithmetic, and the problems are much the same, but more carefully graded.

Elementary Lessons in Algebra (American Book Company, 50 cents) is a series of lessons inculcating a knowledge of algebraic processes and giving facility in the use of algebraic symbols. They set before the learner the combinations of literal quantities into sums, differences, products, and quotients, with little reference to arithmetical processes and without associating number values to the letters—often a source of confusion to the beginner. The book is intended for use in grammar schools.

The puzzling problem of money is treated by *Arthur Kitson* in *A Scientific Solution of the Money Question* (Arena Publishing Company, cloth, $1.25; paper, 50 cents). Although acknowledging important services rendered to political economy by Jevons, the author criticises him and other economists for confusing the subject of value. He further maintains that there is no such thing as an invariable unit of value, but that there may be such a unit of purchasing power, and undertakes to show how the latter may be obtained. In his view the only proper kind of money is one that is itself valueless and the issuance of which is not made a monopoly by law, He advocates the abolition of all laws restricting the issue of currency, and says that the result would be the rise of a variety of competing systems the fittest of which would survive. During the continuance of the struggle for existence people would have to depend on their own discrimination to determine whose money it was safe to take.

The third of the Occasional Papers issued by the trustees of the John F. Slater Fund is an outline of the *Education of the Negroes since 1860*, by *J. L. M. Curry*. It tells of educational work done while the civil war was yet in progress, sketches the labors of the Freedmen's Bureau, and of various religious and benevolent associations, and gives some account of the operations under the Peabody and Slater Funds (Baltimore: The Trustees).

Mr. *C. Osborne Ward*, who is the author of several books on the labor question, has issued a volume in advocacy of communism, under the title *The Equilibration of Human Aptitudes and Powers of Adaptation* (National Watchman Company, Washington, $1.25). He maintains that the competitive system is a failure, and points out its defects, giving especial prominence to the piracy of inventions and plagiarism of literary productions. He praises the trades unions for having made important progress in the right direction, and touches upon a multitude of minor topics to illustrate or enforce his contentions. In his last chapter he gives the average longevity in a large number of occupations and comments upon the injustice that allows quicksilver miners and brakemen to die at the age of twenty-six, while the rich of no occupation, farmers, judges, and some others live till past sixty. The author gives evidence of a wide reading, and expresses himself clearly and vigorously.

Several essays on *The Nature of the State*, by Dr. *Paul Carus*, which first appeared as editorials in The Open Court, have been collected into a half number of The Religion of Science Library (The Open Court Publishing Company, 25 cents). It is explained in the preface that the immediate occasion for the editorials was a defense of the Homestead rioters by General M. M. Trumbull, who was a contributor to The Open Court. The booklet which has now been made from them takes up first the questions, Does the state exist? and Was the individual prior to society? and goes on to discuss the nature of the modern state and the rights of its citizens to revolution.

The question of a Divine Existence is discussed by a nameless author in a small volume under the title *Matter, Force, and Spirit* (Putnams). He is neither materialist nor spiritualist, for while, as the result of his analysis, he affirms the existence of "substance—real and of final units; force dynamic, represented by motion; and force inbeing, represented in its aggregate form by the attractive power of matter," he emphatically denies that "an atom and motion explain all." In the laws and phenomena of matter and force he finds conclusive evidence of a Supreme controlling Spirit, and in the phenomena of life and intelligence he sees proof "that our own being has to some degree the spiritual essence of the Divine nature." He regards God as an absolute and impersonal, but at the same time a sympathetic, near, and loving spirit.

Early in the spring a very practical (though needlessly embellished) *Spray Calendar*, compiled by *E. G. Lodeman*, was issued from the Agricultural Experiment Station at Ithaca, N. Y. It tells in tabular form when to use the spraying solutions and also gives recipes for making them. With this in the hands of every fruit-grower the bugs would have a hard time.

An account of a field investigation of *The Devonian System of Eastern Pennsylvania and New York*, made by *Charles S. Prosser*, has been issued as Bulletin No. 120 of the United States Geological Survey. The investigation was left unfinished, but it is hoped that the contribution may be of some assistance in working out the correlation of the Devonian system of this region.

The first special report of the Factory Inspectors of Illinois on *Smallpox in the Tenement-house Sweat-shops of Chicago* is instructive to all concerned with the public health of large cities. It recounts a considerable number of instances in which garments were being made on the premises where there were cases of smallpox in the epidemic of 1894 in Chicago, and tells of the artifices practiced by the Polish and Bohemian garment-makers to evade the sanitary provisions of the State factory law. It gives also a list of sweat-shops by streets, with the location of smallpox cases in the radius from which these shops draw their employees.

Bulletin No. 10 of the Minnesota Geological Survey is an account of *The Iron-bearing Rocks of the Mesabi Range*, by *J. Edward Spurr*, in which are considered the structure and character of the iron-bearing rocks, the changes they have undergone, and the length of time since their transformation. The volume is illustrated with stratigraphical sections and maps, the latter in colors, and microscopic sections of rocks.

PUBLICATIONS RECEIVED.

Allen, Grant. The Story of the Plants. New York: D. Appleton & Co. Pp. 213. 40 cents.

Bonalde, J. A. Pérez. El Kuerbo por Edgar Allan Poe. Balparaiso: Frankisko Enrrikez. Pp. 29.

Bulletins, Reports, etc. Alabama Geological Survey: Coosa Coal Field.—American Philosophical Society: Proceedings of January (1895) Meeting.—Columbia College Geological Department: A New Fossil from the Laramie Group at Florence, Col. Winglike Appendages on the Petioles of Liriophyllum Populoides Lesq., etc.; Descriptions of New Leaves from the Cretaceous (Dakota Group) of Kansas.—Illinois Factory Inspectors' Report for Year of 1894.—Iowa Health Bulletin. Vol. IX. No. 1.—Linnæan Society: Abstract of Proceedings for Year ending March 26, 1895.—National Flag Committee Proceedings: Appeal to Fifty-fourth Congress on the Misuse of the National Flag.—New England States, Vital Statistics of).—Tennessee State Board of Health Bulletin. Vol. X. No. 2.—Trinity Church Tenements, Report on Sanitary Condition of.—Wisconsin University Bulletins: A Contribution to the Mineralogy of Wisconsin (Hobbs); Studies in Spherical and Practical Astronomy (Comstock). An Experimental Study of Field Methods which will insure to Stadia Measurements greatly Increased Accuracy (Smith).—The Finances of the United States from 1775 to 1889, with Especial Reference to the Budget (Bullock).—On the Quartz Keratophyre and Associated Rocks of the North Range of the Baraboo Bluffs (Weidman).—Utah University Quarterly. Vol. I. No. 2. Pp. 60.—Wagner Free Institute of Science: Transactions. Vol. III, Part III.—Wisconsin State Board of Health: Fifteenth Report.—Yale University Observatory: Report, 1894-'95.

Carmichael, James. How Two Documents may be found in One. Montreal; Gazette Printing Co. Pp. 22.

Carus, Paul. The Gospel of Buddha. Chicago: Open Court Publishing Company. Pp. 275. 35 cents.

Gage, A. P. Principles of Physics. Boston: Ginn & Co. Pp. 634. $1.55.

Grindon, L. H. The Sexuality of Nature. Boston, Mass.: New Church Union. Pp. 124. 75 cents.

Guerber, H. A. Contes et Legends. Pp. 181. 60 cents; and Myths of Northern Lands. Pp. 319. $1.50. New York: American Book Co.

Hensoldt, Heinrich. Prospectus of Popular Lectures on Oriental Travel. Pp. 14.

Hertwig, Oscar. The Cell. Translated by Henry Johnstone Campbell. New York: Macmillan & Co. Pp. 368. $3.

MacClure, Theodore R. Rabies. Pp. 50.

Macnie, John. Elements of Geometry. New York: American Book Co. Pp. 374. $1.25.

Miall, Prof. L. C. The Natural History of Aquatic Insects. New York: Macmillan & Co. Pp. 389. $1.75.

Parkes, Louis. Elements of Health. Philadelphia: P. Blakiston, Son & Co. Pp. 245. $1.25.

Practical Science Monthly. Devoted to the Practical Application of Scientific Electrical Research. Vol. I, No. 1. Pp. 30.

Singleton, M. T. Gravitation and Cosmological Law. Atlanta, Ga.: Franklin Publishing Company. Pp. 21.

Smith, John B. (Smithsonian Bulletin). Contribution toward a Monograph of the Lepidopterous Family Noctuidæ of Boreal North America. Pp. 126.

Warren, L. E. Speech revealed in Facial Expressions. New York: Edgar S. Werner. Pp. 15.

Webster's Academic Dictionary. New York: American Book Co. Pp. 704. $1.50.

Winter, Noel. Pan-Gnosticism. New York: Transatlantic Publishing Company. Pp. 184.

POPULAR MISCELLANY.

The Red Cross.—The organization known as the Red Cross is the result of the international treaty of Geneva, and has for its object the prevention or amelioration of suffering incurred in war. All military hospitals under its flag are neutral, and can not be attacked or captured. Surgeons, nurses, chaplains, attendants, and all non-combatants wearing its badge, all supplies, and whatever else, under its care, are likewise protected. In this country it has a civil branch, known as the "American Amendment," which other countries are adopting, and which provides relief against woes arising from fire, flood, pestilence, and other national calamities. As late as the Crimean War, civil help for military necessities was unknown, and Florence Nightingale walked into a pathless field. In our own civil war relief was afforded by the Sanitary and Christian Commissions. The Red Cross became active first in the Franco-German War of 1870–'71, and the annals of that war were not stained by any record of needless inhumanity or cruelty to wounded or sick. Since then no war between nations within the treaty has taken place in which the Red Cross has not done its work, maintained its position, and been respected. Under the "American Amendment" it has had a share, according to Miss Clara Barton, its originator and leading spirit, in relief work in the case of the forest fires of Michigan in 1881; the overflow of the Mississippi in 1882; the drought in Texas in 1886; the relief of the sufferers from the Mount Vernon cyclone in 1888; the yellow-fever epidemic in Florida in 1888; the Johnstown disaster in 1889; the Russian famine in 1891–'92; and the hurricane and tidal wave of the South Carolina sea-island coast in 1893–'94. It has also, during that time, taken part in several international movements.

Unsolved Problems in the Manufacture of Light.—In a lecture before the Royal Society of Canada, on Unsolved Problems in the Manufacture of Light, Prof. John Cox showed that in practice not more than from seven to sixteen per cent of the energy stored in the coal can be extracted by the steam engine, and theoretical considerations fix an absolute limit to the perfection of that machine, so that we can never hope to convert so much as thirty per cent of the coal by any form of heat engine. This is one of the unsolved problems—unsolved, but still capable of solution if some means of extracting energy from coal otherwise than by heat, and more like the methods used in burning zinc in a battery, can be discovered. In the second stage of the process for producing the electric light, the dynamo is already nearly perfect, and hardly any heat is lost in its conversion into an electrical current. We reach the third stage, the lamp, with some seven per cent of the original energy still available. In this stage our only means of producing luminous energy is to heat the molecules of some substance, whereby we are compelled to waste the greater part of our efforts in producing heat, which is worse than useless, before we obtain the light rays. "Here, then, is the second unsolved problem, since even in the incandescent lamp and the arc lamp not more than from three to five per cent of the energy supplied is converted into light. Thus of the original store in the coal less than three parts in a thousand ultimately become useful. In the last six years, however, some hint of means to overcome the difficulty has been obtained from the proof by Maxwell and Hertz that light is only an electric radiation. Could we produce electric oscillations of a sufficient rapidity, we might discard the molecules of matter and directly manufacture light without their intervention. To do this we must be able to produce oscillations at the rate of four hundred billions per second. Tesla has produced them in thousands and millions per second, and Crookes has shown how by means of high vacua to raise many bodies to brilliant fluorescence at a small expense of energy. . . . These are hints toward a solution of the problem, but give no solution as yet. Prof. Langley states that the Cuban firefly spends the whole of its energy upon the visual rays without wasting any upon heat, and is some four hundred times more efficient as a light producer than the electric arc, and even ten times more efficient than the sun in this respect. Thus, while at present we have no solution of these important problems, we have reason to hope that in the not distant future one may be obtained, and the human inventor may not be put to shame by his humble insect rival."

Friends of the Farmer.—The common white grub, the larva of the June bug, well known as a destroyer of potatoes and the roots of corn, is eaten by a considerable number of small animals. Among those mentioned in the eighteenth report of the State Entomologist of Illinois are thrushes, blackbirds, bluebirds, owls, hawks, the catbird, robin, and some other birds, also pigs, moles, ground squirrels, skunks, toads, and frogs. It is probable that snakes also eat them. Several of the above-named creatures are too destructive themselves to be encouraged on farms, but others either do no damage at all or a trifling amount compared with the service they render. Poultry might have been added to the list given in the report.

Significance of Human Variation.—The Shattuck Lecture, delivered by Prof. Thomas Dwight at a recent meeting of the Massachusetts Medical Society, was on the Range and Significance of Variation in the Human Skeleton. In it the author, who is convinced that every bodily difference between man and non-rational animals is of degree and not of kind, expresses himself "astonished and perplexed by the great network of analogies extending throughout Nature. No one can ignore them without willfully shutting his eyes. But the very multiplicity of these resemblances assures me that some other law than that of heredity must be invoked to account for them. They can not be represented by a treelike figure. They spread out every way. The opinion is daily growing stronger among serious scholars that, if man's body came from a lower form, it was not by a long process of minute modifications, but by some sudden, or comparatively sudden, transition. The fabulous missing link, once so accurately described by Haeckel, is retreating to the limbo of worn-out hypotheses."

Coloration of Birds' Eggs.—The explanations put forth to account for the variations in color of the shells of birds' eggs are arranged by Dr. R. W. Shufeldt in his paper on that subject as follows: In many instances the general color and markings were in conformity with the law of protective coloration. When both sexes are more or less brilliantly colored, the eggs are generally laid where they are not exposed to view, and where the parent hatching them is also concealed to a greater or less extent. This is effected by either the form of nest constructed or by the eggs being laid in burrows or hollow trees. The eggs of such birds are, as a rule, not handsomely marked, or are often only white. When the general tone of the plumage of the incubating parent is in harmony with its environment, the eggs, as a rule, are laid in open nests or places where they are fully exposed to view; such eggs are often very handsomely tinted and marked, or the reverse may be the case. Frequently birds that lay eggs in open and exposed places, as directly on the ground, rock, or sand, without any apology for a nest, have eggs that are either tinted, or colored and marked, or both, so as to be in harmony with their surroundings. The earliest forms of birds probably laid white, ellipsoidal eggs, varying in number to the clutch from one to many. Possibly in some of the lower types of existing birds such an ancestral trait has persisted. In certain instances where birds lay exposed to view either white or light-tinted eggs, or those not otherwise protectively colored, they have the habit of covering the clutch over with leaves, etc., when the incubating parent temporarily quits the nest. The eggs of birds, irrespective of the character of the coloration of their plumage, which habitually lay in inaccessible places, are often either white or light-tinted and exposed to view. Both the age of the bird and the physical condition of its constitution at the time of laying an egg have their influence upon the coloration of its shell. Changes in the constitution may be due to external causes, as fright, etc.; or to internal causes, as disease, etc. The richest-colored eggs of any species (that lay other eggs than white ones) are laid by that species at its prime. The positions of the egg as it passes down the oviduct, as well as its motions, affect the pattern of its markings.

The Great Siberian Railway.—Of the total length of nearly four thousand seven hundred miles of the great Siberian Railway, the rails are already laid over one thousand and six miles, or sixty-eight miles more than one fifth of the whole distance. In this are counted the distances built from the eastern end at Samara to the Irtysh opposite Omsk, and at the western end from Vladivostok along the Usuri River. There was some doubt at first whether the road should follow the northern route, where a railroad is already built along the old caravan road, through Ekaterinburg to Tyreman, on the Tura, or on the southern line where the advantages of population and traffic in central Siberia are more tempting. The southern route was chosen, and the railway, starting from Samara, passes through the densely peopled parts of south Siberia to Ufa, at the junction of the Byela and Ufa Rivers, thence to Zlatonst, the center of the great iron and gold mining district of the southern Urals, when it crosses the mountains, and to Chlyabisk, on the borders of the prairies of southwest Siberia; thence to Omsk, the present terminus, Tomsk, Krasnoyarsk, Irkutsk, Chita, and the southern coast of Lake Baikal. Here a way will have to be cut through the rocky crags that rise abruptly from the waters of the lake: and between Chita and the Amur a series of parallel ranges will have to be crossed. Owing to the unfavorable character of the region for population, the railway between the Amur and the Usuri will probably remain for some time to come a mere strategic line.

Climate of the City of Mexico.—A report by the Director of the Meteorological Observatory of Mexico, published by the director, Señor M. Bárcena, on the climate of that city, gives the mean annual temperature as 59·7°, and the monthly means as ranging from 53·6° in December to 64·6° in May. The absolute maxima in the shade vary from 73·4° in December to 88·9° in April, and the absolute minima from 28·9° in December to 46·8° in August and September. The greatest daily range amounted to 41° in the month of March. The mean annual rainfall amounted to 23·8 inches, the wettest months being June and September. The greatest fall in one day was 2·5 inches in August, 1888. The prevalent wind is northwest, which blows during most of the year, and that is the coldest and wettest quarter. The strongest wind blows from the northeast. The greatest hourly velocity observed was about fifty-six miles an hour. The report is based upon the hourly observations of the sixteen years, 1877 to 1892.

Luchu Island Snake.—Peculiar to the Luchu Islands is the poisonous Trimeresurus snake, called *habu* by the natives, which is described by Prof. B. H. Chamberlain, of the Imperial University of Japan, as being four or five feet long by two inches in diameter, and as an object of universal fear and hatred. It springs out at passers-by from the hedges, where its habits lead it to lie in wait for birds, and actually enters houses, so as to make it perilous during the warm season to walk about the house at night except with a lantern. The general result of bites that do not bring on death is lifelong crippling. Rewards are offered by the authorities for the bodies of these snakes, dead or alive, and the villagers go out in the woods to secure them. Yet the number does not seem to diminish perceptibly, and at least one case is recorded within recent years of a village having been abandoned by its inhabitants because they could not cope with these enemies. Sea snakes are common on some of the islands, of three species, two of which are harmless, while the bite of the other is poisonous. These sea snakes are highly prized, as vipers are in Japan, and are used as food by the rich and, to a smaller extent, as medicine by the poor.

Smoke.—The following, from the American Engineer and Railroad Journal, seems worthy of mention: A mistaken idea exists as to the amount of actual carbon contained in those dense masses of smoke which are seen rising from the tall stacks of manufacturing and other large plants. By passing through water the gases arising from a furnace burning bituminous coal, and weighing the solid particles retained or precipitated, it has been proved, it is claimed, that they amount to less than one sixth of one per cent of the total amount of coal consumed. It is not strange that a different idea is entertained of the quantity of actual carbon seemingly going to waste, when the wonderful coloring power of the finely divided particles of carbon is considered. To prove this it is only necessary to try the well-known experiment of smoking a bit of glass with a candle, and then mixing up with a palette knife a portion of the coloring matter thus secured with a drop or two of gum arabic. A very small portion of this mixture will color many quarts of water. The actual carbon contained in the smoke itself is inappreciable, but the unconsumed invisible gases invariably associated with the smoke are considerable in quantity and indicative of a financial loss much larger than is generally known.

Therapeutic Hypnotism.—The unmistakable signs of the failing belief and interest in hypnotism as a curative agent, and its relegation to the field of curious if not pathological psychology, is pointed out in the editorial columns of the last Lancet. The two deciding questions, about which controversy has raged, have been, first, Are hypnotic phenomena physiological or pathological? and, secondly, Has the induction of hypnosis any therapeutic value? A study of the most successful hypnotic subjects seems to indicate that the phenomenon is really a morbid one, and "associated with feebleness of will and unusual impressionability," and as regards its therapeutics, while it may be of some value in certain functional nervous diseases, such as hysteria and neurasthenia, there are other methods of producing the same effect which have none of the dangers, both moral and physical, with which hypnosis is fraught.

Diphtheria and Milk.—A curious epidemic of diphtheria following a sore throat, caused by drinking a certain milk, is recorded in the British Medical Journal. On the outbreak of the sore throat the milk and its surroundings were closely examined: some of the cows had sore teats; but no disease in the throats of either cows or milkers could be discovered, and there were no Loeffler bacilli in the throat scrapings from the patients. Upon boiling the milk before using, the epidemic promptly subsided. But within less than a week a true epidemic of diphtheria appeared among these same people, and, although careful investigation was made, no source of secondary infection could be discovered. It seems probable that the throat trouble caused by the milk laid the foundation for the diphtheritic bacillus. The outbreak was a very mild one, only one death occurring.

Physical Measurements of School Children.—In J. Allen Gilbert's researches on the mental and physical development of school children, the results in the observations of muscle sense, or sensitiveness to weight, showed a gradual increase in ability to discriminate, from six to thirteen years of age. At thirteen there was a gradual falling off and then another gain. Boys and girls, considered together, gradually increase in ability, but when they are considered separately, marked differences of sex appear. At six years the considerable difference is in favor of the boys; at seven both sexes have the same ability. From this on both gain with equal pace to the age of thirteen, with the exception of an abrupt falling off for boys at eleven. From thirteen to seventeen the difference again becomes manifest in favor of boys. Ability to distinguish different shades of the same color increases with age. The balance of advantage in this test is slightly in favor of the girls. Voluntary motor ability is measured by the number of taps the child can make in five seconds. The average child at six years taps 20·8 times in that interval. From this there is a gradual increase till the age of twelve, when the rate is 29·9 taps. This is lowered one tap at thirteen, after which the increase is resumed and reaches a maximum at seventeen, when the rate of tapping is 33·8 in five seconds. The rate is higher for boys than for girls. After tapping for forty-five seconds fatigue enters into the results very noticeably. The fatigue is most marked at the age of eight and least marked at fifteen. Boys tire more quickly throughout in voluntary movement than girls, but as they act more vigorously it can hardly be said that they tire more easily. Boys have a larger lung capacity than girls throughout. Girls become nearly stationary in it at twelve, but boys do not begin their most rapid growth till they are fourteen years of age. The time of simple reaction decreases with age. The results, when considered for girls and boys separately, show marked differences in sex. The bright children react more quickly than the dull. But all react in about the same time just before those ages—eleven and sixteen—in which changes of growth manifest themselves. In the test for reaction with discrimination and choice, ability increased and the length of time required decreased with advance in age. This test implies more complicated mental activity, and the influences that affect mental life show themselves more plainly in the curve representing such development.

Uses of the Sand Blast.—It appears from an account of the applications of the sand blast given by Mr. J. J. Holtzapffel, in the English Society of Arts, that glass is almost immediately depolished by the blasts now in use, and only a little time is required to pierce and cut holes through sheet and plate glass. Stone, marble, slate, and granite are equally amenable to its action. Iron, steel, and other metals have their surfaces easily reduced and smoothly or coarsely granulated, according to the force and abrasive powder used. The abrasive need not be harder than the metal to which it is applied. The blast is used for frosting and decorating glass, the labeling of graduated measures, for removing hard scale from castings and forgings, for carvings and inscriptions in intaglio or relief on stone, slate, and granite, for delicate drawings for lithography, for removing fur and deposits in tubs and tanks, for cleaning off accumulations of paint and dirt within iron ships, for decorating buttons, for piercing the holes in glass ventilators, for marking pottery and ornamental tiles, for refacing grindstones, emery and corundum wheels, for granulating celluloid films for photography, and on wood to bring out the grain in relief, and, latterly, for blocks for printing.

Tuberculosis in Meat.—The Royal Commission appointed in July, 1890, to inquire into the effect of food derived from tuberculous animals on human health has reported, as the result of its five years' investigations, that it has obtained ample evidence that "food derived from tuberculous animals can produce tuberculosis in healthy animals. The proportion of animals contracting tuberculosis after experimental use of such food is different in one and another class of animals; both carnivora and herbivora are susceptible, and the proportion is high in pigs. In the absence of direct experiments on human subjects we infer that man also can acquire tuberculosis by feeding upon materials derived from tuberculous food animals. The actual amount of tuberculous disease among certain classes of food animals is so large as to afford to man frequent occasions for contracting tuberculous disease through his food." The commission thinks it probable that an appreciable part of the tuberculosis that affects man is obtained through the food. Tuberculous disease is observed most frequently in cattle and in swine. It is found far more frequently in full-grown cattle than in calves, and with much greater frequency in cows kept in town cowhouses than in cattle bred for the express purpose of slaughter. It is but seldom found in the meat substance, but principally in the organs, membranes, and glands. It is found in the milk of cows when the udder has been attacked by tuberculous disease, and seldom or never when the udder is not diseased. In the milk it is exceptionally active in its operation upon animals fed either with the milk or with dairy produce derived from it. Provided every part that is the seat of tuberculous matter be avoided and destroyed, and provided care is taken to save the actual meat substance from contamination by such matter, a great deal of meat from animals affected by tuberculosis may be eaten without risk to the consumer. Ordinary processes of cooking applied to meat which has got contaminated on its surface are probably sufficient to destroy the harmful quality. They would not avail to render wholesome any piece of meat that contained tuberculous matter in its deeper parts. The boiling of milk, even for a moment, would probably be sufficient to make it safe.

Similarities in Culture.—Prof. O. T. Mason closes a somewhat critical discussion of similarities in culture—on which, he suggests, more is sometimes built than can stand—with the conclusion that such similarities may arise through a common humanity, a common stress, common environment, and common attributes of Nature; through acculturation, or contact, commerce, borrowing, appropriating, between peoples in all degrees of kinship; and through common kinship, race, or nationality. Generic similitudes arise by the first cause; special and adventitious similarities by the second cause; and the more profound, co-ordinated, real, and numerous similarities by the third cause. Similarities are partly natural, such as sounds of animals, forms of pebbles, qualities of stone, clay, and the like, but most of them are fundamentally ideal. Where the same idea exists in two areas, a simple one may have come to men independently. One containing two or more elements in the same relation and order is less likely to have so arisen, while a highly organized idea could not often have come to two men far removed from one another. Furthermore, a complex idea is never the progeny of a single mind, and that embarrasses the question further. The generic and adventitious similarities are most striking and most frequently called to notice. The error is in taking them for profound and real similarities. Those similarities that are imbedded in the life of peoples and logically co-ordinated with the annual circle of activities are of the family and stock, and beyond any reasonable doubt proclaim the people to be one. "Furthermore, they exist for the trained and patient eye and hand; they elude the gaze of the superficial observer. The identification of them is the reward of long years of patient research, and the finder is the discoverer of a pearl of great price."

Electric Cooking Vessels.—The first attempt in practice to devise vessels for cooking by electricity was made about four years ago by a Mr. Carpenter, an American, who developed Lane Fox's idea of surrounding the vessel by a coil of insulated wire through which a current should be passed. He attached the resistant wires to the surface of cast-iron plates by an enameling process. Some defects appeared in his method, among which was the liability of the enamel to crack, whereby the wire was exposed to the oxidizing action of the air. These difficulties have been overcome by the English manufacturers Crompton & Co., who have found a safer enamel and substituted a nickel-steel wire as being better adapted to endure the action to which it is exposed than the wire that was used before. By specially adapted methods they are able to apply the wire in somewhat complicated patterns to the surface of any metal plate, and to insulate it therefrom in a very thorough and permanent manner. They exhibit, constructed on this plan, a simple electric heater—a circular plate mounted on short legs, to the under side of which wire is applied and fixed by the enamel, while the upper side is ground flat and polished—a frying pan, saucepan, kettle, griller, hot iron, and radiator. The radiators have been found convenient, safe, and economical for heating theaters and efficient in preventing the deposition of frost on shop windows.

Formation of Stalactites.—Describing the deposition of carbonate of lime in stalactites and stalagmites, Mr. George P. Merrill, of the United States National Museum, says that water filtering through a rock roof, by virtue of the carbonic acid it contains, is enabled to dissolve a small amount of the lime carbonate, which is again deposited when the excess of carbonic acid escapes either through relief from pressure or through the evaporation of the water. Conditions favorable to either process are furnished by the water filtering through the roof of a cave and dripping slowly to the floor beneath. In cases where the water filters sufficiently slowly or evaporation is correspondingly rapid, the deposit of lime carbonate from the roof takes at first the form of a ring around the outer portion of the drop, a natural consequence of the evaporation of a suspended drop of liquid. This process may go on until the ring becomes prolonged into an elongated cylinder or tube, the diameter of which may not exceed five millimetres, though usually ranging from five to ten, and of all lengths up to fifty centimetres. In exceptional cases this length may be exceeded, but owing to the delicacy of the material the stalactite usually breaks from its own weight and falls to the floor before the length of even ten or fifteen centimetres is reached, to become imbedded in the stalagmitic material there forming. Lengths of even these dimensions are comparatively rare, for the reason that the tube becomes shortly closed, either as its upper or lower end, usually the upper, and all growth from the extremity alone ceases, subsequent depositions being wholly exterior and taking place in the form of concentric coatings of the carbonate on the outer surface and at the same time from the top. There is thus formed around the original tube a compact cylindrical mass, in its typical form, constricted at the point of attachment, but thickening rapidly and then tapering gradually into an elongated cone. The material of the stalactites is not always wholly carbonate of lime, but in some cases thin intervening coats of iron disulphide are met with. Through a kind of crystallization the material sometimes undergoes a distinctly fibrous arrangement, but oftentimes the structure is granular throughout.

Snake-bite Antitoxine.—At a recent meeting of the Royal Society of Edinburgh Prof. Fraser delivered a lecture embodying some extremely valuable and interesting data obtained by him during several years of experimental work on an antidote for snake poisons. The principles utilized by him are similar to those employed in the antitoxine treatment of diphtheria and in vaccination for smallpox. He first immunized an animal by repeated small doses of the snake poison, slowly increasing the quantity, until the animal was taking at a single dose many times the minimum lethal amount for a non-immunized individual. He then injected into another animal some of the blood serum from the immunized case, and found that this prevented any ill effects from a subsequent injection of venom. Still a third animal was given an injection of pure venom, and, when distinct symptoms of poisoning appeared, was treated with the immunizing serum, with the result that the symptoms of poisoning disappeared and no ill effects followed. When it is remembered that in British India alone there are each year from eighteen to twenty thousand deaths caused by snake-bite, the great beneficence of this discovery is apparent. Prof. Fraser is at present immunizing a horse, but is having some trouble, owing to the difficulty of procuring the snake-poison in sufficient quantity.

Unsanitary Filters.—For many years before any positive connection was established between typhoid fever and a specific micro-organism it was known that this and other diseases were in some way connected with the composition of the drinking water previously consumed by the patient. By chemical analysis it was found that in almost all such cases the water contained an excess of organic matter; it was accordingly inferred that removing the organic matter would correct the trouble and obviate any further danger; and filters were made with this end in view. It is now known, however, that the danger from waters containing much organic matter lies not in the organic matter *per se*, but arises from the fact that a large amount of organic matter attracts and feeds a proportionately large number of bacteria. It has been proved experimentally that after a filter of this class has been in use for some time, water, in passing through it, becomes much richer in bacteria, and even that sterilized water passed through it is found swarming with micro-organisms. The filter collects the organic matter from the water and with it some of the bacteria. This mass of organic matter serves as an admirable culture medium; as the bacteria multiply, they are taken up by the water as it passes through the filter, so that, instead of serving as a safeguard against disease, such filters are really disease breeders. In order to be effective, a filtering apparatus must either remove or destroy any micro-organisms contained in the water.

Color Photography.—At a recent *soirée* of the Royal Society, in London, Dr. Joly, of Dublin, exhibited some photographic transparencies upon glass plates representing various objects in their natural colors. The subjects photographed were especially chosen because of variety of color and delicate shading, and were reproduced with great naturalness and fidelity. The results were accomplished by the use of a finely ruled glass plate, two hundred to three hundred lines to the inch, each three lines being a complete color series, consisting of an orange-yellow line, a greenish-yellow line, and a blue-violet line, these colors being repeated over and over again. The lines are ruled with colored inks, made up of gum and gelatin mixed in certain proportions, on a gelatin-coated plate. The plate to be exposed is placed in contact with this color-screen, and only exposed to light which has passed through the latter; an extra-long exposure is necessary, owing to the partial opacity of the color-screen. The plate is then developed in the ordinary way. The color-screen is now again placed against the negative, and when the two are held up to the light, if the color-screen is placed just as it was when the exposure took place, an accurately colored reproduction of the original scene appears. The process is so simple and inexpensive that it will probably come rapidly into general use.

The Value of Object Lessons.—In a recent educational circular we find the following on object teaching: "To sum up the main value of object teaching, there are three principal uses: The first and most important is to teach the children to observe, compare, and contrast; the second is to impart information; and the third is to re-enforce the other two by making the results of them the basis for instruction in language, drawing, number, modeling, and other handiwork. There are, however, other important uses of good object teaching. It makes the lives of the children more happy and interesting by opening up an easily accessible and attractive field for the exercise of brain, hand, and eye; it gives the children an opportunity of learning the simplest natural facts; and directs their attention to external objects, making their education less bookish. It further develops a love of Nature and an interest in living things, and corrects the tendency, which exists in many children, to destructiveness and thoughtless unkindness to animals, and shows the ignorance and cruelty of such conduct. The value of the services which many animals render to man should be dwelt upon, and the importance of kindly treating them and preserving them should be pointed out. By these means, and in other ways, good object teaching may lay the foundation for the right direction of the activity and intelligence of the children throughout the whole school."

Sunlight and Pictures.—The question of preventing or mitigating the fading of pictures and pigments has been attacked in earnest and in a practical way by Captain W. de W. Abney, who finds that fading in the course of time is one of the inevitable effects of the operation of ordinary sunlight. Pictures can not well be taken from the light, so the next best thing is to discover which of the solar rays do the most damage, and to mitigate their effects as far as possible. The violet rays prove to be most active in producing fading. If we can eliminate the majority of these rays from white light without appreciably altering the freshness of the colors viewed in such light, we shall practically have prolonged the life of a picture. A variety of experiments made with different pigments tell us that the loss of the violet of the spectrum is practically no loss at all. Even with white light the loss is unnoticeable. If we form a patch of light composed of all the colors except the violet, we shall notice but little change from the pure white that is alongside of it. The case becomes simpler yet when we find that the blue-green light and the yellow light of the spectrum superposed give substantially white. A blue-green glass and a yellow glass interposed against the sunlight practically cut off all the violet, while they give passage to the rays that form white. Captain Abney therefore solves his problem by using glasses of these colors for the window-glazing of his gallery. Making the windows and skylights with alternate strips of these colors, he has a light which when diffused blends into a practical white that allows the pictures to be seen as under usual conditions, while the danger of fading is made the smallest possible.

Pimento.—Pimento, allspice, or Jamaica pepper is the dried berry of the pimento tree of Jamaica, which grows to the height of twenty or thirty feet; and the markets of the world are wholly supplied from this source. The tree will not grow on the coast lands, but flourishes best on the mountains of the interior of the island. The tree from the leaves of which the aromatic principle of bay rum is extracted (*Pimento acris*) is also a native of Jamaica, but its cultivation has been neglected. The pimento tree is a plant of paradoxes. It is not friendly to cultivation, so that it has not been found possible to rear healthy plants from the seeds by artificial planting; and the stock can not be successfully increased by slips. The seedlings thrive, however, when the seed has been digested by a bird, and this source of supply is largely relied upon. When it is desired to stock land with pimento, the trees growing upon it are cut down and their trunks are left lying where they fell. The bushes and the brush are burned, and the ground is planted with provision crops. After the lapse of some months, young pimento plants may be seen springing from the soil in various places. Care must be taken to keep cattle from them, for they are very fond of the spicy leaves and would destroy the young plants. After two or three seasons cultivation is stopped and the grass is allowed to grow. Cattle are permitted to pasture on the land after the trees have grown out of their reach. The planter has now only to keep the land clear of brush and to gather his crops. The harvest begins in August, just before the berries turn black. One of each party of pickers climbs the trees, breaks off the berry-bearing branches, and throws them down to his comrades, who strip off the berries. The tree is left in a ragged condition, and the process seems to be a barbarous one, but it is said to be best for the trees. If they are pruned, the branches cut die to the main stem; while if the limbs are broken off they shortly send forth new shoots; and it is claimed that the year's yield depends largely on the extent to which the limbs have been broken the previous season. The crop is next cured by drying, winnowed, and prepared for the market. Pimento holds the fifth place of importance in the exports from Jamaica, being exceeded in value only by sugar, rum, coffee, and fruit; but the demand for it is declining, and its importance is therefore growing less.

The Tricks of Worthless Companies.—A report lately published by the English Board of Trade on the working of the Companies Winding-up Act during 1893 reveals some startling facts indicating mismanagement. Winding-up proceedings were begun during the year against more than a thousand companies out of a total of 16,104 in England and Wales, while 2,332 new companies were started. The whole number of liquidations during the two years 1892–'93 was nearly equal to one half of the number of companies formed during the same period. Besides these, a large number of new companies annually prove abortive and cease to exist, or, if their names are not taken from the register, remain there as moribund companies. From the figures of the past year it would appear that nearly two thirds of the companies formed fail to establish themselves as permanent enterprises. The report exposes the manner by which fraudulent or mistaken estimates have enticed simple and believing investors to risk and lose their savings. Malpractices begin with the prospectus and continue till liquidation. One case is cited in which the property sold to the company for two hundred and fifty thousand dollars had been bought a few months before by the promoter for three thousand dollars. In another case the interest in the publication of a periodical was bought by the promoter in June for fifteen hundred dollars in cash, and was sold in August to a company, practically consisting of himself, for fifteen thousand dollars in cash and fifteen thousand dollars in debentures, with a view of ultimately disposing of it to the public at a price based upon these figures. In another instance a small and worthless business was represented as a business in the various centers of industry in England

and Ireland, firmly established and very lucrative, and a safe investment, which would, according to the report of an expert sent out with the prospectus, return, taking the previous year's business as a criterion, a profit of fifteen per cent. The worst of the matter is that the report confesses that the statements, false as they were, were not of such specific character that they could be made the subject of criminal indictment.

NOTES.

A practical piece of work is reported in the bulletin of the University of Wyoming. This is a series of determinations of the heating power of fifty-four samples of Wyoming coal, six of petroleum, and two of asphalt, by Prof. Edwin E. Slosson and Prof. L. C. Colburn. Proximate analyses of the coals and a description of the bomb calorimeter used for the heat tests are also given.

It appeared in observations made in Russia during two years that at the depth of about a foot and a half the soil in the open steppe holds only about two thirds as much moisture as the soil of the woods and their immediate borders. The snow covering on the steppe on the 20th of February corresponded with only one third as much water as that in the forest. Frost reached four times the depth in the open land that it did in the woods. In summer, the upper layers of the ground were most dried in the open land, the deeper layers in the forest. It was therefore inferred that the action of trees is one of drainage. Woods planted in the steppes protect the ground against the direct effects of the sun and the wind, but utilize most of the water that falls. The existence and growth of groves depend on water coming from without. The subsoil moisture is too deep down to be available for the young plantations.

Two customs, supposed to be of Thibetan origin, were noticed by the American traveler W. W. Rockhill, as observed by Mongols in connection with the fireplace. When the party had finished drinking a big kettle of tea, the men put the leaves on the hearthstones on which the kettle rested. This practice was held to be equivalent to burning incense or making an oblation to the gods, and is usually observed by the Chinese frontiersmen, even though they profess Islamism. In case a hearthstone cracks, they are always careful to smear it with a little butter—"for good luck," they say.

Of the results of recent antarctic exploration, Prof. Angelo Heilprin, in an address on the Progress of Discovery, mentions the penetration by two Norwegian vessels on the opposite sides of Graham Land to the sixty-eighth and sixty-ninth parallels of latitude, thus far the "farthest south" positions. They discovered new lands and islands, which they called King Oscar II Land, Weather, Robertson, Christensen, and Lindenberg Islands; and found that the supposed continental mass of Graham Land is possibly an archipelago. Two of the islands have active volcanoes. In the arctic regions Captain Johannessen has discovered a new land which he calls Hansenland, fifteen miles northwest of the New Siberian Islands. The new land is described as ruggedly barren, nearly destitute of vegetation, having high mountains, and supporting gigantic glaciers.

Prof. J. Kollmann communicated to the British Association in 1894 the discovery at Schaffhausen, Switzerland, in neolithic interments, side by side with the remains of full-grown European types, those of small-sized people, presumably pygmies of that age. The situation of the remains indicated that the two races lived peacefully together. In connection with this find it is observed that Sergi and Mantie have discovered some living pygmies in Sicily and Sardinia, looking like miniature Europeans. The Schaffhausen bones are declared by Virchow not to be of a pathologically degenerated people, but of those of normal structure. In the author's opinion these small types must not be regarded as diminutive examples of normal races, but as a distinct species of mankind, which may have been the precursor of the larger types of man.

An interesting and instructive enterprise, an International Exhibition of Hygiene, organized under the direction of M. Brouardel, was recently opened in Paris. The exhibits were grouped as follows: (1) Hygiene of Private Houses. (2) City Hygiene. (3) The Prophylactics of Zymotic Diseases, Demography, Sanitary Statistics, etc. (4) Hygiene of Childhood, including Alimentary Hygiene, Questions of Clothing, and Physical Exercises. (5) Industrial and Professional Hygiene.

The International Geographical Congress, which met in London from July 26th to August 3d, had a very successful and interesting week. The exhibits included a series of maps showing the development of English cartography; portraits of explorers and geographers from the thirteenth or fourteenth century down to the present day; a series of globes constructed by von Ravenstein to show how knowledge of the earth's surface has grown from century to century; many rare and curious old maps; a very large collection of photographs representing types of scenery in all parts of the world; and an extensive collection of geographical instruments, both ancient and modern. The congress was divided for convenience into two sections, one dealing with educational and the other with mathematical geography. Most of the prominent geographers of the world were present, and much valuable work was done. The visitors were entertained in royal style, and the social features were not the least attractive part of the meeting.

THE yellow coloration of milk on exposure to heat is due, according to M. Cazeneuve and M. Haddon, to the oxidation of the lactose in presence of the alkaline salts of the milk. Lactose during this oxidation yields acids, especially formic acid, easily detected, the presence of which suffices to explain the coagulation of the milk as it ensues with any acid.

THE French Association for the Advancement of Science will meet at Bordeaux, from August 4th to August 9th, under the presidency of M. E. Trelat.

THREE cases of tuberculosis following tattooing are reported in the British Medical Journal. Three boys were tattooed by the same woman, who used her saliva as a vehicle for the coloring matter. The woman died soon afterward with pulmonary tuberculosis, and all the boys presented unmistakable signs of tuberculosis at the site of the operation.

BACTERIOLOGY has taken up the telephone as a disseminator of disease, and may make necessary the adoption of some device by which the danger of infection from the mouthpiece, which many people allow to touch the lips, can be avoided. The medical journals of Paris are agitating the matter.

THE ultra-conservatism which is so certainly bred by life about an old university was sadly illustrated recently at Oxford by the rejection of a proposal to include anthropology among the subjects of the final school of natural science not as an extra but as an equivalent subject. There are unfortunately still in high positions classical teachers who believe that science is an unessential part of a nineteenth-century education.

RATHER a novel contrivance for utilizing air currents in irrigation is described in the Louisiana Planter. "A crude invention, which is called the 'Jumbo' wind engine, appeared in western Kansas about ten years ago, and is now coming into extensive use. It resembles the paddle wheel of a stern wheel boat, with a shaft twelve or fourteen feet long, with a diameter of twelve or sixteen feet, with six or eight radial arms. The lower half of this horizontal wheel is shielded from the wind, so that the air acts only upon the upper vanes. A crank upon one end of the shaft connects with a pump. Its power can be indefinitely increased by increasing its length. It is said that a Jumbo giving one hundred horse power in a fifteen-mile wind can be put up at a cost of five hundred dollars. The wind acts on this sort of paddle wheel from all points of the compass except two."

THE recorded heights of what are called maximum waves on the ocean vary from forty feet from crest to hollow to ninety feet. The great storm waves travel very far and faster than the storms, so that preceding them they give warning of them. Sometimes they appear as a record of a far-away storm that is spent. When they have traveled beyond the limits of the wind that raised them they become long undulations, hardly noticed in deep water, but very evident in shallow places. These probably form the "rollers" that appear periodically in places situated in latitudes where gales do not occur. Other rollers are believed by Captain W. J. L. Wharton to be due to earthquakes or volcanic eruptions occurring in the bed of the sea. Of these are the sudden great waves which often cause so much destruction on the South American coasts.

A MARKED decrease in the killed and injured among railroad employees in 1894 is attributed in the report of the Interstate Commerce Commission to the smaller number of men, the smaller volume of business transacted, and perhaps to the increased use of automatic appliances and the improved grade of efficiency of the men. One man was killed out of every 428 in service, and one injured out of every 23. One passenger was killed out of each 1,912,618 carried, or for each 44,103,228 miles traveled; and one injured out of each 204,248 carried, or for each 4,709,771 miles traveled. A distribution of accidents to the terminal groups into which the railroads are divided exhibits the diversity in the relative safety of railway employment and of railway travel in the different sections of the country.

THE Reichsbank, the German Government's banking establishment recently made some instructive experiments, with cement as a fireproof covering for safes. A safe consisting of steel wire netting, between two layers of cement, was subjected to a heat of 1,800° F. for over half an hour. When the safe was opened, silk paper was found uninjured, and a maximum thermometer, which had been in the safe, had only registered 85° F.

SOME interesting observations on the relation of dust to rainfall and scenic effect were made during a trip to Greenland last summer by Prof. William H. Brewer, of the Sheffield Scientific School. He says that the fogs progressively thinned as they went farther north; that, owing to the small amount of dust in the air, the rain, even when streams were flowing from the scuppers, was extremely fine, and seemed more like a fog, so that it was difficult to believe one's eyes, and that even a few moments in a thin fog sufficed to thoroughly wet one's outer garments. He also speaks of the absence of that bluish haze which so softens and beautifies a distant view in lower latitudes. Unfortunately, Dr. Brewer was not equipped for accurate meteorological research, or we should doubtless have had from him valuable data on this very important and interesting subject.

A curious attempt to combine color impressions with musical sounds was recently made in London, by Mr. Wallace Rimington. The instrument used, called a "color organ," was so arranged that each organ note had a corresponding colored disk; pressure on the key threw this disk in front of a powerful arc or lime light by which an image was projected on a screen, and at the same time a musical tone was produced by the organ. Extracts from Chopin and Wagner were rendered; the effects are said to have been in the main pleasing, and were certainly novel.

The Royal Academy of Sciences of the Institute of Bologna offers a gold medal of one thousand francs' value for a memoir on a practical system for the prevention or extinction of fire. Italian, French, or Latin may be used; if in another language, it must be accompanied by an Italian translation. The essays should be signed by a *nom de plume* and accompanied by an envelope containing the author's real name. All essays must be in before May 29, 1896, and should be addressed to "*Al segretario della R. Accademia delle Scienze dell' Instituto di Bologna.*"

An examination of teas grown at various altitudes was recently conducted in the Lancet Laboratory, and seems to show that while the content of caffeine, the refreshing and important constituent of the tea leaf, is not materially affected by an increase of altitude, the tannin, the astringent principle, which gives to the stronger teas their harsh, disagreeable flavor, is quite markedly decreased. The essential oils, on which the agreeable flavor and odor depend, are increased by growth in higher altitudes. Unfortunately, the higher the altitude the less the yield—as, for instance, at seven thousand feet above sea level at Darjeeling, the yield is only two hundred to three hundred pounds per acre, while on the plains of Assam, at an elevation of from only one hundred to five hundred feet, the yield averages one thousand pounds per acre.

The report of the British Opium Commission is supplemented in a special memorandum by Sir William Roberts, who gives opium a position as to its effects on the system intermediate between alcohol and tobacco. But the habitual and excessive use of alcohol is followed by special organic changes that can be traced both during life and after death, while this is not the case with either opium or tobacco. Sir William thinks that the number of opium-eaters in India is likely to be underestimated rather than overestimated. He dwells upon the greater tolerance for opium among the natives of India as compared with Europeans, and cites the evidence of Surgeon-Lieutenant-Colonel Crombie as to the very different effect of opium on native and English infants in support of the view that this enhanced tolerance on the part of the natives of India is apparently congenital.

A unique specimen of the great auk's egg was sold recently in London. It is a perfect egg, which was obtained sixty or seventy years ago in Iceland. It sold for $866.25.

In a paper read before the Geographical Club of Philadelphia, Mr. T. W. Balch relates several incidents observed by him in a journey through Alsace and Lorraine illustrative of the people's concealing French hearts under their Germanized exteriors. Among them was the evasion of the law forbidding the display of French flags, perceived in a show window in Strasburg. The storekeeper, with a thoroughly German name on his sign, had put in a conspicuous place some white candles between two packages of red ones, wrapped at the bottom in blue paper. "It was indeed a dull man who did not see at once the tricolor."

OBITUARY NOTES.

Prof. Franz Neumann, of the chair of Physics and Mineralogy at the University of Königsberg, died on May 23d at Königsberg, at the advanced age of ninety-seven. The work which placed him in the front ranks of science was a Mémoire sur la Théorie des Ondulations, presented to the Berlin Academy in 1835.

Prof. Valentine Ball, of Dublin, died on June 17th, aged fifty-two years. He was Director of the Museum of Science and Art of Dublin. He occupied the chair of Geology and Mineralogy in the University of Dublin from 1881 to 1883, and was the author of several works on geology.

Theodore Brorsen, best known from his discovery of five comets, has recently died, in the seventy-seventh year of his age. He discovered the comet that bears his name in 1846, and found its period to be five years and a half. It has since been seen at four returns, but not since 1879. He discovered a second comet in 1846, a third in 1847, and two others in 1851.

DAVID HOSACK.

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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XX.—FROM THE DIVINE ORACLES TO THE HIGHER CRITICISM.

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V. VICTORY OF THE SCIENTIFIC AND LITERARY METHODS.

WHILE the struggle for the new truth was going on in various fields, aid appeared from a quarter whence it was least expected. The great discoveries by Layard and Botta in Assyria were supplemented by the researches of George Smith, Oppert, Sayce, and others, and thus it was revealed beyond the possibility of doubt that the accounts of the Creation, the tree of life in Eden, the institution of the Sabbath, the deluge, the Tower of Babel, and much else in the Pentateuch were simply an evolution out of earlier myths, legends, and chronicles. So perfect was the proof of this that the most eminent scholars in the foremost Christian seats of learning were obliged freely to acknowledge it.

The more general conclusions which were thus given to biblical criticism were all the more impressive from the fact that they had been revealed by various groups of earnest Christian scholars working on different lines, by different methods, and in various parts of the world. Very honorable was the full and frank testimony to these results given in 1885 by the Rev. Francis Brown, a professor in the Presbyterian Theological Seminary at New York. In his admirable though brief book on Assyriology, starting with the declaration that "it is a great pity to be afraid of facts," he showed how Assyrian research testifies in many ways to the historical value of the Bible record; but at the same time he freely allowed to Babylonian history an antiquity fatal to the sacred chronology of the Hebrews. He also cast aside a mass of doubtful apologetics and dealt frankly with the fact that very many of the early narratives in Genesis belong to the common stock of ancient tradition, and, mentioning as an example the cuneiform inscriptions which record a story of the Accadian king Sargon—how "he was born in retirement, placed by his mother in a basket of rushes, launched on a river, rescued and brought up by a stranger, after which he became king"—he did not hesitate to remind his readers that Sargon lived a thousand years before Moses; that this story was told of him several hundred years before Moses was born; and that it was told of various other important personages of antiquity. The professor dealt just as honestly with the inscriptions which show sundry statements in the book of Daniel to be unhistorical; candidly making admissions which but a short time before would have filled orthodoxy with horror.

A few years later came another testimony even more striking. Early in the last decade of the nineteenth century it was noised abroad that the Rev. Professor Sayce, of Oxford, the most eminent Assyriologist and Egyptologist of Great Britain, was about to publish a work in which what is known as the "higher criticism" was to be very vigorously and probably destructively dealt with in the light afforded by recent research among the monuments of Assyria and Egypt. The book was looked for with the most eager expectation by the supporters of the traditional view of Scripture; but, when it appeared, the exultation of the traditionalists was speedily changed to dismay. For Prof. Sayce, while showing some severity toward sundry minor assumptions and assertions of biblical critics, confirmed all their more important conclusions which properly fell within his province. A few of the statements of this champion of orthodoxy may be noted. He allowed that the week of seven days and the Sabbath rest are of Babylonian origin; indeed, that the very word "Sabbath" is Babylonian; that there are two narratives of Creation on the Babylonian tablets, wonderfully like the two leading Hebrew narratives in Genesis, and that the latter were undoubtedly drawn from the former; that the "garden of Eden" and its mystical tree were known to the inhabitants of Chaldæa in pre-Semitic days; that the beliefs that woman was created out of man, and that man by sin fell from a state of innocence, are drawn from very ancient Chaldæan-Babylonian texts; that Assyriology confirms the belief that the book Genesis is a compilation; that portions of it are by no means so old as the time of Moses; and that the story of Joseph and Potiphar's wife was drawn in part from the old Egyptian tale of The Two Brothers. Finally, after a multitude of other concessions, Prof. Sayce allowed that the book of Jonah, so far from being the work of the prophet himself, can not have been written until the Assyrian Empire was a thing of the past; that the book of Daniel contains serious mistakes; that the so-called historical chapters of that book so conflict with the monuments that the author can not have been a contemporary of Nebuchadnezzar and Cyrus; that "the story of Belshazzar's fall is not historical"; that the book must have been written at a period later than that of Alexander the Great; and that it associates persons and events which are really many years apart. He also acknowledged that the book of Esther "contains many exaggerations and improbabilities, and is simply founded upon one of those same historical tales of which the Persian chronicles seem to have been full." Great was the dissatisfaction of the traditionalists with their expected champion; well might they repeat the words of Balak to Balaam, "I took thee to curse mine enemies, and behold! thou hast blessed them altogether." *

No less fruitful have been modern researches in Egypt. While, on one hand, they have revealed a very considerable number of geographical and archæological facts proving the good faith of the narratives entering into the books attributed to Moses, and have thus made our early sacred literature all the more valuable, they have at the same time revealed the limitations of the sacred authors and compilers. They have brought to light facts utterly disproving the sacred Hebrew date of creation and the

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* For Prof. Brown's discussion, see his Assyriology, its Use and Abuse in Old Testament Study, New York, 1885, *passim*. For Prof. Sayce's views, see The Higher Criticism and the Monuments, third edition, London, 1894, and especially his own curious anticipation, in the first lines of the preface, that he must fail to satisfy either side. For the declaration that the "higher critic" with all his offenses is no worse than the orthodox "apologist," see p. 21. For important admission that the same criterion must be applied in researches into our own sacred books as into others, and even into the mediæval chronicles, see p. 26. For justification of critical skepticism regarding the history given in the book of Daniel, see pp. 27, 28, also chap. xi. For very full and explicit statements, with proofs, that the "Sabbath," both in name and nature, was derived by the Hebrews from the Chaldæans, see pp. 74 *et seq*. For a very full and fair acknowledgment of the "Babylonian element in Genesis," see chap. iii, including the statement that the expression in our sacred book, "The Lord smelled a sweet savor," at the sacrifice made by Noah, is "identical with that of the Babylonian poet," and "it is impossible to believe that the language of the latter was not known to the biblical writer," on p. 119. For an excellent summary of the work, see Dr. Driver's article in the Contemporary Review for March, 1894. For the inscription on the Assyrian tablets relating in detail the exposure of King Sargon in a basket of rushes, his rescue and rule, see George Smith, Chaldæan Account of Genesis, Sayce's edition, London, 1880, pp. 319, 320. For the derivation of the Hebrew Sabbath, not only the institution but the name, from the Chaldæan, see ibid., p. 308. For various other points of similar interest see ibid., *passim*, especially chaps. xvi and xvii; also Jensen, Die Kosmologie der Babylonier, and Schrader, The Cuneiform Inscriptions and the Old Testament; also Lenormant, Origines de l'Histoire.

main framework of the early biblical chronology; they have shown the suggestive correspondence between the ten antediluvian patriarchs in Genesis and the ten early dynasties of the Egyptian gods, and have placed by the side of these the ten antediluvian kings of Chaldæan tradition, the ten heroes of Armenia, the ten primeval kings of Persian sacred tradition, the ten "fathers" of Hindu sacred tradition, and multitudes of other tens, throwing much light on the manner in which the sacred chronicles of ancient nations were generally developed.

These scholars have also found that the legends of the plagues of Egypt are in the main but natural exaggerations of what occurs every year; as, for example, the changing of the water of the Nile into blood—evidently suggested by the phenomena exhibited every summer, when, as various eminent scholars, and, most recent of all, Maspero and Sayce, tell us, "about the middle of July, in eight or ten days the river turns from grayish blue to dark red, occasionally of so intense a color as to look like newly shed blood." These modern researches have also shown that some of the most important features in the legends can not possibly be reconciled with the records of the monuments; for example, that the Pharaoh of the Exodus was certainly not overwhelmed in the Red Sea. As to the supernatural features of the Hebrew relations with Egypt, even the most devoted apologists have become discreetly silent.

Egyptologists have also translated for us the old Nile story of The Two Brothers, and have shown, as we have already seen, that one of the most striking parts of our sacred Joseph legend was drawn from it; they have been obliged to admit that the story of the exposure of Moses in the basket of rushes, his rescue, and subsequent greatness, is a story told not only of King Sargon, but of various other great personages of the ancient world; they have published plans of Egyptian temples and copies of the sculptures upon their walls, revealing the earlier origin of some of the most striking features of the worship and ceremonial claimed to have been revealed especially to the Hebrews; they have given to the world copies of the Egyptian texts showing that the theology of the Nile was one of various fruitful sources of later ideas, statements, and practices regarding the brazen serpent, the golden calf, trinities, miraculous conceptions, incarnations, resurrections, ascensions, and the like, and that Egyptian sacro-scientific ideas contributed to early Jewish and Christian sacred literature statements, beliefs, and even phrases regarding the Creation, astronomy, geography, magic, medicine, diabolical influences, with a multitude of other ideas, which we also find coming into early Judaism in greater or less degree from Chaldæan and Persian sources.

But Egyptology, while thus aiding to sweep away the former conception of our sacred books, has aided biblical criticism in making them far more precious; for it has shown them to be a part of that living growth of sacred literature whose roots are in all the great civilizations of the past, and through whose trunk and branches are flowing the currents which are to infuse a higher religious and ethical life into the civilizations of the future.*

But while archæologists thus influenced enlightened opinion, another body of scholars rendered services of a different sort—the center of their enterprise being the University of Oxford. By their efforts was presented to the English-speaking world a series of translations of the sacred books of the East, which showed the relations of the more Eastern sacred literature to our own, and proved that in the religions of the world the ideas which have come as the greatest blessings to mankind are not of sudden

* For general statements of agreements and disagreements between biblical accounts and the revelations of the Egyptian monuments, see Sayce, The Higher Criticism and the Monuments, especially chap. iv. For discrepancies between the Hebrew sacred accounts of Jewish relations with Egypt and the revelations of modern Egyptian research, see Sharpe, History of Egypt; Flinders Petrie, History of Egypt; and especially Maspero and Sayce, The Dawn of Civilization in Egypt and Chaldæa, London, published by the Society for Promoting Christian Knowledge, 1894. For the statement regarding the Nile, that about the middle of July "in eight or ten days it turns from grayish blue to dark red, occasionally of so intense a color as to look like newly shed blood," see Maspero and Sayce, as above, p. 23. For the relation of the Joseph legend to the Tale of Two Brothers, see Sharpe and others cited. For examples of exposure of various great personages of antiquity in their childhood, see G. Smith, Chaldæan Account of Genesis, Sayce's edition, p. 320. As to Trinities in Egypt and Chaldæa, see Maspero and Sayce, especially pp. 104–106, p. 175, and pp. 659–663. For miraculous conception and birth of sons of Ra, ibid., pp. 388, 389. For ascension of Ra into heaven, ibid., pp. 167, 168; for resurrections, see representations in Lepsius, Prisse d'Avennes, *et al.;* and for striking resemblance between Egyptian and Hebrew ritual and worship, and especially the ark, cherubim, ephod, Urim and Thummim, and wave offerings, see same, *passim.* For very full exhibition of the whole subject, see Renan, Histoire du Peuple Israel, vol. i, chap. xi. For Egyptian and Chaldæan ideas in astronomy, out of which Hebrew ideas of "the firmament," "pillars of heaven," etc., were developed, see text and engravings in Maspero and Sayce, pp. 17 and 543. For creation of man by a divine being in Egypt out of clay, see Maspero and Sayce, p. 154; for a similar idea in Chaldæa, see ibid., p. 545; and for the creation of the universe by a word, ibid., pp. 146, 147. For Egyptian and Chaldæan ideas on magic and medicine, dread of evil spirits, etc., anticipating those of the Hebrew Scriptures, see Maspero and Sayce, as above, pp. 212–214, 217, 636; and for extension of these to neighboring nations, pp. 782, 783. For visions and use of dreams as oracles, ibid., p. 641 and elsewhere. See also, on these and other resemblances, Lenormant, Origines de l'Histoire, vol. i, *passim;* see also George Smith and Sayce, as above, chaps. xvi and xvii, for resemblances especially striking, combining to show how simple was the evolution of many Hebrew sacred legends and ideas out of those of earlier civilizations. For an especially interesting presentation of the reasons why Egyptian ideas of immortality were not seized upon by the Jews, see the Rev. Barham Zincke's work upon Egypt. For the sacrificial vessels, temple rites, etc., see the bas-reliefs figured by Lepsius, Prisse d'Avennes, Mariette, Maspero, *et al.*

revelation or creation, but of slow evolution out of a remote past.

The facts thus shown did not at first elicit much gratitude from supporters of traditional theology, and perhaps few things brought more obloquy on Renan, for a time, than his statement of the simple fact that "the influence of Persia is the most powerful to which Israel was submitted." But this was now seen to be strictly true. Not only was it made clear by study of the Zend Avesta that the Old and New Testament ideas regarding Satanic and demoniacal modes of action were largely due to Persian sources, but it was also shown that the idea of immortality was mainly developed in the Hebrew mind during the close relations of the Jews with the Persians. Nor was this all. In the Zend Avesta were found in earlier form sundry myths and legends which, judging from their frequent appearance in early religions, grow naturally about the history of the adored teachers of our race. Typical among these was the Temptation of Zoroaster.

It is a fact very significant and full of promise that the first large, frank, and explicit revelation regarding this whole subject in form available for the general thinking public was given to the English-speaking world by an eminent Christian divine and scholar—the Rev. Dr. Mills. Having already shown himself by his translations a most competent authority on the subject, he in 1894 called attention, in a review widely read, to "the now undoubted and long since suspected fact that it pleased the Divine Power to reveal some of the important articles of our Catholic creed first to the Zoroastrians, and through their literature to the Jews and ourselves." Among these beliefs Dr. Mills traced out very conclusively many Jewish doctrines regarding the attributes of God, and all, virtually, regarding the attributes of Satan. There, too, he found accounts of the Miraculous Conception, Virgin Birth, and Temptation of Zoroaster. As to the last, Dr. Mills showed a series of striking coincidences with our own later account. As to its main features, he showed that there had been developed among the Persians, many centuries before the Christian era, the legend of a vain effort of the arch-demon, one seat of whose power was the summit of Mount Arezura, to tempt Zoroaster to worship him; of an argument between tempter and tempted, and of Zoroaster's refusal; and the doctor continued: "No Persian subject in the streets of Jerusalem, soon after or long after the Return, could have failed to know this striking myth." Dr. Mills then went on to show that, among the Jews, "the doctrine of immortality was scarcely mooted before the later Isaiah—that is, before the captivity—while the Zoroastrian scriptures are one mass of spiritualism, referring all results to the heavenly or to the infernal worlds." He concludes by saying that, as regards the Old and New Testaments, "the humble, and to a certain extent prior, religion of the Mazda worshipers was useful in giving point and beauty to many loose conceptions among the Jewish religious teachers, and in introducing many ideas which were entirely new, while, as to the doctrines of immortality and resurrection—the most important of all—it positively determined belief." *

Even more extensive were the revelations made by scientific criticism applied to the sacred literature of southern and eastern Asia. The resemblances of sundry fundamental narratives and ideas in our own sacred books with those of Buddhism were especially suggestive.

Here, too, had been a long preparatory history. The discoveries in Sanskrit philology made in the latter half of the eighteenth century and the first half of the nineteenth, by Sir William Jones, Carey, Wilkins, Foster, Colebrooke, and others, had met at first with some opposition from theologians. The declaration by Dugald Stewart that the discovery of Sanskrit was fraudulent, and its vocabulary and grammar patched together out of Greek and Latin, showed the feeling of the older race of biblical students. But researches went on. Bopp, Burnouf, Lassen, Weber, Whitney, Max Müller, and others continued the work during the nineteenth century. More and more evident became the sources from which many ideas and narratives in our own sacred books had been developed. Studies in the sacred books of Brahminism, and in the institutions of Buddhism, the most widespread of all religions, its devotees outnumbering those of all branches of the Christian Church together, proved especially fruitful in facts relating to general sacred literature and early European religious ideas.

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* For the passages in the Vendidad of special importance as regards the Temptation Myth, see Fargard, xix, 18, 20, 26, also 140, 147. Very striking is the account of the Temptation in the Pelhavi version of the Vendidad. The devil is represented as saying to Zaratusht (Zoroaster), "I had the worship of thy ancestors, do thou also worship me." I am indebted to Prof. E. P. Evans, formerly of the University of Michigan, but now of Munich, for a translation of the original text from Spiegel's edition. For a good account, see also Haug, Essays on the Sacred Language, etc., of the Parsees, edited by West, London, 1884, pp. 252 *et seq.* See also Mills's and Darmesteter's work in Sacred Books of the East. For Dr. Mills's article referred to, see his Zoroaster and the Bible, in The Nineteenth Century, January, 1894. For the citation from Renan, see his Histoire du Peuple Israel, tome xiv, chap iv; see also, for Persian ideas of heaven, hell, and resurrection, Haug, as above, pp. 310 *et seq.* For an interesting *résumé* of Zoroastrianism, see Laing, A Modern Zoroastrian, chap. xiii, London, eighth edition, 1893. For the Buddhist version of the judgment of Solomon, etc., see Fausböll, Buddhist Birth Stories, translated by Rhys Davids, London, 1880, vol. i, p. 14, and following. For very full statements regarding the influence of Persian ideas upon the Jews during the captivity, see Kohut, Ueber die jüdische Angelologie und Daemonologie in ihren Abhängigkeit von Parsismus, Leipsic, 1866.

Noteworthy in the progress of this knowledge was the work of Fathers Huc and Gabet. In 1839 the former of these, a French Lazarist priest, set out on a mission to China. Having prepared himself at Macao by eighteen months of hard study, and having arrayed himself like a native, even to the wearing of the queue and the staining of his skin, he visited Pekin and penetrated Mongolia. Five years later, taking Gabet with him, both disguised as Lamas, he began his long and toilsome journey to the chief seats of Buddhism in Thibet, and after two years of fearful dangers and sufferings accomplished it. Driven out finally by the Chinese, Huc returned to Europe in 1852, having made one of the most heroic, self-denying, and, as it turned out, one of the most valuable efforts in all the noble annals of Christian missions. His accounts of these journeys, written in a style simple, clear, and interesting, at once attracted attention throughout the world. But far more important than any services he had rendered to the Church he served was the influence of his book upon the general opinions of thinking men. For he completed a series of revelations made by earlier, less gifted, and less devoted travelers, and brought to the notice of the world the amazing similarity of the ideas, institutions, observances, ceremonies, and ritual, and even the ecclesiastical costumes of the Buddhists to those of his own Church.

Buddhism was thus shown with its hierarchy, in which the Grand Lama, an infallible representative of the Most High, is surrounded by its minor Lamas, much like cardinals, with its bishops wearing mitres, its celibate priests with shaven crown, cope, dalmatic, and censer, its cathedrals with clergy gathered in the choir; its vast monasteries filled with monks and nuns vowed to poverty, chastity, and obedience; its church arrangements, with shrines of saints and angels; its use of images, pictures, and illuminated missals; its service, with a striking general resemblance to the Mass; antiphonal choirs; intoning of prayers; recital of creeds; repetition of litanies; processions; mystic rites and incense; the offering and adoration of bread upon an altar lighted by candles; the drinking from a chalice by the priest; prayers and offerings for the dead; benediction with outstretched hands; fasts, confessions, and doctrine of purgatory—all this and more was now clearly revealed. The good father was evidently staggered by these amazing facts; but his robust faith soon gave him an explanation: he suggested that Satan, in anticipation of Christianity, had revealed to Buddhism this divinely constituted order of things. This naïve explanation did not commend itself to his superiors in the Roman Church. In the days of St. Augustine or of St. Thomas Aquinas it would doubtless have been received much more kindly; but in the days of Cardinal Antonelli this was hardly to be expected: the Roman authorities, seeing the danger of such plain revelations in the nineteenth century, even when coupled with such devout explanations, put the book under the ban, though not before it had been spread throughout the world in various translations. Father Huc was sent on no more missions.

Yet there came even more significant discoveries, especially bearing upon the claims of that great branch of the Church which supposes itself to possess a divine safeguard against error in belief. For now was brought to light by literary research the irrefragable evidence that the great Buddha—Sakya Muni himself—had been canonized and enrolled among the Christian saints whose intercession may be invoked, and in whose honor images, altars, and chapels may be erected; and this, not only by the usage of the mediæval Church, Greek and Roman, but by the special and infallible sanction of a long series of Popes, from the end of the sixteenth century to the end of the nineteenth—a sanction granted under one of the most curious errors in human history. The story throws an additional light upon the way in which many of the beliefs of Christendom have been developed, and especially upon the way in which they have been influenced from the seats of older religions.

Early in the seventh century there was composed, as is now believed, at the Convent of St. Saba near Jerusalem, a pious romance entitled Barlaam and Josaphat, the latter personage, the hero of the story, being represented as a Hindu prince converted to Christianity by the former.

This story, having been attributed to St. John of Damascus in the following century, became amazingly popular, and was soon accepted as true: it was translated from the Greek original not only into Latin, Hebrew, Arabic, and Ethiopic, but into every important European language, including even Polish, Bohemian, and Icelandic. Thence it came into the pious historical encyclopædia of Vincent of Beauvais, and, most important of all, into the Lives of the Saints.

Hence the name of its pious hero found its way into the list of saints whose intercession is to be prayed for and it passed without challenge until about 1590, when, the general subject of canonization having been brought up at Rome, Pope Sixtus V, by virtue of his infallibility and immunity against error in everything relating to faith and morals, sanctioned a revised list of saints, authorizing and directing it to be accepted by the Church; and among those on whom the seal of Heaven was thus forever infallibly set was included "The Holy Saint Josaphat of India, whose wonderful acts St. John of Damascus has related." The 27th of November was appointed as the day set apart in honor of this saint, and the decree, having been enforced by successive popes for over two hundred and fifty years, was again officially approved by Pius IX in 1873. This decree was duly accepted as infallible, and in one of the largest cities of Italy may to-day be seen a Christian church dedicated to this saint. On its front are the initials of his Italianized name; over its main entrance is the inscription *Divo Josafat;* and within is an altar dedicated to the saint—above it being a pedestal bearing his name and supporting a large statue which represents him as a youthful prince wearing a crown and contemplating a crucifix.

Moreover, relics of the saints were found, and bones alleged to be parts of his skeleton having been presented by a Doge of Venice to a King of Portugal, are now treasured at Antwerp.

But even as early as the sixteenth century a pregnant fact regarding this whole legend was noted: for the Portuguese historian Diego Conto showed that it was identical with the legend of Buddha. Fortunately for the historian, his faith was so robust that he saw in this resemblance only a trick of Satan; the life of Buddha being, in his opinion, merely a diabolic counterfeit of the life of Josaphat centuries before the latter was lived or written—just as good Abbé Huc saw in the ceremonies of Buddhism a similar anticipatory counterfeit of Christian ritual.

There the whole matter virtually rested for about three hundred years—various scholars calling attention to the legend as a curiosity, but none really showing its true bearings, until, in 1859, Laboulaye in France, Liebrecht in Germany, and others following them in research, demonstrated that this Christian work was drawn almost literally from an early biography of Buddha, being conformed to it in the most minute details, not only of events but of phraseology; the only important changes being that, at the end of the various experiences showing the wretchedness of the world, identical with those ascribed in the original to the young Prince Buddha, the hero becomes a Christian, and that for the appellation of Buddha—"Bodesat"—is substituted the more scriptural name Josaphat.

Thus it was that by virtue of the infallibility vouchsafed to the papacy in matters of faith and morals Buddha became a Christian saint.

Yet these were by no means the most pregnant revelations. As the Buddhist scriptures were more fully examined, there were disclosed interesting anticipations of statements in later sacred books. The miraculous conception of Buddha and his virgin birth, like that of Horus in Egypt and of Krishna in India; the previous annunciation to his mother Maja; his birth during a journey by her; the star appearing in the east, and the angels chanting in the heavens at his birth; his temptation—all these and a multitude of other statements were full of suggestions to larger thought regarding the development of sacred literature in general. Even the eminent Roman Catholic missionary, Bishop Bigandet, was obliged to confess in his scholarly life of Buddha these striking similarities between the Buddhist scriptures and those which it was his mission to expound, though by this honest statement his own further promotion was rendered impossible. Fausböll also found the story of the judgment of Solomon imbedded in Buddhist folklore; and Sir Edwin Arnold, by his poem, The Light of Asia, spread far and wide a knowledge of the anticipation in Buddhism of some ideas which, down to a recent period, were considered distinctively Christian. Imperfect as the revelations thus made of an evolution of religious beliefs, institutions, and literature still are, they have not been without an important bearing upon the newer conception of our own sacred books: more and more manifest has become the interdependence of all human development;* more and more clear the truth that Chris-

* For Huc and Gabet, see Souvenirs d'un Voyage dans la Tartarie, le Thibet, la Chine, English translation by Hazlitt, London, 1851; also supplementary work by Huc. For Bishop Bigandet, see his Life of Buddha, *passim*. As authority for the fact that his book was condemned at Rome and his own promotion prevented, the present writer has the bishop's own statement. For notices of similarities between Buddhist and Christian institutions, ritual, etc., see Rhys Davids's Buddhism, London, 1894, *passim*; also Lillie, Buddhism and Christianity—especially chaps. ii and xi. It is somewhat difficult to understand how a scholar so eminent as Mr. Rhys Davids should have allowed the Society for Promoting Christian Knowledge, which published his book, to eliminate all the interesting details regarding the birth of Buddha, and to give so fully everything that seemed to tell against the Roman Catholic Church; cf. p. 27 with p. 246 *et seq.* For more thorough presentation of the development of features in Buddhism and Brahmanism which anticipate those of Christianity, see Schroeder, Indiens Literatur und Cultur, Leipsic, 1887, especially Vorlesung xxvii and following. For full details of the canonization of Buddha under the name of St. Josaphat, see Fausböll, Buddhist Birth Stories, translated by Rhys Davids, London, 1880, pp. xxxvi and following; also Prof. Max Müller in the Contemporary Review for July, 1890; also the article Barlaam and Josaphat, in ninth edition of the Encyclopædia Britannica. For the more recent and full accounts, correcting some minor details in the foregoing authorities, see Kuhn, Barlaam und Joasaph, Munich, 1893, especially pp. 82, 83; also Zotenberg, cited by Gaston Paris in the Revue de Paris for June, 1895. For the transliteration between the appellation of Buddha and the name of the saint, see Fausböll and Sayce as above, p. xxxvii, note; and for the multitude of translations of the work ascribed to St. John of Damascus, see Table III on p. xcv. The reader who is curious to trace up a multitude of the myths and legends of early Hebrew and Christian mythology to their more eastern and southern sources can do so in Bible Myths, New York, 1883. The present writer gladly avails himself of the opportunity to thank the learned Director of the National Library at Palermo, Monsignor Marzo, for his kindness in showing him the very interesting church of San Giosafat in that city; and to the custodians of the church for their readiness to allow photographs of the saint to be taken. The writer's visit was made in April, 1895, and copies of the photographs may be seen in the library of Cornell University. As to the more rare editions of Barlaam and Josaphat, a copy of the Icelandic translation is to be seen in the remarkable collection of Prof. Willard Fiske, at Florence.

tianity, as a great fact in man's history, is not dependent for its life upon any parasitic growths of myth and legend, no matter how beautiful they may be.

No less important was the closer research into the New Testament during the latter part of the nineteenth century. This work has already been touched upon, but a few of the main truths which it brought before the world may be here summarized.

By the new race of Christian scholars it has been clearly shown that the first three Gospels, which, down to the close of the last century, were so constantly declared to be three independent testimonies agreeing as to the events recorded, are neither independent of each other nor in that sort of agreement which was formerly asserted. All biblical scholars of any standing, even the most conservative, have come to admit that all three took their rise in the same original sources, growing by the accretions sure to come as time went on—accretions sometimes useful and often beautiful, but in no inconsiderable degree ideas and even narratives inherited from older religions; it is also fully acknowledged that to this growth process are due certain contradictions which can not otherwise be explained. As to the fourth Gospel, exquisitely beautiful as large portions of it are, there has been growing steadily and irresistibly the conviction, even among the most devout scholars, that it represents an infusion of Greek conceptions into Hebraism, and that its final form is mainly due to some gifted representative or representatives of the Alexandrian school. Bitter as the resistance to this view has been, it has during the last years of the nineteenth century won its way more and more to acknowledgment. A careful examination made in 1893 by a competent Christian scholar showed facts which are best given in his own words, as follows: "In the period of thirty years ending in 1860, of the fifty great authorities in this line, *four to one* were in favor of the Johannine authorship. Of those who in that period had advocated this traditional position one quarter—and certainly the very greatest—finally changed their position to the side of a late date and non-Johannine authorship. Of those who have come into this field of scholarship since about 1860, some forty men of the first class, two thirds reject the traditional theory wholly or very largely. Of those who have contributed impor-

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As to the influence of these translations, it may be noted that, when young John Kuncewicz, afterward a Polish archbishop, became a monk, he took the name of the sainted Prince Josafat; and, having fallen a victim to one of the innumerable murderous affrays of the seventeenth century between Greek and Roman Christians in Poland, he also was finally canonized under that name, evidently as a means of annoying the Russian Government. (See Contieri, Vita di S. Giosafat, Arcivescovo e Martira Ruteno, Roma, 1867.)

tant articles to the discussion from about 1880 to 1890, about *two to one* reject the Johannine authorship of the Gospel in its present shape; that is to say, while forty years ago great scholars were *four to one in favor of*, they are now *two to one against*, the claim that the apostle John wrote this gospel as we have it. Again, one half of those on the conservative side to-day—scholars like Weiss, Beyschlag, Sanday, and Reynolds—admit the existence of a dogmatic intent and an ideal element in this Gospel, so that we do not have Jesus's thought in his exact words, but only in substance." *

In 1881 came an event of great importance as regards the development of a more frank and open dealing with scriptural criticism. In that year appeared the Revised Version of the New Testament. It was exceedingly cautious and conservative; but it had the vast merit of being absolutely conscientious. One thing showed, in a striking way, ethical progress in theological methods. Although all but one of the English revisers represented Trinitarian bodies, they rejected the two great proof texts which had so long been accounted essential bulwarks of Trinitarian doctrine. Thus disappeared at last from the Epistle of St. John the text of the Three Witnesses, which had for centuries held its place in spite of its absence from all the earlier important manuscripts, and of its rejection in later times by Erasmus, Luther, Isaac Newton, Porson, and a long line of the greatest biblical scholars. And with this was thrown out the other like unto it in spurious origin and zealous intent, that interpolation of the word "God" in the sixteenth verse of the third chapter of the First Epistle to Timothy which had for ages served as a warrant for condemning some of the noblest of Christians, even such men as Newton and Milton and Locke and Priestley and Channing.

Indeed, so honest were the revisers that they substituted the correct reading of Luke, ii, 33, in place of the time-honored corruption in the King James version which had been thought necessary to safeguard the dogma of the virgin birth of Jesus of Nazareth. Thus came the true reading, "*His father* and his mother," instead of the old piously fraudulent words "*Joseph* and his mother."

An even more important service to the new and better growth of Christianity was the virtual setting aside of the last twelve

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* For the citations given regarding the development of thought in relation to the fourth Gospel, see Crooker, The New Bible and its Uses, Boston, 1893, pp. 29, 30. For a very careful and candid summary of the reasons which are gradually leading the more eminent among the newer scholars to give up the Johannine authorship of the fourth Gospel, see Schürer, in the Contemporary Review for September, 1891.

verses of the Gospel according to St. Mark. For among these stood that sentence which has cost the world more innocent blood than any other—the words "He that believeth not shall be damned." From this source had logically grown the idea that the intellectual rejection of this or that dogma which dominant opinion had happened at any given time to pronounce essential, since such rejection must bring punishment infinite in agony and duration, is a crime to be prevented at any cost of finite cruelty. Still another service rendered to humanity by the revisers was in substituting a new and correct rendering for the old reading of the famous text regarding the inspiration of Scripture, which had for ages done so much to make our sacred books a fetich. By this more correct reading the revisers gave a new charter to liberty in biblical research.*

Most valuable, too, have been studies during the latter part of the nineteenth century upon the formation of the canon of Scripture. The result of these has been to substitute something far better for that conception of our biblical literature, as forming one book handed out of the clouds by the Almighty, which had been so long practically the accepted view among probably the majority of Christians. Reverent scholars have demonstrated our sacred literature to be a growth in obedience to simple laws natural and historical; they have shown how some books of the Old Testament were accepted as sacred, centuries before our era, and how others gradually gained sanctity, in some cases only acquiring it long after the establishment of the Christian Church. The same slow growth has also been shown in the New Testament canon. It has been demonstrated that the selection of the books composing it was a gradual process, and indeed that the rejection

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* The texts referred to as most beneficially changed by the revisers, are I John, v, 7; I Timothy, iii, 16.

Though the revisers thought it better not to suppress altogether the last twelve verses of St. Mark's Gospel, they softened the word "damned" to "condemned," and separated them from the main Gospel, adding a note stating that "the two oldest Greek manuscripts, and some other authorities, omit from verse nine to the end"; and that "some other authorities have a different ending to this Gospel."

The resistance of staunch high churchmen of the older type even to so mild a reform as the first change above noted may be exemplified by a story told of Philpotts, Bishop of Exeter, about the middle of the nineteenth century. A kindly clergyman reading the invitation to the holy communion, and thinking that so affectionate a call was disfigured by the harsh phrase "eateth and drinketh to his own damnation," ventured timidly to substitute the word "condemnation." Thereupon the bishop, who was kneeling with the rest of the congregation, threw up his head and roared "*damnation!*" The story is given in T. A. Trollope's What I Remember, vol. i, p. 444. American churchmen may well rejoice that the fathers of the American branch of the Anglican Church were wise enough and Christian enough to omit from their prayer book this damnatory clause, as well as the Commination Service and the Athanasian Creed.

of some books and the acceptance of others was accidental, if anything is accidental.

So, too, scientific biblical research has, as we have seen, been obliged to admit the existence of much mythical and legendary matter, as a setting for the great truths, not only of the Old Testament but of the New. It has also shown, by the comparative study of literatures, the process by which some books were compiled and recompiled, adorned with beautiful utterances, strengthened or weakened by interpolations expressing the views of the possessors or transcribers, and assigned to personages who could not possibly have written them. The showing forth of these things has greatly weakened that sway of mere dogma which has so obscured the simple teachings of Christ himself; for it has shown that the more we know of our sacred books, the less certain we become as to the authenticity of proof texts, and it has disengaged more and more, as the only valuable residuum, like the mass of gold at the bottom of the crucible, the personality and general teaching and ideals of the blessed Founder of Christianity. More and more, too, the new scholarship has developed the conception of the New Testament as, like the Old, the growth of literature in obedience to a divine law—a conception which in all probability will give it its strongest hold on the coming centuries. In making this revelation Christian scholarship has by no means done work mainly destructive. It has, indeed, swept away a mass of noxious growths, but it has at the same time cleared the ground for a better growth of Christianity—a growth through which already pulsates the current of a nobler life. It has forever destroyed the contention of scholars like those of the eighteenth century, who saw, in the multitude of irreconcilable discrepancies between various biblical statements, merely evidences of priestcraft and intentional fraud. The new scholarship has shown that even such absolute contradictions as that between the date assigned for the crucifixion in the first three Gospels and that given in the fourth, and other discrepancies hardly less serious, do not affect the historical character of the essential part of the narrative. Even the hopelessly conflicting genealogies of the Saviour and the evidently mythical accretions about the simple facts of his birth and life are thus full of interest when taken as a natural literary development.*

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* Among the newer English works on the canon of Scripture, especially as regards the Old Testament, see Ryle in work cited. As to the evidences of frequent mutilations of the New Testament text, as well as of frequent charge of changing texts made against each other by early Christian writers, see Reuss, History of the New Testament, vol. ii, § 362. For a reverent and honest treatment of some of the discrepancies and contradictions which are absolutely irreconcilable, see Crooker, as above; also Matthew Arnold, Literature and Dogma.

Among those who have wrought most effectively to bring the leaders of thought in the English-speaking nations to this higher conception, Matthew Arnold should not be forgotten. By poetic insight, broad scholarship, pungent statement, pithy argument, and an exquisitely lucid style, he aided effectually during the latter half of the nineteenth century in bringing the work of specialists to bear upon the general development of a broader and deeper view. In the light of his genius a conception of our sacred books at the same time more literary as well as more scientific has grown widely and vigorously, while the older view which made of them a fetich and support for unchristian dogmas has been more and more thrown into the background. The contributions to these results by the most eminent professors at the great Christian universities of the English-speaking world, Oxford and Cambridge taking the lead, are most hopeful signs of a new epoch. Very significant, also, is a change in the style of argument against the scientific view. Leading supporters of the older opinions see more and more clearly the worthlessness of rhetoric against ascertained fact: mere dogged resistance to cogent argument evidently avails less and less, and the readiness of the more prominent representatives of the older thought to consider opposing arguments, and to acknowledge any force they may have, is certainly of good omen. The concessions made in Lux Mundi regarding scriptural myths and legends have been already mentioned.

Typical, also, among the evidences of a better spirit in controversy has been the treatment of the question regarding mistaken quotations from the Old Testament in the New, and especially regarding quotations by Christ himself. For a time this was apparently the most difficult of all matters dividing the two forces; but, though here and there appear champions of tradition, like the Bishop of Gloucester, effectual resistance to the new view has virtually ceased; in one way or another the most conservative authorities have accepted the undoubted truth revealed by a simple scientific method. Their arguments have indeed been varied. While some have fallen back upon Le Clerc's contention that "Christ did not come to teach criticism to the Jews," and others upon Paley's argument that the Master shaped his statements in accordance with the ideas of his time, others have taken refuge in scholastic statements—among them that of Irenæus regarding "a quiescence of the divine word," or the somewhat startling explanation by sundry recent theologians that "our Lord emptied himself of his Godhead." *

* For Matthew Arnold, see especially his Literature and Dogma and his St. Paul and Protestantism. As to the quotations in the New Testament from the Old, see Toy, Quota-

But for all this dissolving away of the traditional opinions regarding our sacred literature, there has been a cause far more general and powerful than any which has been given, for it is a cause surrounding and permeating all. This is simply the atmosphere of thought engendered by the development of all sciences during the last three centuries.

Vast masses of myth, legend, marvel, and dogmatic assertion, coming into this atmosphere, have been dissolved and are now dissolving quietly away like icebergs drifted into the Gulf Stream. In earlier days, when some critic in advance of his time insisted that Moses could not have written an account embracing the circumstances of his own death, it was sufficient to answer that Moses was a prophet; if attention was called to the fact that the great early prophets, by all which they did and did not do, showed that there could not have existed in their time any "Levitical code," a sufficient answer was "mystery"; and if the discrepancy was noted between the two accounts of creation in Genesis, or between the genealogies or the dates of the crucifixion in the Gospels, the cogent reply was "infidelity." But the thinking world has at last been borne by the general development of a scientific atmosphere beyond that kind of refutation.

If, in the atmosphere generated by the earlier developed sciences, the older growths of biblical interpretation have drooped and withered and are evidently perishing, new and better growths with roots running down into the newer sciences have arisen. Comparative mythology and folklore, comparative religion and literature, by searching out and laying side by side the main facts in the upward struggle of humanity in various old seats of civilization, are giving a new interpretation of these great problems which dogmatic theology has long labored in vain to solve. Thus, while they have established the fact that accounts formerly supposed to be special revelations to Jews and Christians are but repetitions of widespread legends dating from far earlier civilizations, and that beliefs formerly thought fundamental to Judaism and Christianity are simply based on ancient myths, they have also begun to impress upon the intellect and conscience of the thinking world the fact that the

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tions in the New Testament, 1889, p. 72; also Kuenen, The Prophets and Prophecy in Israel. For Le Clerc's mode of dealing with the argument regarding quotations from the Old Testament in the New, see earlier parts of the present chapter. For Paley's mode, see his Evidences, Part III, chapter iii. For the more scholastic expressions from Irenæus and others, see Gore, Bampton Lectures, 1891, especially note on p. 267. For a striking passage on the general subject, see B. W. Bacon, Genesis of Genesis, p. 33, ending with the words, "We must decline to stake the authority of Jesus Christ on a question of literary criticism."

religious and moral truths thus disengaged from the old masses of myth and legend are all the more beautiful and serviceable, and that all individual or national life of any value must be vitalized by them.*

Nor should there be omitted a tribute to the increasing justice and courtesy shown in late years by leading supporters of the older view. During the last two decades of the present century there has been a most happy departure from the older method of resistance, first by plausibilities, next by epithets, and finally by persecution. To the bitterness of the attacks upon Darwin, the Essayists and Reviewers, and Bishop Colenso, have succeeded, among really eminent leaders, a far better method and tone. While Matthew Arnold, no doubt, did much in commending "sweet reasonableness" to theological controversialists, Mr. Gladstone, by his perfect courtesy to his opponents, even when smarting under their heaviest blows, has set a most valuable example. Nor should the spirit shown by Bishop Ellicott, leading a forlorn hope for the traditional view, pass without a tribute of respect. Truly pathetic is it to see this venerable and learned prelate, one of the most eminent representatives of the older biblical research, even when giving solemn warnings against the newer criticisms, and under all the temptations of *ex cathedra* utterance, remaining mild and gentle and just in the treatment of adversaries whose ideas he evidently abhors. Happily, he is comforted by the faith that Christianity will survive; and this faith his opponents fully share.†

Thus at last, out of the old conception of our Bible as a collection of oracles—a mass of entangling utterances, fruitful in wrangling interpretations, which have given to the world long and weary ages of "hatred, malice, and all uncharitableness," of fetichism, subtlety, and pomp, of tyranny, bloodshed, and solemnly constituted imposture, of everything which the Lord Jesus Christ most abhorred—has been gradually developed through the centuries, by the labors, sacrifices, and even the martyrdom of a long succession of men of God, the conception of it as a sacred literature, a growth in obedience to divine light in the mind and heart and soul of man. No longer an oracle, good for the "lower

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* For plaintive lamentations over the influence of this atmosphere of scientific thought upon the most eminent contemporary Christian scholars, see the Christus Comprobator, by the Bishop of Gloucester and Bristol, London, 1893, and the article in the Contemporary Review for May, 1892, by the Bishop of Colchester, *passim*. For some less known examples of sacred myths and legends, inherited from ancient civilizations, see Lenormant, Les Origines de l'Histoire, *passim*, but especially chapters ii, iv, v, vi. See also Goldziher.

† As examples of courtesy between theologic opponents may be cited the controversy between Mr. Gladstone and Prof. Huxley, Principal Gore's Bampton Lectures for 1891, and Bishop Ellicott's Charges, published in 1893.

orders" to accept, but to be quietly sneered at by "the enlightened"—no longer a fetich, whose defenders must become persecutors or "apologists," but a most fruitful fact, which religion and science may accept as a source of strength to both.*

PROFESSIONAL INSTITUTIONS.

VI.—MAN OF SCIENCE AND PHILOSOPHER.

By HERBERT SPENCER.

CLEAR as are the connections between the priesthood and the several professions thus far treated of, the connection between it and the professions which have enlightenment as their function is even clearer. Antagonistic as the offspring now are to the parent they were originally nurtured by it.

We saw that the medicine-man, ever striving to maintain and increase his influence over those around, is stimulated more than others to obtain such knowledge of natural phenomena as may aid him in his efforts.

Moreover, when seeking to propitiate the supernatural beings he believes in, he is led to think about their characters and their doings. He speculates as to the causes of the striking things he observes in the Heavens and on the Earth; and whether he regards these causes as personal or impersonal, the subject-matter of his thought is the subject-matter which, in later times, is distinguished as philosophical—the relations between that which we perceive and that which lies beyond perception.

As was said at the outset, a further reason why he becomes distinguished from men around by his wider information and deeper insight is that he is, as compared with them, a man of leisure. From the beginning he lives on the contributions of others; and therefore he is better able to devote himself to those observations and inquiries out of which science originates.

Save some knowledge of medicinal herbs and special animal

* To the fact that the suppression of personal convictions among "the enlightened" did not cease with the Medicean Popes there are many testimonies. One especially curious was mentioned to the present writer by a most honored diplomatist and scholar at Rome. While this gentleman was looking over the books of an eminent cardinal, recently deceased, he noticed a series of octavos bearing on their backs the title Acta Apostolorum. Surprised at such an extension of the Acts of the Apostles, he opened a volume and found the series to be the works of Voltaire. As to a similar condition of things in the Church of England may be cited the following from Froude's Erasmus: "I knew various persons of high reputation a few years ago who thought at bottom very much as Bishop Colenso thought, who, nevertheless, turned and rent him to clear their own reputations—which they did not succeed in doing." See work cited, close of Lecture XI.

products, with perhaps a little information about minerals, often joined with such observations of weather-signs as enables them to foresee coming changes, and so, apparently, to bring rain or sunshine, there is little to be named as rudimentary science among the medicine-men, or quasi-priests, of savages. Only when there has arisen that settled life which yields facilities for investigation and for transmitting the knowledge gained, can we expect priests to display a character approaching to the scientific. Hence we may pass at once to early civilizations.

Evidence from the books of Ancient India may first be set down. Demonstration is yielded by it that science was originally a part of religion. Both astronomy and medicine, says Weber, "received their first impulse from the exigencies of religious worship." More specific, as well as wider, is the following statement of Dr. Thibaut:—

"The want of some rule by which to fix the right time for the sacrifices gave the first impulse to astronomical observations; urged by this want the priest remained watching night after night the advance of the moon. . . . and day after day the alternate progress of the sun toward the north and the south. The laws of phonetics were investigated because the wrath of the gods followed the wrong pronunciation of a single letter of the sacrificial formulas; grammar and etymology had the task of securing the right understanding of the holy texts."

Further, according to Dutt, "geometry was developed in India from the rules for the construction of altars." A sentence from the same writer implies that there presently arose a differentiation of the learned class from the ceremonial class.

"Astronomy had now come to be regarded as a distinct science, and astronomers by profession were called Nakshatra, Darsa, and Ganaka . . . sacrificial rites were regulated by the position of the moon in reference to these lunar asterisms."

So, too, we have proof that philosophy, originally forming a part of the indefinite body of knowledge possessed by the priesthood, eventually developed independently. Hunter writes:—

"The Bráhmans, therefore, treated philosophy as a branch of religion. . . . Bráhman philosophy exhausted the possible solutions . . . of most of the other great problems which have since perplexed Greek and Roman sage, mediæval schoolman, and modern man of science."

And in this, as in other cases, the speculative and critical activity presently led to rationalism. There came "a time when philosophers and laymen were alike drifting toward agnostic and heterodox opinions."

Concerning the relations of science to theology among the Babylonians and Assyrians, current statements almost suffice for the purpose of the argument. A few facts in illustration must, however, be given. All the astronomical knowledge of the Babylonians had as its ends the regulation of religious worship, the preparation of charms, the prediction of events. Here are extracts from Rawlinson, Layard, and Maury showing how religion and science were mingled.

"We are, perhaps, justified in concluding, from the careful emplacement of Urukh's temples, that the science of astronomy was already cultivated in his reign, and was regarded as having a certain connection with religion."

"At a very early period the Assyrian priests were able to fix the date of events by celestial phenomena, and to connect the public records with them."

The familiar fact that the cycle of lunar eclipses was discovered by the Chaldean priests, shows how exact and how long-continued were their observations.

"Comparative philology seems to have been largely studied, and the works upon it exhibit great care and diligence. Chronology is evidently much valued, and very exact records are kept whereby the lapse of time can even now be accurately measured. Geography and history have each an important place in Assyrian learning; while astronomy and mythology occupy at least as great a share of attention."

Les Chaldéens avaient "une caste sacerdotale et savante qui se consacra à l'observation du ciel, en vue de pénétrer davantage dans la connaissance des dieux. . . . De la sorte, les temples devinrent de véritables observatoires: telle était la célèbre tour de Babylone, monument consacré aux sept planètes."

Of testimonies concerning science in Egypt, we may fitly begin with one from Maspero, which contrasts Egyptian views with the views of the Assyrians.

"In Egypt the majority of the books relating to science are sacred works composed and revealed by the gods themselves. The Assyrians do not attribute such a lofty origin to the works which teach them the courses and explain the influences of the stars: they believe them to have been written by learned men, who lived at different epochs, and who acquired their knowledge from direct observation of the heavens."

Basing his account on the statements of various ancient writers, Sir G. C. Lewis says of the Egyptian priesthood that—

"they were relieved from toil, and had leisure for scientific study and meditation; and that from a remote period they habitually observed the stars, recorded their observations, and cultivated scientific astronomy and geometry. The Egyptian priests are moreover related to have kept registers, in which they entered notices of remarkable natural phenomena." (Strab. xvii, 1. § 5.)

Similar is the description of the actions and achievements of the Egyptian priests given by Diodorus:—

They "are diligent observers of the course and motions of the stars; and preserve remarks of every one of them for an incredible number of years, being used to this study, and to endeavor to outvie one another therein, from the most ancient times. They have with great cost and care, observed the motions of the planets; their periodical motions, and their stated stops."

How intimate was the connection between their science and their religion is proved by the fact that "in every temple there was . . . an astronomer who had to observe the heavens;" and how their science was an outgrowth of their religion is shown by the remark of Duncker, that their writings, at first containing traditional invocations of the gods and ceremonial rules, "grew into a liturgical canon and ecclesiastical codex of religious and moral law, and a comprehensive collection of all the wisdom known to the priests." But, as is remarked by Bunsen, "the Egyptians never arrived at a systematic dialectically-conducted philosophy"—a fact of much significance; for I may remark in passing that among oriental peoples at large, and other peoples long habituated to despotic control, thinking and teaching are entirely dogmatic: absolute authority characterizes at once external government and internal government. It is only on passing to partially-free societies that we meet with appeals to individual judgments—a giving of reasons for beliefs.

Apparently because Greece was a congeries of independent states often at variance with one another, and because these states had their respective religious worships akin but not identical, there never arose in Greece a priestly hierarchy; and apparently the lack of one impeded some of the professional developments. Partly, perhaps, for this reason, but chiefly for the reason that scientific progress in Egypt and Assyria preceded Greek civilization, science in as lightly developed state was imported. Sir G. C. Lewis repeats the testimonies of sundry ancient authors to the effect that the Egyptian priests—

"regarded their astronomical science as an esoteric and mysterious doctrine, and that they disclosed it to curious strangers with reluctance (Strab. xvii. 1. § 29). . . . Similar statements are made with respect to Assyrian astronomy (Plat. Epinom. § 7, p. 987). This derivation does not rest merely on general declarations, but it is fortified by detailed accounts of visits of Greek philosophers to Egypt, to Assyria, and to other oriental countries, made for the purpose of profiting by the lessons of the native priests and sages." Thus Thales, Pherecydes of Syros, Pythageras, Democritus, Œnopides of Chios, Eudoxus, Solon, Anaxagoras, Plato are said to have visited Egypt, and to have received instruction from the priests.

And from his work may be added this further passage:—"Aristotle . . . says that mathematical science originated in Egypt, on account of the leisure which the priests enjoyed for contemplation." Respecting which statement may be interposed the remark that whether the name "geometry" was a translation of the Egyptian equivalent word or was independently originated, we equally see, in the first place, that this concrete half of mathematics germinated from the practical needs for measuring out the Earth's surface, and we see, in the second place, that since temples (which served also as king's palaces) were in early times the sole permanent and finished buildings (the rest being of wood or of sun-dried clay) it is inferable that this great division of science, first employed in the orientation and laying out of them, took its earliest steps in the service of religion. Returning now from this parenthesis to the subject of Greek science, we find that development of it can be but in very small measure ascribed to the priesthood. From Curtius we learn that "the localities of the oracles became places where knowledge of various kinds was collected, such as could not be met with elsewhere," and that "the Greek calendar fell under the superintendence of Delphi," and also that "the art of road-making and of building bridges took its first origin from the national sanctuaries, especially from those of Apollo:" some culture of science being thus implied. But, practically, the scientific advances made by the Greeks were not of sacred but of secular origin. So, too, was it with their philosophy. Though Mahaffy thinks "we have no reason to doubt the fact that philosophers were called in professionally to minister in cases of grief," and though in ministering they assumed a function characteristic of priests, yet we can not assume that they acted in a religious capacity. Evidently in the main their speculations took their departure not from theological dogmas but from the facts which scientific observation had elsewhere established. Before there was time for an indigenous development of science and philosophy out of priestly culture, there was an intrusion of that science and philosophy which priestly culture had developed elsewhere.

The normal course of evolution having been in Rome, still more than in Greece, interrupted by intruding elements, an unbroken genealogy of science and philosophy is still less to be looked for. But it seems as though the naturalness of the connection between priestly culture and scientific knowledge led to a re-genesis of it. Mommsen, after stating that there were originally only two "colleges of sacred lore"—the augurs and the pontifices, says:—

"The five 'bridge-builders' (pontifices) derived their name from their function, as sacred as it was politically important, of conducting the building and demolition of the bridge over the Tiber. They were the Roman engineers who understood the mystery of measures and numbers; whence there devolved upon them also the duties of managing the Calendar of the State, of proclaiming to the people the time of the new and full moon and the days of festivals, and of seeing that every religious and every judicial act took place on the right day . . . thus they acquired . . . the general oversight of Roman worship and of whatever was connected with it—and what was there that was not so connected? . . . In fact the rudiments of spiritual and temporal jurisprudence as well as of historical composition proceeded from this college."

A curious parallel, not unsuggestive, is thus displayed. As in Greece the art of bridge-building arose in connection with the national sanctuaries, and as in Rome the building of bridges was the function of a priestly college, the implication appears to be that since in those days building a bridge was one of the most difficult of undertakings, it naturally fell into the hands of those who were reputed to have the greatest knowledge and skill—the priests. And, probably, the connection between the priesthood and this piece of applied science was furthered by the apparent supernaturalness of the arch—a structure which must have seemed to the people incomprehensible. But alike in science and in philosophy, the Romans were the pupils of the Greeks; and hence possibly may have arisen the parallelism between a certain function of the philosopher in Greece and one he exercised in Rome.

> The philosopher "was generally to be found in a large mansion acting almost like a private chaplain, instructing in ethics those who wished to learn, and attending the death-beds of members of the family."

Most likely, the ethics and the consolations here indicated were more or less tinged with ideas theologically derived; but even if not, the function described appears semi-priestly.

During those dark days which followed the fall of the Roman Empire, nothing to be called science existed. But when, along with gradual reorganization, the re-genesis of science began, it began as in earlier instances among the cultured men—the priesthood. It was not, indeed, a re-genesis *de novo*, but one which took its departure from the knowledge, the ideas, and the methods, bequeathed by the older civilizations. From these, long buried, it was resuscitated, almost exclusively in the monasteries. In his *Science and Literature in the Middle Ages* Lacroix writes:—

> "At the death of Charlemagne, the exact sciences, which had flourished for a brief space at his court, seemed to shrink into the seclusion of the monasteries. . . . The order of St. Benedict had almost made a monopoly of the exact sciences, which were held in high honor at the Abbeys of Mount Cassini, in Italy; of St. Martin, at Tours (France); of St. Arnulph, at Metz; of St. Gall, in Switzerland; of Prum, in Bavaria; of Canterbury, in England, etc."

A significant parallelism has here to be noted. We saw that in India, in Assyria, and in Egypt, the earliest steps in science were made in subservience to religious needs: their primary purpose was to regulate the times of religious sacrifices so as to avoid offense to the gods. And now, strange to say, mediæval records show that among Christian peoples science was first called in for fixing the date of Easter.

How on the Continent was illustrated the monopoly of science and philosophy by the priesthood in early days, scarcely needs pointing out. Such philosophical dogmas as were current during the ages of darkness were supplementary to the current theological dogmas and in subordination to them. When, in the time of Charlemagne, some intellectual life began, it was initiated by the establishment of schools in connection with all abbeys throughout his dominions. These schools, carried on under priestly rule, eventually became the centers at once of philosophy and science: the philosophy distinguished as scholasticism being of such kind as consisted with the authorized theology, and the science—geometry, arithmetic, astronomy, and music—being such as did not obviously conflict with it or could be conformed to it. That is to say, alike in their nature and in their agency, the philosophy and science of the time diverged in a relatively small degree from the theology—the differentiation was but incipient. And the long continued identification of the cultivators of philosophy and science with the cultivators of theology is seen in the familiar names of the leading scholastics—William of Champeaux, Abelard, Albertus Magnus, Thomas Aquinas, etc. To which may be added the notable fact that such independence of theological dogma as was thought to be implied in the doctrine of the Nominalists, was condemned alike by the Pope and by secondary ecclesiastical authorities—the differentiation was slowly effected under resistance.

In England there was a no less clear identity of the priest with the philosopher and the man of science. In his account of the Saxon clergy Kemble writes:—

"They were honorably distinguished by the possession of arts and learning, which could be found in no other class. . . . To them England owed the more accurate calculations which enabled the divisions of times and seasons to be duly settled."

The first illustration is furnished by Bede, a monk who, besides works of other kinds, wrote a work on *The Nature of Things*, in which the scientific knowledge of his day was gathered up. Next may be named Dicuil, an Irish monk and writer on geography. And then comes Archbishop Dunstan:—

He "was very well skilled in most of the liberal arts, and among the rest in refining metals and forging them; which being qualifications much above the genius of the age he lived in, first gained him the name of a conjurer, and then of a saint."

Though, soon after the Conquest, there lived two cultivators of science who seem not to have been clerical—Gerland and Athelard of Bath—yet it is to be remarked of the first that his science was devoted to a religious purpose—making a *Computus* or calculation of Easter,—and of the other that his scientific knowledge was acquired during travels in the East, and can not be regarded as an indigenous development. In Richard the First's time flourished Abbot Neckham, who wrote a scientific treatise in Latin verse, and the Bishop-elect Giraldus Cambrensis, who was a topographer. Under John we have Bishop Grosseteste, a writer on physical science, and in the next reign comes the Franciscan monk Roger Bacon, whose scientific reputation is familiar. The 15th century yields us among clerical men of science John Lydgate, chiefly known for his poetry. When we turn back to see who were the first to occupy themselves with the science of the sciences—philosophy—we perceive this same connection. In the old English period lived Scotus Erigena, a philosophical ecclesiastic whose philosophy was theological in its bearings. After a long interval, the next of this class was prior Henry of Huntingdon, who, as a moralist, brought other incentives than divine commands to bear on conduct. Presently came Bishop John of Salisbury, who, besides being classed as a writer on morality, was more distinctly to be classed as a writer on ancient philosophy. Grosseteste to his physical philosophy added mental philosophy, as also did Roger Bacon.

Joined with the fact that in mediæval days scarcely any laymen are named as devoted to studies of these kinds, the facts above given suffice to show that in Christian Europe, as in the pagan East, the man of science and the philosopher were of priestly origin. Inductive proof seems needless when we remember that during pre-feudal and feudal days, war and the chase were thought by the ruling classes the only honorable occupations. Themselves unable to read and write, they held that learning should be left to the children of mean people. And since learning was inaccessible to the masses, it becomes a necessary implication that the clerical class was the one to which mental culture of all kinds, inclusive of the scientific and philosophical kinds, was limited.

To trace the stages by which has been gradually effected the differentiation of the scientifico-philosophical class from the clerical class is not here requisite. It will suffice to note the leading characters of the change, and the state now reached.

The first broad fact to be observed is that the great body of doctrine distinguished by being based on reason instead of authority, has divided into a concrete part and an abstract part; with the result of generating two different classes of cultivators—the man of science and the philosopher. In the ancient East the distinction between the two was vague. Among the Greeks, from Thales onward, the thinker was one who studied physical facts and drew his general conceptions from them. Even on coming to Aristotle we see in the same man the union of scientific inquiry and philosophical speculation. So all through the development of knowledge in Europe, down to the time of Newton, when the use of the term "natural philosophy" for physical science implies an indefinite distinction between the two. But now the distinction has become tolerably definite—quite definite in Germany and in large measure definite here. The philosopher does not enter upon scientific investigations and often knows little about scientific truths; while, conversely, the man of science, of whatever class, is little given to philosophical speculation, and is commonly uninformed about the philosophical conclusions held by this or that school. How distinct the two classes have become is implied by the contempt not unfrequently expressed by each for the other.

Simultaneously there has progressed a separation within the body of scientific men into those who respectively deal with the inorganic and the organic. Nowadays, men who occupy themselves with mathematical, physical and chemical investigations are generally ignorant of biology; while men who spend their lives in studying the phenomena of life, under one or other of its aspects, are often without interest in the truths constituting the exact sciences. Between animate and inanimate things there is a marked contrast, and there has come to be a marked division between the students of the two groups.

Yet a further transformation of the same nature has been going on. Within each of these groups differentiations and sub-differentiations have been taking place. The biologists have divided themselves primarily into those who study plant-life and those who study animal-life—the phytologists (commonly called botanists) and the zoölogists. In each of these great divisions there have been established large sub-divisions: in the one those who devote themselves to the classification of species, those who treat of plant-morphology, those who treat of plant-physiology; and in the other the classifiers, the comparative anatomists, the animal-physiologists. More restricted specializations have arisen. Among botanists there are some who study almost exclusively this or that order; among physiologists, some who commonly take one class of function for their province, and among zoölogists there are first of all the divisions into those who are professed entomologists, ornithologists, ichthyologists, etc., and again within each of these are smaller groups, as among the entomologists, those who study more especially the coleoptera, the lepidoptera, the hymenoptera, etc.

Respecting these major and minor differentiations it has only further to be remarked that though the prosecution of science as a whole is not called a profession (the whole being too extensive and heterogeneous), yet the prosecution of this or that part of it has come to be thus distinguished. We have "professors" of various divisions and sub-divisions of it; and this implies that the bread-winning pursuit of science, irrespective of the particular kind, must be regarded as a profession.

The combinations of like units which have accompanied these separations of unlike units, are equally conspicuous. Those occupied in science as a whole, as well as those occupied in particular divisions of science, have everywhere tended to segregate themselves and consolidate.

On the Continent each nation has a scientific academy or equivalent body, and in some cases several such. In our own country we have, similarly, a fixed general union among scientific men—the Royal Society; in addition to which we have a nomadic general union—the British Association.

Then beyond these largest corporations including all kinds of scientific men, we have various smaller corporations, each comprised of those devoted to a particular branch or sub-branch of science—a Mathematical Society, a Physical Society, a Chemical Society, an Astronomical Society, a Geological Society, a Physiological Society; and others occupied with sub-divisions of Biology —Botany, Zoölogy, Anthropology, and Entomology: all of them being children of the Royal Society and in some measure aids to it. Nor let us forget that besides these metropolitan societies there are scattered throughout the kingdom local societies, devoted to science in general or to some division of science.

This is not all. Integration, general and special, of the scientific world is made closer, and the co-operation of all parts aided, by continuous publications: weekly and monthly and quarterly journals which are general in their scope, and others of like periodicities which are special in their scope. Thus minor aggregates held in connection as parts of a great aggregate have their activities furthered by literary inter-communication; and as elsewhere implied (see *Essays*, vol. i, "The Genesis of Science"), the vast organism thus constituted has acquired a power of digesting and assimilating the various classes of phenomena which no one part of it alone could effectually deal with.

How the style of house-building may be affected by the character of the neighborhood is illustrated by the observation of Captain H. Bowen, that while traveling in Turkistan, after crossing the Kotli-i Kandahar Pass, from the Tung River into the valley of the Wachi River, the houses bore evidence of the fear in which the inhabitants live of their neighbors on the south, the Kunjuts. Instead of scattered farmhouses, the traveler invariably found several houses joined together and presenting a fortlike appearance.

TROUT CULTURE.

By FRED MATHER.

IN the early days of fish culture, which for many years was only trout culture, the statement was often made that any farmer who had a small spring of cool water could, within a few years, realize enormous profits from it, and that an acre of water was worth more than an acre of land. Those of us who went into the business a quarter of a century ago found much to learn, and many dropped out discouraged. The writer bought a farm in Monroe County, New York, in 1868, and made ponds below a fine spring; and after some failures, due to ignorance—for there was then no literature of the subject—he began to succeed in raising many fish, only to find, after raising them, that they had cost more than they were worth, because there was no available food near, and it required a man to drive fourteen miles to the city of Rochester twice or more per week for food. To-day we know that something more than a good spring of cool water of about 50° F. is necessary, and also that some acres of water may be worth more than some land, but that so many local and other conditions enter into the calculation that, as a general statement, the comparison is not true. To-day there are several successful trout farms where the fish are raised for market at a profit, and in all of them there are large, never-failing springs of cool water and cheap food, as well as intelligent management. There are other important considerations in choosing the location of a trout farm, such as a proper amount of fall to the water in order to control it and give it aëration between the ponds and a formation that will allow all surface water to be led aside and not to enter the ponds. A sudden thaw with frozen ground may destroy the work of years, and in summer the surface water brings leaves and trash, which clog screens and either burst or overflow them.

The first thing to be considered is whether the trout farmer wishes to merely hatch his fish and turn them into a suitable lake or pond where they will find their own food and where he can take a few for sport and market, and perhaps let anglers fish it for a fixed sum, or whether he prefers to raise his fish by hand in small pools.

The first method is the simplest, involving the least care, but, if the conditions are favorable, not so profitable as the other. One is like keeping a few fowls that pick up what they can, and the other like poultry breeding, with this exception: poultry will not eat their young, while trout will devour their fellows which are smaller. A trout under a year old feeds mainly on insects and their larvæ in a state of nature, but a large trout of two pounds weight prefers something more substantial, like a yearling trout or two for breakfast and a few more at intervals, with flies and worms for dessert; and this cannibalism is what keeps the balance of life in a natural state. If, however, it is decided to follow the first-named system, it will only be necessary to provide spawning races for the adults and follow the rules for hatching the eggs, and either turn out the product as fry or as yearlings; the latter will give the best results where transportation is not needed, as in the work of the fish commissions of the different States.

Stripping a Small Trout.

Where it is desired to make a business of trout-raising a series of small ponds are necessary. After leaving the springs the water, in summer, is continually approaching the temperature of the air; and when it gets to 70° the danger line is reached. In swift water our brook trout have lived at five degrees above that point, but they suffered, and some have died, while others lived until the declining sun permitted the water to cool a trifle. This is a point that should be in mind when planning ponds, for it is of the greatest importance. A spring brook that will sustain many trout in a pond of half an acre might fail to keep a single one if the area was doubled. The surface and the shallows are warmer in summer than the deeper portions, and in the case of springs in the bottom of lakes or ponds the trout will gather about them in warm weather. In the pond system the ponds are so small that the fish can be seen at all times and their growth noted, so that those which have outstripped their fellows may be taken out and placed with others of the same size. This is practiced once a year with the larger fish and about three times during summer with the "babies," or those not yet arrived at the dignity of yearlings. Cannibalism is not only prevented by this, but the smaller ones will have a chance to get food at the first table, from which they have been debarred.

Perhaps a description of the ponds that I have made for the Fishery Commission of the State of New York at Cold Spring Harbor, Long Island, may best illustrate the idea of small ponds, first explaining that the object of the ponds is not only to grow trout, but to get the greatest amount of eggs for hatching in order to stock public waters with the different species of trout, such as our native brook trout, the brown trout, or common brook trout of Europe, and the rainbow trout of California. The trout for distribution are sent out when about ready to take food—in March and April. Those to be kept at the station for breeders are fed in the troughs for a month or more, and are then put in the "baby ponds." These are of two-inch yellow-pine sides and one-inch bottoms, twenty-five feet long, three feet wide, and about twenty inches deep, with a strong flow and double screens of No. 8 wire cloth, between which is a dam an inch higher than the pond below. In these ponds are "rests," made of projections from the sides or of dams, with a surface stop-water a few inches below them, which causes the water to flow up and over the dam, and is then again deflected below. This keeps weak fish from being swept against the screens, and makes eddies for the food to swirl about in, instead of sinking. Mr. Hoxsie has patented an ingenious device to

Trying the Big One without Help.

feed young fish in, and it is somewhat different from this plan which I used at Honeoye Falls, N. Y., in 1874 and since. Of these "baby ponds" we have ten, and, as we put ten thousand fry in each, we start in with only three of them stocked; but the little fellows have a way of getting around screens that are supposed to be tight, and before they are an inch and a half long some are found in the lower ponds, having gone through joints in the planks or sides or bottom, or around some loose screen, if not through a neglected worm hole or nail hole. Their persistence in getting out of the place where they are put is wonderful.

When the fish are about six months old, say in September, they are taken out of the baby ponds, assorted in three or four sizes, and put in the yearling ponds, where they remain until the following year, when the largest are sent to the breeding ponds. At the same time the water is lowered in all the ponds, and they are thoroughly swept out preparatory to the taking of spawn, and the fish are not again disturbed until spring. The breeding ponds are cleansed in this way in midsummer, but all are daily gone over with long-handled nets to remove the ordure and any un-

WHEN A LARGE TROUT STRUGGLES.

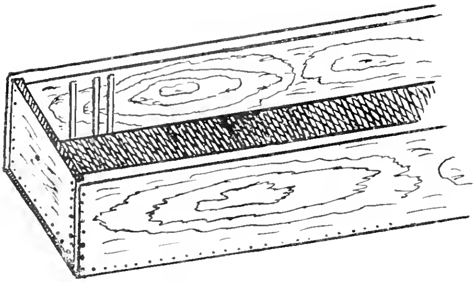
eaten food; the screens in the baby ponds are not taken out, but are cleaned with brooms or a scrubbing brush on a handle.

The breeding ponds are best if about sixty feet long, fifteen feet wide, and from two to three feet deep. In such a pond from one thousand to four thousand trout of half a pound may be kept if the flow is sufficient. If the supply of water is scant in summer, make the pond narrower or shallower, in order to give a quicker change to the fish.

Each breeding pond must have a spawning race at its head, and these are narrow and shallow, making an ideal place for a trout to deposit its precious burden. They are from twenty-five to fifty feet long, two to three feet wide, with water from five to ten inches deep. The bottom is covered with gravel of the size of a pigeon's egg, and the top with boards cleated together in convenient lengths to lift. Here are all the requisites of a nesting place—swift, shallow water, gravel, and shade, with its security from overhead enemies and light. If undisturbed, a pair of trout would whip a nest in the gravel and lay their eggs and retire after covering them, and the next pair would whip them out again in their efforts to perpetuate their species, and in a state of nature a horde of yearlings would follow the breeders to feast upon the eggs, for of all fish baits the eggs of trout and salmon are among the best. The spawning race is only to entice the trout to spawn there; a net on a frame sliding into grooves at the lower end is slipped in, the covers lifted, and the fish driven into the bag. They are then assorted. Those not ready to spawn to-day or later are thrown back into the pond, the ripe males are put into one tub and the ripe females in another, and to judge of this we note the swollen vent and the softness of the abdomen. This is the first test; the next is the ready flow of eggs.

Here it may be well to say, in nature not more than forty per per cent of the eggs are impregnated, owing to the failure of the milt to reach all the eggs. Of those that are impregnated fully one half are killed by the fungus that grows on the dead infertile eggs, and the remainder are subject to suffocation from freshets, depredations by young trout, eels, ducks, and other animals, as well as the sun, while in our so-called artificial propagation we get such a close contact of milt and eggs that the impregnation amounts to about ninety-five per cent, and there is no loss from sediment, fungus, enemies, nor direct sunlight. There is a loss of perhaps five per cent in deformed fish, such as crooked tails, double heads, twins with one umbilicus, and premature bursting of the shell, but we beat Nature in trout-hatching far more than we do in the breeding of any other animal, and the only comparison that seems fit is that of cultivating trees and plants, where we produce more than Nature can or does.

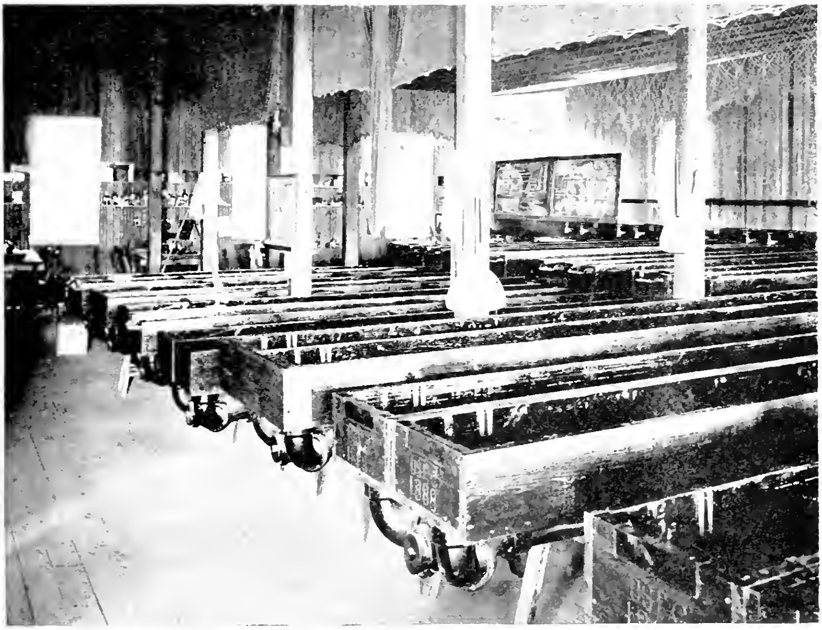
Our brook trout usually spawn from November to January on Long Island, in the early part of the day, while the lake trout, improperly called "salmon trout," spawn at night, thus preventing hybridization by means of drifting milt. About 8 A. M. we place a net at the foot of the spawning race and drive the fish that have run up for nesting into it. They are then put into tubs and assorted. The males are put together; the females that appear to be ripe are placed in other tubs, and those which are not near ripe are returned to the pond. A ripe male is known by its slim body and bright color; often his back will be buff, the sides scarlet, and the lower abdomen with a black stripe on each side. The ripe female is soft, and the vent is swollen and protruding. Unless the eggs flow at a light touch, it is better to return her to the pond, for eggs that have to be forced are not ripe, and if they can be fertilized make weak fish. For the manner of handling the fish, see illustrations from photographs. The so-called "dry method" is the best. A pan is wet and the water drained from it. The eggs of a female are taken by repeated strokes of the forefinger, if the trout is small, or by the hand if large. The eggs will be found to lie the full length of the body cavity, and the strokes begin near the vent and are then worked farther up toward the head. A bending of the back, as shown, often starts the eggs. This operation takes less time than it does to write it, and some water drips from the fish. A male is then stripped over the eggs and water enough to cover them is added, after which they are left to stand until they "free." The eggs are soft as they leave the fish, and for twenty minutes or more they absorb the milt and water, and while doing this they adhere to the pan, but become free when filled. They should not be disturbed until free, when they are washed by changing the water and then are placed on trays in the troughs. If an egg is not impregnated before it fills with water it never can be fertilized, and the advantage of this "dry method" over taking the eggs in a pan of water is that each egg is brought into contact with the milt, which suddenly becomes active when it comes in contact with water.



Lower End of Hatching Trough.

This work and all troughs should be in a building and protected from storms and sunshine, but hatching troughs have been successfully worked in the open air. Rats are fond of trout eggs, sediment will smother the embryo within the shell, and direct sunlight will kill it. In a hatching house a distributing trough should run the length of one side. If this is ten inches wide and nine inches deep, with occasional cleats on top to prevent spreading, it will be about right. The water may flow in at one end and out at the other, over a dam six or seven inches high. With hatching troughs at right angles to this and supplied by inch-and-a-half cocks or gates the flow will be regular at all times. These cocks should be halfway between the bottom of the distributing trough and the surface of the water, and may have a fine screen above them, or may pour into one below, as seems best, always looking out that the flow is not stopped nor any fine material enters the trough that would clog the screen at the lower end of the hatching trough and cause it to overflow and the fry to escape.

These hatching troughs are best made of soft wood, preferably sound, clear white pine, and if possible have them up so that the tops are three feet six inches above the floor, for convenience in working over them. If the bottoms are an inch and a half thick, three carpenter's horses will sustain them. A trough thirteen feet long, fourteen inches and a quarter wide, and seven inches deep, inside measure, will be sufficient for twenty-five thousand trout fry after they are hatched and feeding, but will be capable of developing four times that number of eggs. The troughs should be made of regular width, to a hair's breadth, in order to have any hatching tray fit every trough in any part of it, and the edges of the bottoms should be carefully dressed and the



Lower Ends of Troughs with Outlet Pipes.

sides nailed to them after being touched with thin white lead. The ends should be let in (see cut), in order to be nailed both ways and be tight. An inch-and-a-half hole in the bottom of the lower end will take the waste water where required; a sink outlet with the cross-pieces cut out is good to attach a waste-pipe to; above this hole nail an upright strip to each side to hold the dam. During the egg stage use one of two inches or less; after hatching begins, put in one of five inches and a screen above it. Just above the dam put two strips each side to hold the screen, which must fit tight all around, or tails will get in cracks and the fish will die. This screen should be of No. 14 wire cloth, and is sometimes placed upright and at others with its top up stream to give more surface and to release a weak fish from it by its own weight, but the difficulty in keeping a screen so placed clean is an offset to its advantages. If space permits, the troughs should be placed by twos, but some prefer them by threes.

Coal Tar.—All troughs, screens, trays, and all wood and iron that is in contact with water, should be painted with coal tar, which can be had from the gas-works. Thin it with spirits of turpentine, and give it two or three coats with a half-worn painter's brush in hot weather. It must be perfectly dry before water is let in, and then there will be no taste, rust, flavor of pine, nor fungus. Asphaltum is used, but I have not tried it. After the first season one coat each year is sufficient.

If the hatching troughs are all exactly one width, make the trays one quarter of an inch narrower and about twenty-seven inches long; use half-inch pine, cut in strips three quarters of an inch wide and laid flat, so that the frame is only half an inch deep; make the corners strong. If the frames are fourteen inches wide outside, have wire cloth especially woven of a length to cover them all, but half an inch narrower than the frames, for the selvage will be uneven; have it made with a mesh three quarters by an eighth of an inch, the long way of the mesh across the cloth; this holds the egg, but lets the fish drop through. Use No. 18 wire for the cross-wires, and finer wire for the double over and under, for the warp. A double-pointed carpet tack under each corner of the tray allows circulation beneath and prevents crushing the fry.

Having shown how to make the troughs, screens, and trays, and how to take the eggs, we must now proceed to the care of the eggs and fry. Our implements are few and simple: a wisp broom, a pair of nippers, a small, flat net, and the wing-feather of a goose set in a handle of light wood are all, except an outfit of pans which are to be used in stripping the fish. The little hand broom is used daily; a tray of eggs is taken from the bottom of the trough and soused in and out of the water to remove sediment, and is put over into the next trough, etc. When all are out, the dam below is removed and all slime washed out and both dam and eggs replaced. The nippers are cut out of wood, red cedar preferred, and are about six inches long, with a spread of three quarters of an inch at the points; the latter are best when finished with a loop of brass wire, but can do good service without this. A dead egg turns white, and can be seen at a glance among the amber ones, and an egg that has not been fertilized often remains clear until the rest are nearly hatched, but it can not stand any rough usage, and shows up in numbers after each washing, and, if left for two or three days, will develop a fungous growth that will attach the surrounding eggs in a mass and kill them all. In our early work, when we hatched on fine gravel, fungus was the bugbear: a dead egg would get down in the gravel and send out its deadly tentacles unseen; but with wire cloth and daily supervision fungus is unknown. It is this that kills the eggs in the brooks, and avoiding this cause of mortality from

Front of Hatchery, showing Inlet Trunk from Reservoir.
By courtesy of Mr. W. H. Cooper, President of the Photo-Section, Brooklyn Institute.

unimpregnated eggs is one of the reasons why we beat the methods of Nature in increasing a species by protection from its enemies.

At about fifteen days old the expert can take trout eggs in a glass tube or vial and, by holding them above his eye, can see the line of vertebræ which marks the impregnated egg; a few days later he can pick out the "ringers," or eggs which, having no fish in them, retain the ring which they first had on top of the egg. At thirty days, more or less, according to temperature, the eyes show, and the development goes on until the hatching begins at sixty to ninety or more days, according to the thermometer, but the colder waters produce the strongest trout.

When hatching begins, the water in the trough is raised, and the trays are brought near the surface and held there by light wedges which do not spring the sides of the troughs. The feather sweeps the bottom of sediment, taking care not to injure the delicate embryos, for they are more delicate when first hatched than when in the egg. At this time cleaning should be confined to the removal of any dead eggs or fry and of egg-shells on the screen, and here is where the little flat net of milliner's "millinet," on a three-inch brass-wire frame, is found most useful. This wire is covered with muslin to which the netting is sewed, and, moved quickly through the water, it gathers the shells which are clogging the screen, and a smart rap on a pan cleans the net. It is also of use in taking out dead fry and foreign matter from the bottom, as well as deformed fish, for we find crooked-tailed fish that can not swim and take food, double-headed fish, and twins attached to one sac, which never live.

When first hatched the embryo trout hardly look like fish; they have simply burst the shell in which they appeared as a slim, dark body, with big eyes, coiled around the yolk, and now merely straighten out and have the great yolk-sac still attached, and so heavy that they can not swim, but lie on their sides and huddle together to avoid light; and now there is danger of the bottom ones being smothered. Cover the trough in spots to induce them to gather in different places, and keep them as dark as possible. At this stage there is nothing to do but to remove the few dead—sediment can not hurt them now—and keep the outlet screen free. When they get to be about a month old the sac will be nearly gone, and the fry begin to show signs of swimming by occasional darts from the bottom to examine some floating particle. They will take food some days before the sac is absorbed, and it should be offered to them in small quantities.

The best food that I have found is beef liver, after abandoning it for soft clams (*Mya arenaria*) salt-water mussels, and horse meat. The clams made the young fish grow fast, but did not produce the expected number of eggs; the mussels were tried raw and cooked, with the same result; and, as the principal object at this State hatchery was the production of fry for planting public waters, we next tried raw horse flesh, which was very objectionable on account of the large proportion which was passed undigested and clogged the screens and fouled the water. Several fish culturists have found an admixture of bran, shorts, or mill feed with liver to be excellent. This I have not tried, because the trout is not a vegetarian in the least degree, and it remains to be proved that such vegetable addition to the food is of real advantage.

The liver is fed raw; for the "babies" it is run through a

Rearing and Breeding Ponds at Cold Spring Harbor, showing Sunshades and Spawning Races for Large Ponds.
By courtesy of Mr. W. H. Cooper, President of the Photo-Section, Brooklyn Institute.

meat cutter having holes one thirty-second of an inch at first, the holes increasing in size as the fish can take larger particles. This is mixed with sufficient water, and little by little scattered along the troughs from a wooden spatula, taking care not to feed so much at once that it will not be eaten. With twenty troughs one man should feed all day, getting back to the first one in half an hour, for, like all small animals, the trout want but little at a time, but want it often. For this reason I never advise a novice who receives fish from the State to pen them up and feed them; they would surely be starved, for if the young are not fed a dozen times a day they will show it by a shrunken body which appears to be all head. A trout at two to three months old should be larger around the abdomen than about the head, and there should be no pinched look behind the gills. If you can not give the babies this care, turn them into the stream or lake, and let them find their food and face their enemies, and you will have more and better fish. To take trout eggs and hatch them is not difficult, but the best trout breeder is the one who brings the greatest percentage of what he has hatched to be thrifty fish at six months old.

For the yearling trout the liver may be cut in pieces from a quarter to half an inch, and they should be fed all they can eat at least twice a day. Larger fish will take more and larger pieces, and will get along if fed once each day, preferably in the evening, but they do not suffer if neglected for a day as the babies do, and we find the same rule all through animal life in mammals and birds, with which most people are more familiar—the young require frequent feeding.

Too much importance can not be attached to the feeding of the fry in the early days of their taking food. It is the critical time, not only of their lives, but of their future development. No amount of feeding can make a thrifty fish of one which has been stunted by scant food in its first few months of life, and right here is where intelligent care turns the scale between profit and loss.

During the quarter of a century in which I have been engaged in this work, and have had to trust the care of the fish to employees because my own time was fully occupied with other work, the man most valued was he who took best care of the babies and fed them as though he loved them, and not in the spirit of one who did it as a task.

If one wishes to raise trout on artificial food he must bend to the task as he would if he were to raise any other stock in quantities in confined quarters; but he can arrange natural spawning races, and either take the eggs by hand or let them be laid by the fish, and be satisfied with a much less number of fish hatched, and then let them take care of themselves in a large pond or lake of suitable temperature, and, if the water is not infested with sunfish, perch, and other enemies which are beginning to look for food in the spring when the young trout is also looking for its first food, there is every prospect of success.

RECENT RECRUDESCENCE OF SUPERSTITION.

By Prof. E. P. EVANS.

I.

In 1879 a Catholic professor of theology in the University of Bonn, Dr. Heinrich Reusch, published a little volume entitled Die deutschen Bischöfe und der Aberglaube (The German Bishops and Superstition), in which he called attention to the vast increase of superstitious beliefs and observances within the Catholic Church since the middle of the present century, and to the official approval and promulgation of them by the highest ecclesiastical authorities. He animadverted severely on the extent to which this tendency had tainted the religious literature most widely diffused by the clergy among the masses of the people, and censured especially the pious pamphlets and periodicals issued by the Jesuits, such as Monat-Rosen zu Ehren der Unbefleckten Gottes-Mutter Maria, and Der Sendbote des götthichen Herzens Jesu, both of which are edited by disciples of Loyola at Innsbruck under the auspices of the Bishops of Salzburg, Brixen, and Trent, and with the benediction of Pope Pius IX. In these monthly sheets one would seek in vain for a moral maxim or practical precept inculcating kindness, truthfulness, and honesty in the common relations of life, but their pages are filled with records of miracles wrought and demons discomfited by consecrated medals, chrisms, holy waters, sacred scapularies, seraphic girdles, and relics of the saints.

During the fifteen years that have elapsed since Prof. Reusch uttered his earnest protest against this gross abuse of sacerdotal functions and spiritual power, the evils which he lamented and endeavored to correct have grown decidedly worse. In Germany the most important of the influences and events that have contributed to this deplorable result was the so-called *Kulturkampf*, or antagonism of the state to the Church in the interests of modern culture as opposed to the arrogant claims of a mediæval hierarchy. The inevitable effect of this conflict was to consolidate the forces of ultramontanism and to render them supreme in the papacy, to bind priests and people more firmly together, and to alienate the clergy from the cultivated classes of civil society. Universities have been superseded to a considerable extent by cloistral schools and special seminaries for the instruction of ecclesiastics, who, in consequence of such intellectual isolation, are as ignorant of the achievements of modern science and the chief currents of modern thought as though they lived in the ninth instead of the nineteenth century. Quite recently the German Imperial Government suggested the desirability and indicated the intention of establishing a Catholic faculty of theology in connection with the University of Strasburg; but the project was disapproved by the Alsatian bishop and met with general opposition on the part of the Catholic press in Germany, so great was the distrust of any intimate association with the centers of higher secular education. Also the convention of Catholics held at Cologne during the last week in August, 1894, expressed no word in favor of the afore-mentioned plan, but passed a resolution urging the immediate founding of a university at Fulda, which should be sanctioned by the Pope, controlled by the bishops, and wholly independent of the state. The kind of instruction which young men would receive in such an institution may be easily imagined. The hexahemera of the fathers and the works of Albertus Magnus would be the text-books in natural science, while theology and philosophy would be nothing but a rehash of the quiddities and quodlibets of Thomas Aquinas and Duns Scotus.

Two books recently published may be cited as fair specimens of the sort of researches to which the professors of the proposed Fulda University would probably devote their time and talents. The first of these volumes is entitled Wunder und göttliche Gnadenerweise bei der Ausstellung des heiligen Rockes zu Trier im Jahre 1891; aktenmässig dargestellt von Dr. Felix Korum, Bischof von Trier, of which a fourth edition has just been issued by the Paulinus printing office in Trier (Treves). When it was announced in 1890 that the "holy coat" of Trier would, after a lapse of forty-six years, be again exhibited for the adoration of the faithful, many sincere Catholics could hardly believe that, in the latter half of the nineteenth century, such an appeal to the crassest religious credulity would be made, or that it would meet with any general response. Nevertheless the exhibition took place in the following year and was crowned with immense success. Vast crowds of people flocked to the sacred shrine, and rumors went forth throughout the land of persons who had touched the garment and proved its miraculous virtue by being healed of their infirmities. This immense concourse of devotees presented to the eyes of the bishop a "glorious spectacle" and is characterized by him as in itself a "moral miracle"; a mind less blinded by bigotry, and therefore more capable of tracing the logical connection between cause and effect, would discover in this marvelous phenomenon only the natural result of the kind of religious instruction that has been systematically imparted by the Catholic clergy to the souls intrusted to their special care and spiritual cure during the last fifty years, and against which Prof. Reusch deemed it necessary to utter his solemn words of protest and of warning.

Dr. Korum seeks to give his *brochure* a quasi-scientific character by a so-called "documentary representation" of the miracles wrought by the "holy coat," consisting of certificates issued by obscure curates and country doctors and indorsed by an episcopal commission of theologians and physicians, who have very discreetly forgotten to sign their names to their reports and thus relieved themselves of all personal responsibility for their opinions. The Council of Trent decreed that no new miracles are to be accepted as authentic unless allowed and approved by the diocesan bishop, who, after taking the advice of theologians and other pious men, is to come to a decision which shall be consentaneous to truth and piety (*veritati et pietati consentanea*). Unfortunately, the interests of truth and piety are not always identical, and the demands of the former are apt to prove fatal to the claims of the latter. The diseases reported by our author as having been healed were nervous and hysterical affections, chorea or St. Vitus's dance, and a few cases of certain milder forms of lupus and tabes, which, as is well known, often disappear for months and even for years without the aid of medicine or miracles. It is also essential to a miracle that the afflicted person should be instantaneously relieved, or "cured from that very hour." The bishop, however, records no instance of this kind; as a rule, a very con-considerable time elapsed, often weeks and months, before the contact with the "holy coat" began to produce any perceptible effects; meanwhile the patient had been subject to a variety of sanitary influences, such as change of scene and other diversions, any one of which might have brought about the desired result, and in some cases also underwent medical treatment. Under such circumstances it would be the height of absurdity even for those who admit the possibility of the miraculous healing of disease to claim that the recovery was due to supernatural causes. Indeed, of the thirty-eight cures said to have taken place during the exhibition of the "holy coat," Dr. Korum owns that twenty-seven may have been effected by natural means, thus leaving only eleven in which he would fain discover the working of divine agencies.

One of the most eminent of modern neuropathologists, the late Prof. Charcot, published shortly before his death an interesting paper on faith-healing, in which he acknowledges the reality of the cures performed by this means, and states that his own practice furnishes many examples of the kind; but every therapeutic miracle, he adds, has its explanation, and we are gradually becoming better acquainted with the laws which govern the origin and evolution of such phenomena, and better able to trace them to their natural causes. Two factors are absolutely essential to cures of this kind: first, a peculiar mental constitution of the patient, easily accessible to confidence, credulity, or, as it is now called, suggestibility: secondly, a certain definite form of disease confined to a very small province in the domain of therapeutics, and comprising only those affections which the influence exerted by the mind upon the body suffices to heal. To this class of ailments belong partial or complete paralysis, cramps, convulsions, and similar functional disorders, tumors and ulcers, muscular atrophy, defective vision and other troubles of a hysterical nature, which can be cured by hypnotic suggestion, or by impressing upon the mind of the patient the conviction of their nonexistence, or by appealing to the firm belief in some remedy which has no intrinsic virtue. Under such circumstances a cripple may recover the use of his limbs simply by being commanded to rise up and walk, or a person suffering from *tabes dorsualis* may be restored to health and strength by wearing a holy relic of high repute or by going on a pilgrimage to some wonder-working shrine. In both cases the cure is effected by the exercise of credulity under more or less morbid and abnormal conditions produced either by somnambulism or superstition; but in neither case is the result attributable to supernatural causes. The sole aim of the physician is to heal the sick, and he should be liberal-minded enough to make use of any remedy which experience has proved to be effective—it may be a pill or a pilgrimage, a dose of sulphur or devotion to a saint. In conclusion, Dr. Korum declares that "the Lord by these marvelous manifestations of his almighty power has in a special manner indorsed and confirmed the worship of relics," and adds that "the occurrence of so many miracles in our enlightened nineteenth century is annihilating to the haughtiness of scientific research." The good bishop does not seem to be aware that the events which he records, admitting the accuracy of his descriptions, are merely illustrations and confirmations of the most recent scientific researches and discoveries in the province of neuropathology.

Dr. Korum also endeavors to show that miracles involve no violation of the laws of Nature, but are only the temporary counteraction of their ordinary effects through the operation of higher laws. The following example may serve as a specimen of his reasoning on this point: A stone falls to the ground in obedience to the law of gravitation; the human arm or other agency may cause it to rise into the air; this upward movement is, however, no violation of the law of gravitation, but merely a counteraction of its usual workings through the intervention of a superior force; therefore, miracles are wrought without violating natural laws. We commend this palpable *non sequitur* to any writer who wishes to make a collection of peculiarly gross fallacies for a work on logic.

An admirable reply to Dr. Korum's book is a *brochure* of eighty-three pages written by Friedrich Jaskowski, and entitled Der Trierer Rock und seine Patienten vom Jahre 1891 (Saarbrücken: Carl Schmidtke, 1894). The author is a Catholic priest in the diocese of Trier, and therefore under the jurisdiction of the bishop, the absurdity of whose statements and the untenableness of whose arguments he so courageously exposes and so conclusively refutes. The holy coat, he says, has been in the custody of the cathedral since the twelfth century, and was exhibited and adored as a sacred relic probably a dozen times from 1512 to 1810, but during these three centuries no healing virtue or wonder-working power was ever ascribed to it. In 1810 some ignorant and superstitious devotees reported that miracles had been wrought by it, but these stories were not indorsed by the ecclesiastical authorities. Not until 1844 did the popular demand for miracles become so loud and persistent that Bishop Arnoldi finally yielded to it and announced officially that "bodily wonders" or miraculous cures had been performed. If the holy coat can restore the sick, Jaskowski thinks it rather odd that it should have no power of self-restoration; it gets moldy when shut up in a damp closet, wears out by use, and has to be cleaned, darned, and patched like any other garment. The miracles of healing cited by Dr. Korum are then subjected to a critical examination and shown to be utterly unworthy of credence. In several instances the persons said to have been cured died shortly afterward. Of the thirty-eight cases cited, thirteen were men and twenty-five women. "This predilection for the fair sex" is a rather suspicious circumstance, indicating that the maladies were mostly hysterical and nervous and might be easily ameliorated by any influence that would powerfully affect the imagination, without the aid of either medicine or miracles. Jaskowski quotes Prof. Charcot, Dr. Forel, and other neuropathologists to prove that hetero-suggestion emanating from a physician or priest, or auto-suggestion originating in the person's own mind, may often be the most effective remedy for disorders of this kind. In auto-suggestion the patient is possessed with the fixed idea that the doing of a certain thing, which may be in itself absolutely indifferent, will afford relief; as an example of this faith-cure Jaskowski refers to the woman who was diseased with an issue of blood, and approaching

Jesus said within herself, "If I may but touch his garment, I shall be whole." This is precisely the position taken by Jesus himself, who turned to the woman and said: "Daughter, be of good comfort; thy faith hath made thee whole." On another occasion it is expressly declared by the evangelist that in a certain place the unbelief of the people, or their lack of faith, prevented the doing of many wondrous works. Jaskowski does not deny that on this principle, which is now recognized by the most eminent physicians, some persons may have been restored to health by touching the holy coat of Trier: and there is no doubt that the popular belief in Bishop Korum's assertion that it is the same garment which Jesus wore and the woman touched, would greatly increase its healing efficacy through the force of auto-suggestion. In conclusion Jaskowski declares that the cases of healing, so far as they actually occurred, "were not due to a miracle or any direct interference of God with the established course of things, but happened in a purely natural manner."

The success, both devotional and pecuniary, which attended the exhibition of the holy coat of Trier in 1891 on German soil excited the religious and patriotic zeal of French Catholics, who resolved to try what healing virtue might still inhere in the "holy seamless coat" of Argenteuil. This rival relic, the gift of the Byzantine Empress Irene to Charlemagne, had not been officially exposed and had its therapeutic powers publicly tested since 1680, and it was decided that the "elevation" should take place from May 14 to June 10 in the year of grace 1894. No sooner was this announcement made than it greatly alarmed the jealousy of Trier, whose bishop published a pastoral letter denying the genuineness of the coat at Argenteuil, and inviting the faithful to pay their devotions only to that at Trier. This view was also taken by a French ecclesiastic, the Benedictine Abbé Vonel, who wrote a pamphlet declaring that the legend of the Argenteuil relic had no historical foundation, and that the whole thing was merely a "pious illusion," which the Church should have sufficient love of truth as well as sense of her own worthiness to repudiate. This conclusion filled the inhabitants of Argenteuil with consternation; especially the tradesmen and innkeepers of the little town on the Seine uttered loud and indignant protests against the attempt to tarnish the traditional glory of this sacred shrine and to diminish the prospect of putting money in their pockets, while the people of Trier rejoiced at the condemnation and probable extinction of a dangerous competitor. At this juncture Monseigneur Richard, Archbishop of Paris, intervened and induced the Abbé Vonel to withdraw his *brochure* from publication. In order to remove any lingering traces of skepticism from the public mind, the Bishop of Versailles submitted a small piece of the holy seamless coat to the chemists of the Gobelin manufactory, who reported that the web might possibly date from the time of Christ, and that the stains may have been produced by blood; whether it was really the vesture upon which the Roman soldiers cast lots they would not undertake to decide. This vague and utterly worthless document was eagerly seized upon by the bishop and printed in the newspapers as a confirmation of the truth of ancient tradition by modern science.

We may add that the ecclesiastical authorities of Argenteuil do not deny the genuineness of the relic at Trier, but only assert that it is an upper garment, one of those which Christ's crucifiers parted among them, whereas theirs is an under garment, worn next to the skin, and therefore endowed with greater healing virtue than could possibly be possessed by a mere overcoat. The masses, however, do not seem to have been seriously affected by the accusations and recriminations passed backward and forward between the guardians of the two shrines vying for public patronage. On May 14th, the first day of the "elevation," thirty-seven extra trains left Paris for Argenteuil, and forty-two thousand persons paid their devotions to the wonder-working coat; and when the exhibition closed on June 10th half a million pilgrims had visited the little town on the Seine where, nearly eight centuries ago, the youthful Héloïse took the veil after her separation from Abélard. That thousands were healed of otherwise incurable diseases, and the maimed, the halt, and the blind recovered the use of their limbs and had their sight restored, has undoubtedly been fully recorded, and will in due time be officially reported.

Meanwhile the Bonapartists made a bold attempt to take the tide of popular superstition at the flood, hoping it might lead on to political fortune. One of their agents, while kneeling in adoration before the holy seamless coat, claims to have received a divine revelation through the newly canonized tutelar saint of France, Joan of Arc, who, it seems, has already begun to take a hand in French politics and to utter prophecies concerning the future of the land of which she was once the divinely commissioned defender. According to this revelation from on high, which has been printed on a single sheet of four large octavo pages and distributed in thousands of copies among the rural population and in the provincial towns, Prince Victor Napoleon V is the predestined ruler of France, and will be elected to the presidency of the republic by popular suffrage, or attain to sovereignty after bloody civil contests. In either case, Alsace and Lorraine will, on his accession to power, be reunited to France either through diplomatic negotiations or as the issue of a short but sanguinary foreign war. The recipient of this communication asserts that he is now seventy-two years of age, but that God had assured him, through the mouth of the Virgin, that his eyes shall see the salvation of France, and that he shall not die until these predictions have been fulfilled. That such crass superstition should be made the means of political propagandism in the last decade of the nineteenth century is certainly a strange phenomenon.

Another book indicating the rank growth of superstition in recent times is Dr. Theobald Bischofberger's Die Verwaltung des Exorcistats nach Massgabe des römischen Benediktionale, of which a new edition, revised and enlarged, was published by Roth at Stuttgart in 1893. The author evidently prides himself upon his powers as an exorcist, and relates with great unction and assurance his experiences in casting out devils by a hocus-pocus worthy of an American medicine-man or an African conjurer. In the section of his manual entitled Recognition of Demoniac Diseases he states that the signs of diabolical possession are quite conspicuous, but not altogether infallible, such as understanding foreign tongues without having learned them, and revealing the place where objects have been hidden, a peculiar faculty now known as mind-reading. Some persons thus affected are subject to fits of fainting; others shake and shiver as though they had the ague; others break out into profuse perspiration, or are seized with an irrepressible tendency to yawn, often developing into chronic oscitation. Sometimes the symptoms are imperceptible to the observer, as when the patient complains of internal heat, or suffers from constriction of the head, confusion of ideas, roaring in the ears, and similar troubles. Dr. Bischofberger admits that disorders produced by demons are difficult to distinguish from those due to natural causes. Thus the paroxysms of an epileptic who is diabolically possessed do not differ from those of an epileptic who has anæmia of the brain or other cerebral affection. The sensations of the *aura epileptica* and the convulsions that follow them are the same, whatever may be their origin. There is, however, one sure means of determining whether a disease is demoniac or not—namely, the use of the *præceptum probativum* or *exorcismus probationis*, by which the demon or demons, if there are several of them, are commanded in the name of Jesus to give a clear and manifest sign of their presence, and, if they have any power over this creature of God in his sickness, to agitate him and do the same things in the presence of the exorcist that they have been wont to do in his absence: Præcipio tibi dæmon, vel vobis dæmonibus, si plures sitis, in nomine Jesu, ut mihi aliquod signum evidens et manifestum faciatis vestriæ præsentiæ, si aliquam potestatem habeatis in hanc creaturem Dei in hac ejus in ægrotatione, agitando eam vel coram me aliquid ex iis faciendo, quod me absente in ea faciebatis—in nomine Pa+tris, etc. While repeating this formula, which is efficacious only in Latin, the priest is to lay his hand or, better still, some holy relic on the person possessed. "This conjuration," says our author, "may make the ungodly laugh, but the devil must obey and make his presence known, so great is the potency of these words." If the evil spirit were ordered to come out of the person, the command might not be obeyed, owing to some moral or physical obstacle to the demon's exit, which must first be removed; but if told to give a sign of his presence he must do so; otherwise (and mark the peculiar cogency of the priest's logic) there would be no truth in the apostle Paul's assertion that "at the name of Jesus every knee should bow, of things in heaven, and things in earth, and things under the earth. . . . The inhabitants of heaven," he adds, "bow the knee in rapturous devotion, the pious children of the Church in humble faith, and the spirits of hell with repugnance and gnashing of teeth, but they yield to compulsion and bow the knee."

Herr Bischofberger prudently leaves many a loophole of escape in case of failure: the demon may refuse to obey if the priest lacks faith, or utters the words in jest, or lives an evil life, or if the patient has little or no faith, or by the commission of a deadly sin has fallen into the toils of Satan, who has thus acquired an irreversible right to his soul. One would think that these exceptions would cover most instances of obstinacy on the part of the demon. Our author states that often, in his own experience, "the *præceptum probativum* did not produce any effect until the patient had made a general confession and received full absolution." He also notes that devils, like all evil-doers, are fond of going about in disguise, and if they perceive that they hold possession by a precarious tenure, and that their *incognito* is endangered, they will sometimes depart before the exorcist asks their names, or practice all sorts of equivocations and evasions, like a criminal under inquisition of the police.

If the demoniac infestation is connected with a physical malady of any sort, the case becomes exceedingly complicated, and the exorcism is attended with great difficulty, since the evil spirits obstinately resist all efforts to expel them by intrenching themselves in the ills that flesh is heir to. Diabolical possession, if permitted to continue for a long time, finally gets to be chronic and inveterate, and develops into an organic and incurable disease. Very often, too, it is quite impossible to determine whether the demon is the originary cause of the malady or merely takes occasion of it to get possession of the person through the breach made by illness, like an enemy lying in wait and ready to seize every opportunity to assault the temporary citadel of the soul. Women, however healthy, are, from the very nature of their sex, subject to various bodily indispositions from which men are wholly free, and are therefore more liable to demoniac affections; hence the vast number of unfortunate women who have suffered as witches in times past, not necessarily because they were wicked or morally corrupt, but because they were weak, the devil taking advantage of their physical infirmities to get possession of their persons and to make them the agents of his will.

The theory that "sin is the source of demoniac infestations" is accepted by Dr. Bischofberger only in its general application to the human race; if applied to individuals and families, he thinks it often works great injustice. He censures the conduct of many guardians of souls, who say to those afflicted by demons: "It serves you right; you ought to lead a different life; Satan has power only over bad people." Such remarks betray a lamentable ignorance of the devil's devious ways and cunning devices. Equally reprehensible is it to tell mothers who seek help from the Church for their suffering children: "Your child has been baptized and is in a state of saving and sanctifying grace and inaccessible to devils. You must consult a physician." The truth is, adds our author, little children are very frequently demoniacally possessed for the same reason that women are; on this account the old diocesan benedictionals contained a special *exorcismus parvulorum a dæmone infestatorum*, which has now been in a great measure superseded by the equally effective formula *benedictio puerorum ægrotantium* of the Romish benedictional.

In illustration of his views on this subject Dr. Bischofberger asserts that a place where a murder or other heinous crime has been committed, if the offense remains undetected and unexpiated, is sure to become the haunt of evil spirits and the scene of all sorts of diabolic orgies, such as are so frequently described in the annals of witchcraft. This state of things may continue for centuries, and a house or barn built upon such a spot will be demoniacally infested, to the great annoyance of the indwellers, whether men or cattle. The same is true of houses whose inhabitants have been guilty of gross iniquities, murder, brutality, blasphemy, caricature of sacred rites, mockery of holy things, necromancy, etc. Satan, having once got possession, is a tenacious tenant and can not be easily dislodged; and a subsequent proprietor, however pure and pious he may be, will have to suffer the consequences of these sins. Indeed, it is a noteworthy fact that, so long as such a dwelling is occupied by godless persons, the demons are comparatively quiet, the devil recognizing them as his allies and letting them alone; but no sooner does it pass into the possession of a good Christian than "the long-repressed flame of demoniac infestation bursts forth." It therefore behooves purchasers of real estate to ascertain not only that the deed to the property is valid and the conveyance firm in law, but that it is also unencumbered by devils as well as by debts since a Satanic lien may ultimately be the source of greater annoyance than a mortgage or mortmain, or any other sort of legal claim. On this principle, property that has been in the hands of pious people from time immemorial ought to have a higher market value than the dwelling places of the notoriously wicked. Our author thus emphasizes the truth of Holy Writ by showing that not only is "godliness profitable unto all things," but also, as mediæval writers were wont to say, unto some things besides, which the apostle Paul in his admonitions to his "son Timothy" never dreamed of.

Exorcism may be practiced by any regularly consecrated priest with the approval of the diocesan bishop. It is by no means necessary to be a saint in order to possess this power. "Such a demand would be absurd. Saints can not be stamped out of the ground at pleasure, although it would be an excellent thing if all priests were saints. . . . Priestly ordination and a pure life suffice to overcome demons, at least in most cases." But in addition to sacerdotal dignity and personal worthiness certain physical qualities are desirable. A priest who is infirm or prone to melancholy or of a timid disposition ought not to undertake such duties. Strong faith, robust health, moral courage, force of will, and a certain inventive genius in extemporizing expedients within permissible limits are essential to the highest success in coping with devils. "The instructions which precede the *exorcismus ad liberandos obsessos*, in the Roman ritual, leave much to the personal initiative and spontaneity of the exorcist, who, by making a proper use of this freedom, is often able to confuse and conquer the infernal adversary beyond the most sanguine expectation." Dr. Bischofberger gives an example of what can be accomplished by such ingenuity from his own experience. In order to expel the devils from a house in which a murder had been committed fifty years before and gone unpunished, he bored holes in the four corners of the doors, and after filling them with consecrated objects pegged them in. After a time, seeing that this measure had proved ineffectual, he investigated the matter, and found that the pegs had been pulled out and the contents of the holes removed. He then replaced the holy objects, scorched the pegs in the flame of a consecrated candle, dipped them in holy water, and drove them into the holes. This ingenious device threw the devils into the utmost confusion and compelled them to vacate the premises, from which repeated efforts had been made to expel them for more than three months.

Demons are said to watch with lively interest the progress of modern science and to build great hopes upon it. On one occasion, when the priest came with consecrated oil (*oleum simplex*) and holy water and began to utter the prescribed exorcism, the evil spirit cried out: "Woe is me! I thought that rubbish had long since gone out of vogue and been discarded as dead superstition." In the ages of faith it was customary to cast out devils in the presence of the whole congregation; but, owing to the growth of skepticism even among so-called believers, it is now deemed better to do it *scorsum a multitudine* (apart from the crowd), which would be attracted by idle curiosity rather than by the spirit of devotion. It is desirable, however, that the priest should select from the kinsmen and friends of the energumen a number of pious men who, after confessing and taking the communion, shall sustain him by prayer and fasting. Dr. Bischofberger firmly believes that our insane asylums contain many demoniacs who might be healed by the Church, but whom "science falsely so called" has condemned to the madhouse and the strait-jacket; he condemns the priests who would fain show their enlightenment by indorsing the decisions of the alienist, and exclaims: "O spirit of the age! How strongly hast thôu infected even the clergy!" It may also be regarded as a concession to this spirit that it is now admissible to call in a physician in order to repair the damages done by the demon to the bodily organism, whereas in the middle ages, and indeed down to the seventeenth century, the Church positively forbade any such intervention, and maintained that the divine power which cast out the devil would also heal the breach. With the general decline of faith in miracles it is permitted to have recourse to medicine, which, however, must be blessed by a priest before being administered to the patient.

In Italy a priest is usually called in, not only to bless newly erected buildings but also to sprinkle with holy water and to fumigate with incense every house in the octaves of Easter. Dr. Bischofberger regrets that this "laudable custom" does not prevail in Germany, since the old maxim that "an ounce of prevention is worth a pound of cure" applies with peculiar force to the treatment of demonical possession. We are also told that a very disagreeable "*aura corrumpens*" is apt to pervade all dwellings which have been infested for a long time, and that this taint remains many years after the demons have been expelled. A sensitive person can not enter such a house without being seized with dizziness, nausea, or strange nervous sensations which manifest themselves in palpitations of the heart, sudden paleness, and trembling of the limbs. The carnal mind, which is at enmity with all supernatural interpretations of natural phenomena, would suggest that these symptoms indicate inadequate ventilation and would seek relief in opening the windows and letting in fresh air rather than in aspersions and adjurations and *benedictiones locorum*.

Essentially the same method is to be pursued in freeing stables and cattle from demons, only other formulas of benediction are used, such as the *benedictus stabuli*, or *pabuli*, or *jumentorum*, or *medicinæ pro animalibus*, as the case may be. The first thing to be done is to bore holes in the four corners of the doorcase and to fill them with bits of Easter candles and other consecrated objects. Great efficacy is attributed to this procedure, "since doors have a symbolical significance, on account of which the Jews were commanded to smear the door-posts with the blood of the paschal lamb." Signs of the cross are also to be burned in the hair of the cattle between their horns and in the manes of horses while pronouncing in Latin the words "In the name of the Father, the Son, and the Holy Ghost." Curiously complicated knots and intricate twists and tangles in the hair of animals "are always signs of demoniac infestation." Some eleven years ago the cattle of a peasant in Dr. Bischofberger's parish had their jaws so cramped and contracted that they could hardly eat. The demoniac attack, although severest at feeding time, extended more or less over the whole day and night. If the cows succeeded in getting a little fodder into their mouths, they would keep it there almost motionless for half an hour or more, and only swallow just enough to keep them alive, and after four or five weeks they were all reduced to the verge of starvation. Our learned doctor of divinity then went through with the prescribed benedictions of kine, fodder, stall, etc., as above mentioned, and standing before each animal in turn said, "I command you, demon, in the name of Jesus Christ, the Son of God, that you desist from tormenting this creature of God and no longer disturb it in the exercise of its natural functions." Gradually they began to chew their food slowly, and no sooner was a cross burned in the tuft of hair between the horns than they fell to and ate with a ravenous appetite.

In another case with which he had to deal he found the devil more obstinate. A peasant woman had suffered from various ailments, and after giving birth to a child fell into a state of extreme nervous prostration. The *præceptum probativum* indicated demoniac infestation. By the use of consecrated oil and the proper benedictions the evil spirit was cast out of the woman, but went into the stable, where the cattle became strongly agitated. The bovine benedictions expelled it from the cattle, when it returned to the woman, from whom it passed into her husband and children, but, owing to their good health and bodily soundness, it could find no firm foothold there and was easily driven out, whereupon it went back to the woman and one of the cows. A veterinarian gave the animal some medicine, which the priest had blessed, and benedictions were pronounced upon the entire building with all its inmates, men and cattle. Shortly afterward it was found that the devil, instead of going back to hell as told to do, had taken up his abode in the well, which was about half a dozen yards from the house, for no sooner did the cows drink the water than their hair bristled and stood on end; also the woman had a relapse after taking a sip of it. Dr. Bischofberger expelled the devil from the well by throwing into it a little consecrated salt, and, after chasing him with the weapons of the Church from one nook and corner to another, finally succeeded in getting rid of him and purgating the whole premises. "We thus see," he concludes, "how the demon makes every effort to deceive, weary, and discourage the officiating priest."

Another important sacerdotal function is the cleansing of milk pails, churns, and other vessels used in the dairy from demoniac infection, which is frequently caused by women touching such vessels during menstruation. However excellent the cream may appear to be, no amount of churning can convert it into butter. In such cases the churn and all the other vessels connected with the dairy should be scalded with hot water and then sprinkled with holy water and dried in the sun, after which it would be well to ward off the possible return of the evil spirit by pronouncing over them the *benedictio ad omnia*. "The hot water removes the natural hindrances and the holy water the demoniac hindrances to the production of butter."

The secret and inexplicable abduction of milk and eggs is also the work of devils. "It is well known," says our author, "that angels, at least some choirs or orders of them, have the power of moving visible objects in an invisible manner from one place to another." Ecclesiastical history, especially in the province of hagiology, contains numerous instances of the exercise of this power. Thus, in 1867, when St. Francisca of the Five Wounds (or Stigmata) was canonized, her claims to sainthood were based in part upon a legend of this kind. It was seriously related on that occasion that while her pastor and confessor, Father Bianchi, was celebrating mass, after the transubstantiation in the eucharist had taken place, the cup suddenly disappeared for a moment and returned to the altar. "This happened repeatedly, and it was subsequently ascertained" (how, we are not informed) "that the archangel Raphael had meanwhile carried the cup to Saint Francisca at times when she would otherwise have had to go without the holy communion." (Leben der Heiligen (Francisca). Mainz: Kirchheim, 1880, pp. 193 *sqq*). It is easy enough to explain how a blear-eyed priest in a dark church might for a minute lose sight of a small object on the altar, such as a goblet or a pyx, without the intervention of an archangel. Indeed, almost every one has had a similar experience in looking for something on a table or shelf in vain, and then finding it there a few moments later. The momentary oversight may be due to mental abstraction or to a transient visual blur. The angels, we are assured, did not lose by their fall this power of carrying off things invisibly, which therefore remains an attribute of devils, and enables them to indulge their propensity to steal without detection. They sometimes pilfer fruit and grain, but seem to have a special fondness for milk and eggs, a very simple diet, one would think, for infernal spirits. Many persons who keep fowls are often surprised that they do not get any eggs. The hen sits on the nest, lays or at least cackles, but the nest is empty. If such a hen be killed, plenty of eggs in a more or less advanced stage of development will be found in the ovary, and the oviduct will prove to be perfectly healthy and normal. From these facts a strictly logical mind, like that of our learned doctor, can come to only one conclusion: a demon stole the eggs. The same is true of cows, goats, and other lactiferous animals which grow lean and cease to give milk, although they are provided with the most nutritious fodder. "In such cases it is right to assume the workings of witchcraft, and to apply the formula *contra maleficium invisibilis ablationis lactis*, etc., of the Constance Benedictional." In the earlier centuries of the Christian era, before this ritual existed, simpler methods of exorcism were employed and are still effective, such as blessing the stalls, the fodder, and the cows, and washing the teats with holy water, which may be warmed if the animals are sensitive to cold. Snarled tufts of hair or tangles of hemp indicate demonism, and should be thrown into the fire with the words "In the name of the Father, the Son, and the Holy Ghost." Dr. Bischofberger admits that "egg-stealing is more difficult to stop, because the priest has less power over hens." The best remedy is to surround the nests with consecrated things, so that the demon can not get through without coming in contact with them; he will then probably desist. Granaries and fruit lofts are to be protected in the same manner.

In conclusion, the author of this manual of exorcism says, "People fondly imagine that these cunning devices of the Prince of Darkness may have been practiced in former centuries, but that they have been dissipated by the light of the nineteenth century like the mist before the sun." His thirty-seven years' experience as a priest prove this optimistic assumption to be wholly unfounded.

THOMAS HENRY HUXLEY.

By Prof. MICHAEL FOSTER.

TWO scenes in Huxley's life stand out clear and full of meaning amid my recollections of him, reaching now some forty years back. Both took place at Oxford, both at meetings of the British Association. The first, few witnesses of which now remain, was the memorable discussion on Darwin in 1860. The room was crowded though it was a Saturday, and the meeting was excited. The bishop had spoken; cheered loudly from time to time during his speech, he sat down amid rapturous applause, ladies waving their handkerchiefs with great enthusiasm; and in almost dead silence, broken merely by greetings which, coming only from the few who knew, seemed as nothing, Huxley, then well-nigh unknown outside the narrow circle of scientific workers, began his reply. A cheer, chiefly from a knot of young men in the audience, hearty but seeming scant through the fewness of those who gave it, and almost angrily resented by some, welcomed the first point made. Then as, slowly and measuredly at first, more quickly and with more vigor later, stroke followed stroke, the circle of cheers grew wider and yet wider, until the speaker's last words were crowned with an applause falling not far short of, indeed equaling, that which had gone before, an applause hearty and genuine in its recognition that a strong man had arisen among the biologists of England.

The second scene, that of 1894, is still fresh in the minds of all. No one who was present is likely to forget how, when Huxley rose to second the vote of thanks for the presidential address, the whole house burst into a cheering such as had never before been witnessed on any like occasion, a cheering which said, as plainly as such things can say, "This is the faithful servant who has labored for more than half a century on behalf of science with his face set firmly toward truth, and we want him to know that his labors have not been in vain." Nor is any one likely to forget the few carefully chosen, wise, pregnant words which fell from him when the applause died away. Those two speeches, the one long and polemical, the other brief and judicial, show, when taken together, many of the qualities which made Huxley great and strong.

Among those qualities perhaps the most dominant, certainly the most effective as regards his influence on the world, were, on the one hand, an alertness, a quickness of apprehension, and a clear way of thinking, which, in dealing with a problem, made him dissatisfied with any solution incapable of rigid proof and incisive expression; he seemed always to go about with a halo of clear light immediately around him; and, on the other hand, that power of foreseeing future consequences of immediate action which forms the greater part of what we call sagacity. The former gave him his notable dialectic skill, and mark all his contributions to scientific literature; the latter made him, in addition, an able administrator and a wise counselor, both within the tents of science and beyond. These, at least, were his dominant intellectual qualities; but even more powerful were the qualities in him which, though allied, we distinguish as moral; and perhaps the greater part of his influence over his fellows was due to the fact that every one who met him saw in him a man bent on following the true and doing the right, swerving aside no tittle, either for the sake of reward or for fear of the enemy, a man whose uttered scorn of what was mean and cowardly was but the reciprocal of his inward love of nobleness and courage.

Bearing in mind his possession of these general qualities, we may find the key to the influence exerted by him on biological science in what he says of himself in his all too short autobiographic sketch—namely, that the bent of his mind was toward mechanical problems, and that it was the force of circumstances which, frustrating his boyish wish to be a mechanical engineer, brought him to the medical profession. Probably the boyish wish was merely the natural outcome of an early feeling that the solution of mechanical problems was congenial to the clear, decisive way of thinking, to which I referred above, and which was obviously present even in the boy; and that it was not the subject-matter of mechanical problems, but the mode of treating them which interested him, is shown by the incident recorded by himself, how when he was a mere boy a too zealous attention to a post-mortem examination cost him a long illness. It is clear that the call to solve biologic problems came to him early; it is also clear that the call was a real one; and, as he himself has said, he recognized his calling when, after some years of desultory reading and lonely, irregular mental activity, he came under the influence of Wharton Jones at Charing Cross Hospital. That made him a biologist, but confirmed the natural aptitude of his mind in making him a biologist who, rejecting all shadowy, intangible views, was to direct his energies to problems which seemed capable of clear demonstrable proof. In many respects the biologic problems which lend themselves most readily to demonstrable solutions capable of verification are those which constitute what we call physiology; and if at the time of his youth the way had been open to him, Huxley would probably have become known as a physiologist. But at that time careers for physiologists were of the fewest. His master, Wharton Jones, a physiologist of the first rank, whose work in the first half of this century still remains of classic value, had been driven to earn his bread as an ophthalmic surgeon, and an even greater physiologist, William Bowman, was following the same course. There was no opening in physiology for the young student at Charing Cross, and he was driven by stress of circumstances to morphological rather than to strictly physiological problems; but it was not until long after, when he had achieved eminence as a morphologist, that he finally abandoned his old wish to hold a physiological chair.

Looking back on the past, we may now be glad that circumstances were against his wishes; for (though in every branch of science there is need at all times of a great man) there was at the middle of the century, in the early fifties, a special need in morphology for a man of Huxley's mold. Richard Owen was then dominant, and it is an acknowledged feature of Owen's work that in it there was a sudden leap from most admirable detailed descriptive labor to dubious speculations, based for the most part on, or at least akin to, the philosophy of Oken. Of the "new morphology" in which Johannes Müller was leading the way, and the criteria of which had been furnished by the labors of von Baer, there was then but little in England save, perhaps, what was to be found in the expositions of Carpenter. Of this new morphology, by which this branch of biology was brought into a line with other exact sciences, and the note of which was not to speculate on guiding forces and on the realization of ideals, but to determine the laws of growth by the careful investigation, as of so many special problems, of what parts of different animals, as shown among other ways by the mode of their development, were really the same or alike, Huxley became at once an apostle. His very first work, that on the *Medusæ*, wrought out amid the distractions of ship life, written on a lonely vessel plowing its solitary way amid almost unknown seas, away from books and the communion of his fellow-workers, bears the same marks which characterize his subsequent memoirs; it is the effort of a clear mind striving to see its way through difficult problems, bent on holding fast only to that which could be proved. This is not the occasion to insist in detail on the value of the like morphological work which he produced in the fifties and the sixties, or to show how he applied to other forms of animal life, to echinoderms, to tunicates, to arthropods, to molluscs, and last though not least to vertebrates, the same method of inquiry which guided the work on the *Medusæ*. Nor need I dwell on the many valuable results which he gained for science by attacking in the same spirit the problems offered by the remains of extinct forms. Moreover, he strengthened the effect of his own labors by admirable expositions of the results of others. Further, unlike his great predecessor, who formed no school and had few if any disciples, it was

Huxley's delight to hold out his hand to every young man who he thought could profit by his help, and before many years were over his spirit was moving in the minds of many others. Thus it came about that during the latter half of this century, owing largely to Huxley's own labors and to the influence which he exerted not only in England but abroad, there has been added to science a large body of morphological truths, truths which have been demonstrated and must remain, not mere views and theories which may be washed away.

The excitement of the Darwinian controversy, with its far-reaching issues, has been apt to make us forget how great has been the progress of animal morphology during the past half century. Undoubtedly the solution of special problems touching animal forms, and the great theory of natural selection through the struggle for existence, have been closely bound together: the special learning has furnished support for the general theory, and the general theory, besides strongly stimulating inquiry, has illumined the special problems. But the two stand apart, each on its own basis; and were it possible to wipe out, as with a sponge, everything which Darwin wrote, and which his views have caused to be written, there would still remain a body of science touching animal forms, both recent and extinct, acquired since 1850, of which we may well be proud. In gaining that knowledge Huxley, as well by his own labors as by his influence over others, stands foremost, Gegenbaur being almost his only peer; and had Huxley done nothing more, his name would live as that of one of the most remarkable biologists of the present century.

As we all know, he did much more; his influence on England and on the world went far beyond that of his purely scientific writings. But when we reflect that a hundred years hence the image of the man as he went to and fro among men, so bright and vivid to-day, will have become dim and colorless, a shadow as it were, and that then the man will be judged mainly by the writings which remain, we must count these writings as the chief basis of his fame. And, though we may think it possible that the world of that day, much that is unwritten having been forgotten, may find it in part difficult to understand how great a power Huxley was in his time, the lapse of years will, we may be sure, in no way lessen, it may be will heighten, the estimate of his contributions to exact science.

As we all know, he did much more. To the public outside science he first became known as the bold, outspoken exponent and advocate of Darwin's views, and indeed to some this is still his chief fame. There is no need here to dwell on this part of his work, and I speak of it now chiefly to remark that the zeal with which he threw himself into this advocacy was merely a part of the larger purpose of his life. Science, or, to use the old phrase of the Royal Society, natural knowledge, had a twofold hold on Huxley. On the one hand, he felt deeply all the purely intellectual and, if we may use the word, selfish joys of fruitful progressive inquiry after truth. This was dominant in his early days, and to it we owe the long list of valuable researches of which I just now spoke, and which followed each other rapidly in the fifties and the sixties. On the other hand, feeling deeply, as he did, his duties as a citizen of the world, science laid hold of him as being the true and sure guide to conduct man in all his ways; and this latter working of science in him, evident even in early days (witness his Address to Workingmen at St. Martin's Hall in 1854), grew stronger and stronger as the years went on, until at last it took almost entire possession of him. To him, indeed, it may be said, science was all in all. He saw, as others see, in science a something which is broadening and strengthening human life by unceasingly bending Nature to the use of man, and making her resources subservient to his desires; he saw the material usefulness of science, but he saw something more. He saw also, as others see, in science a something in which the human mind, exercising and training itself, makes itself at once nimble and strong, and dwelling on which is raised to broad and high views of the nature of things; he saw in science a means of culture, but he saw something more. He saw in science even as it is, and still more in science as it will be, the sure and trustworthy guide of man in the dark paths of life. Many a man of science goes, or seems to others to go, through the world ordering his steps by two ways of thinking. When he is dealing with the matters the treatment of which has given him his scientific position, with physical or with biological problems, he thinks in one way; when he is dealing with other matters, those of morals and religion, he thinks in another way; he seems to have two minds, and to pass from the one to the other according to the subject-matter. It was not so with Huxley. He could not split himself or the universe into two halves, and treat the one and the other half by two methods radically distinct and in many ways opposed; he applied the one method, which he believed to be the true and fruitful one, to all problems without distinction. And as years came over him, the duty of making this view clear to others grew stronger and stronger. Relinquishing, not without bitter regret, little by little, the calm intellectual joys of the pursuit of narrower morphological problems, he became more and more the apostle of the scientific method, driven to the new career by the force of a pure altruism, not loving science the less but loving man the more. And his work in this respect was a double one: he had to teach his scientific brethren, at least his biologic brethren, the ways of science, and he had to teach the world the works of science. It was this feeling which, on the one hand, led him to devote so much labor to the organization of biologic science in order that his younger brethren might be helped to walk in the straight path and to do their work well. It was this feeling, on the other hand, which made him urgent in the spread of the teaching of science. It was this, and no vain love of being known, which led him to the platform and the press. The zeal with which he defended the theory of natural selection came from his seeing the large issues involved; to him the theory was a great example of the scientific method applied successfully to a problem of more than biologic moment; while the fierceness of his advocacy was a natural expression of resentment on the part of one who saw a scientific conclusion, gained with unstinted pains and large reasoning, judged contemptuously by men who knew nothing of science according to methods in which science had no part.

Science, under this aspect, is a part of what is sometimes called philosophy; and though Huxley felt, in common with others, and felt deeply the pleasures of the intellectual wrestler, struggling with problems which, seemingly solved and thrown to the ground, spring up again at once in unsolved strength, it was not these pleasures alone which led him, especially in his later years, to devote so much time and labor to technical philosophic studies. He hoped out of the depths of philosophy to call witnesses to the value of the scientific method. Indeed, nearly all the work of the latter part of his life, including the last imperfect fragment, written when the hand of disease which was to be the hand of death was already laid upon him, and bearing marks of that hand, was wrought with one desire—namely, to show that the only possible solutions of the problems of the universe were such as the scientific method could bring. This was at the bottom of that antagonism to theology which he never attempted to conceal, and the real existence of which no one who wishes to form a true judgment of the man can ignore. He recognized that the only two consistent conceptions of man and the universe were the distinctly theologic one and the scientific one: he put aside as unworthy of serious attention all between. He was convinced that the theologic conception was based on error, and much of his old age was spent in the study of theologic writings whereby he gathered for himself increasing proof that there was no flaw in the judgment which had guided his way from his youth upward. Not only so, but he was no less convinced that, owing to what he believed to be the essential antagonism of the theologic and the scientific methods, the dominance of the former was an obstacle to the progress of the latter. This conviction he freely confessed to be the cause of his hostile attitude; he believed it to be the justification of even his bitter polemics.

But while on the objective side his scientific mode of thought thus made him a never-failing opponent of theologic thought of every kind, a common tie on the subjective side bound him to the heart of the Christian religion. Strong as was his conviction that the moral no less than the material good of man was to be secured by the scientific method alone, strong as was his confidence in the ultimate victory of that method in the war against ignorance and wrong, no less clear was his vision of the limits beyond which science was unable to go. He brought into the current use of to-day the term "agnostic," but the word had to him a deep and solemn meaning. To him "I do not know" was not a mere phrase to be thrown with a light heart at the face of an opponent who asks a hard question; it was reciprocally with the positive teachings of science the guide of his life. Great as he felt science to be, he was well aware that science could never lay its hand, could never touch, even with the tip of its finger, that dream with which our little life is rounded, and that unknown dream was a power as dominant over him as was the might of known science; he carried about with him every day that which he did not know as his guide of life no less to be minded than that which he did know. Future visitors to the burial place on the northern heights of London, seeing on his tombstone the lines—

"And if there be no meeting past the grave,
If all is darkness, silence, yet 'tis rest.
Be not afraid, ye waiting hearts that weep,
For God 'still giveth his belovèd sleep,'
And if an endless sleep he wills—so best"—

will recognize that the agnostic man of science had much in common with the man of faith.

There is still much more to say of him, but this is not the place to say it. Let it be enough to add that those who had the happiness to come near him knew that besides science and philosophy there was room in him for yet many other things; they forgot the learned investigator, the wise man of action, and the fearless combatant as they listened to him talking of letters, of pictures, or of music, always wondering which delighted them most, the sure thrust with which he hit the mark, whatever it might be, or the brilliant wit which flashed around his stroke. And yet one word more. As an object seen first at a distance changes in aspect to the looker-on who draws nearer and yet more near, features unseen afar off filling up the vision close at hand, so he seemed to change to those who, coming nearer and nearer to him, gained a happy place within his innermost circle; his incisive thought, his wide knowledge, his sure and prompt judgment, his ready and sharp word, all these shrunk away so as to seem but a small part of him; his greater part, and that which most shaped his life, was seen to be a heart full of love, which, clinging round his family and his friends in tenderest devotion, was spread over all his fellow-men in kindness guided by justice.—*Nature.*

PLEASURES OF THE TELESCOPE.

By GARRETT P. SERVISS.

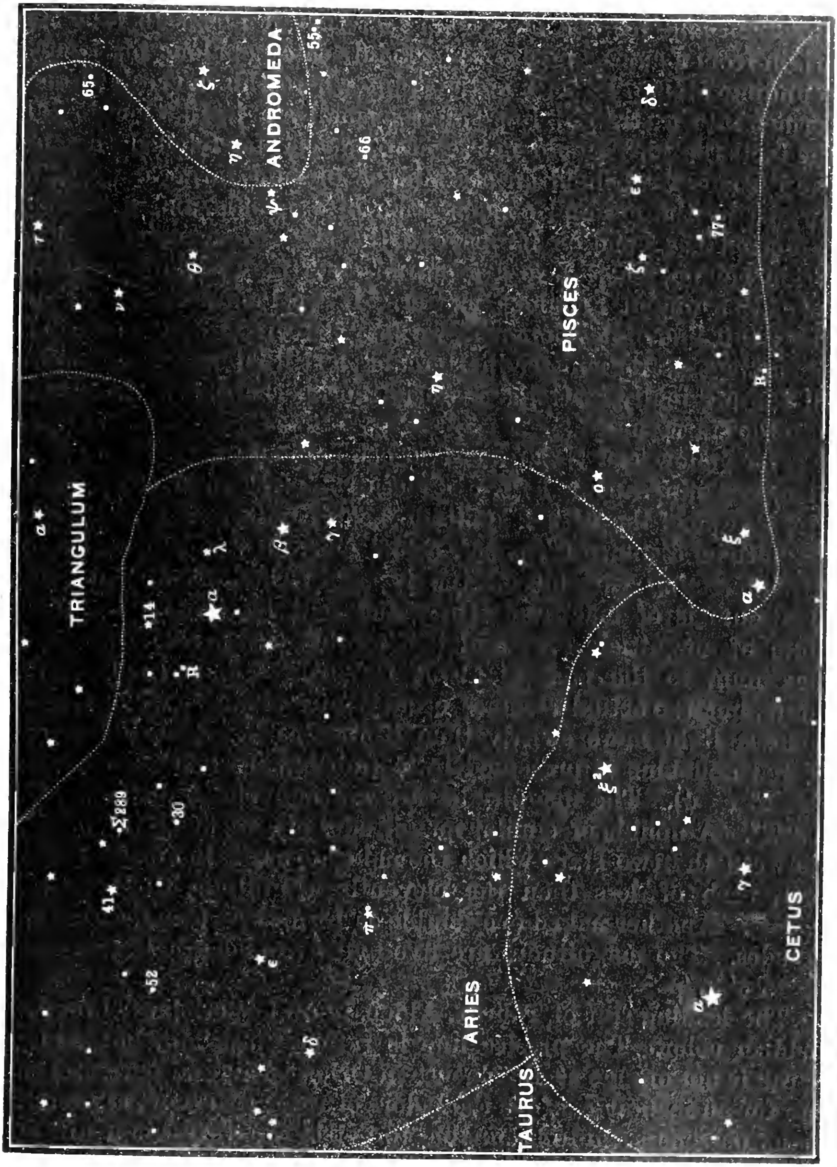
VII.—PISCES, ARIES, TAURUS, AND THE NORTHERN STARS.

THE eastern end of Pisces, represented in map No. 22, includes most of the interesting telescopic objects that the constellation contains. We begin our exploration at the star numbered 55, a double that is very beautiful when viewed with the three-inch glass. The components are of magnitudes five and eight, distance 6·6″, p. 192°. The larger star is yellow and the smaller deep blue. The star 65, while lacking the peculiar charm of contrasted colors so finely displayed in 55, possesses an attraction in the equality of its components which are both of the sixth magnitude and milk-white. The distance is 4·5″, p. 118°. In 66 we find a swift binary whose components are at present far too close for any except the largest telescopes. The distance in 1894 was only 0·36″, p. 329°. The magnitudes are six and seven. In contrast with this excessively close double is ψ, whose components are both of magnitude five and a half, distance 30″, p. 160°. Dropping down to 77 we come upon another very wide and pleasing double, magnitudes six and seven, distance 33″, p. 82°, colors white and lilac or pale blue. Hardly less beautiful is ζ, magnitudes five and six, distance 24″, p, 64°. Finest of all is α, which exhibits a remarkable color contrast, the larger star being greenish and the smaller blue. The magnitudes are four and five, distance 3″, p. 320°. This star is a binary, but the motion is slow. The variable R ranges between magnitudes seven and thirteen, period three hundred and forty-four days.

The constellation Aries contains several beautiful doubles, all but one of which are easy for our smallest aperture. The most striking of these is γ, which is historically interesting as the first double star discovered. The discovery was made by Robert Hooke in 1664 by accident, while he was following the comet of that year with his telescope. He expressed great surprise on noticing that the glass divided the star, and remarked that he had not met with a like instance in all the heavens. His observations could not have been very extensive or very carefully conducted, for there are many double stars much wider than γ Arietis which Hooke could certainly have separated if he had examined them. The magnitudes of the components of γ are four and four and a half, or, according to Hall, both four; distance 8·5″, p. 180°. A few degrees above γ, passing by β, is a wide double λ, magnitudes five and eight, distance 37″, p. 45°, colors white and lilac or violet. Three stars are to be seen in 14: magnitudes five and a half, ten, and nine, distances 83″, p. 36°, and 106″, p. 278°, colors white, blue, and lilac. The star 30 is a very pretty double, magnitudes six and seven, distance 38·6″, p. 273°. Σ 289 consists of a topaz star combined with a sapphire, magnitudes six and nine, distance 28·5″, p. 0°. The fourth-magnitude star 41 has several faint companions. The magnitudes of two of these are eleven and nine, distances 34″, p. 203°, and 130″, p. 230°. We discover another triple in π, magnitudes five, eight, and eleven, distances 3·24″, p. 122°, and 25″, p. 110°. The double mentioned above as being too close for our three-inch glass is ϵ, which, however, can be divided with the four-inch, although the five-inch will serve us better. The magnitudes are five and a half and six, distance 1·26″, p. 202°. The star 52 has two companions, one of which is so close that our instruments can not separate it, while the other is too faint to be visible in the light of its brilliant neighbor without the aid of a very powerful telescope.

We are now about to enter one of the most magnificent regions in the sky, which is hardly less attractive to the naked eye than Orion, and which men must have admired from the beginning of their history on the earth, the constellation Taurus (map No. 23). Two groups of stars especially distinguish Taurus, the Hyades and the Pleiades, and both are exceedingly interesting when viewed with the lowest magnifying powers of our telescopes.

We shall begin with a little star just west of the Pleiades, Σ 412, also called 7 Tauri. This is a triple, but we can only see it as a double, the third star being exceedingly close to the primary. The magnitudes are six and a half, seven, and ten, distances 0·3″, p. 216°, and 22″, p. 62°. In the Pleiades we naturally turn to the brightest star η, or Alcyone, famous for having once been regarded as the central sun around which our sun and a multitude of other luminaries were supposed to revolve, and picturesque on account of the little triangle of small stars near it which the least telescopic assistance enables us to see. One may derive much pleasure from a study of the various groupings of stars in the Pleiades. Photography has demonstrated, what had long been suspected from occasional glimpses revealed by the telescope, that this celebrated cluster of stars is intermingled with curious forms of nebulæ. The nebulous matter appears in festoons, apparently attached to some of the larger stars, such as Alcyone, Merope, and Maia, and in long, narrow, straight lines, the most remarkable of which, a faintly luminous thread starting midway between Maia

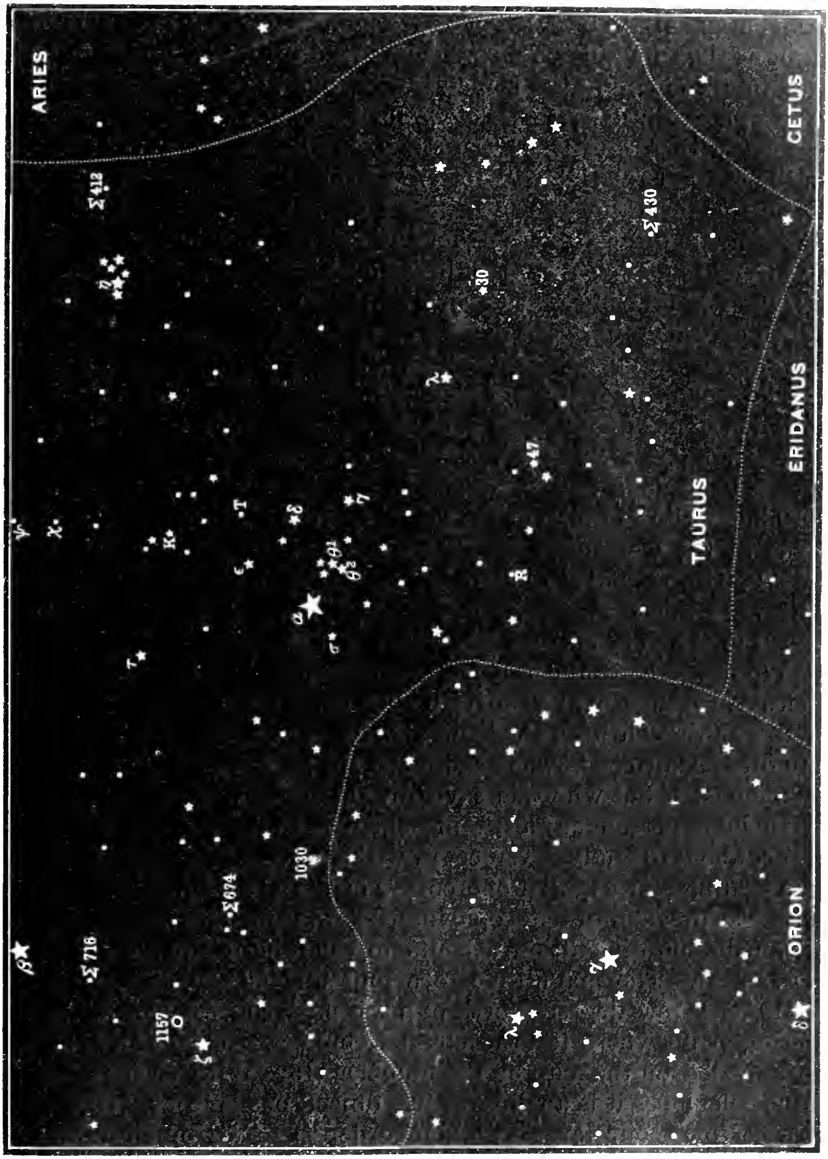


MAP No. 22.

and Alcyone and running eastward some 40′, is beaded with seven or eight stars. The width of this strange nebulous streak is, on an average, 3″ or 4″, and there is, perhaps, no more wonderful phenomenon anywhere in celestial space. Unfortunately, no telescope is able to show it, and all our knowledge about it is based upon photographs. It might be supposed that it was a nebulous disk seen edgewise, but for the fact that at the largest star involved in its course it bends sharply about 10° out of its former direction, and for the additional fact that it seems to take its origin from a curved offshoot of the intricate nebulous mass surrounding Maia. Exactly at the point where this curve is transformed into a straight line shines a small star! In view of all the facts the idea would not seem to be very far-fetched that in the Pleiades we behold an assemblage of suns, large and small, formed by the gradual condensation of a nebula, and in which evolution has gone on far beyond the stage represented by the Orion nebula, where also a group of stars may be in process of formation out of nebulous matter. If we look a little farther along this line of development, we may perceive in such a stellar assemblage as the cluster in Hercules, a still later phase wherein all the originally scattered material has, perhaps, been absorbed into the starry nuclei.

The yellow star Σ 430 has two companions: magnitudes six, nine, and nine and a half, distances 26″, p. 55°, and 39″, p. 302°. The star 30 of the fifth magnitude has a companion of the ninth magnitude, distance 9″, p. 58°, colors emerald and purple, faint. An interesting variable, of the type of Algol, is λ, which at maximum is of magnitude three and four tenths and at minimum of magnitude four and two tenths. Its period from one maximum to the next is about three days and twenty-three hours, but the actual changes occupy only about ten hours, and it loses light more swiftly than it regains it. A combination of red and blue is presented by ϕ (mistakenly marked on map No. 23 as ψ). The magnitudes are six and eight, distance 56″, p. 242°. A double of similar magnitudes is χ, distance 19″, p. 25°. Between the two stars which the naked eye sees in κ is a minute pair, each of less than the eleventh magnitude, distance 5″, p. 324°. Another naked-eye double is formed by θ^1 and θ^2, in the Hyades. The magnitudes are five and five and a half, distance about 5′ 37″.

The leading star of Taurus, Aldebaran (α), is celebrated for its reddish color. The precise hue is rather uncertain, but Aldebaran is not orange as Betelgeuse in Orion is, and no correct eye can for an instant confuse the colors of these two stars, although many persons seem to be unable to detect the very plain difference between them in this respect. Aldebaran has been called "rose-red," and it would be an interesting occupation for an amateur to determine, with the aid of some proper color scale, the precise hue of this star, and of the many other stars which exhibit chromatic idiosyncrasy. Aldebaran is further interesting as being a standard first-magnitude star. With the four-inch glass we see without difficulty the tenth-magnitude companion following Aldebaran at a distance of 114″, p. 35°. There is an



MAP No. 23.

almost inexplicable charm about these faint attendants of bright stars, which is quite different from the interest attaching to a close and nearly equal pair. The impression of physical relationship is never lacking though it may be deceptive, and this awakens a lively appreciation of the vast differences of magnitude that exist among the different suns of space.

The actual size and might of this great red sun form an attractive subject for contemplation. As it appears to our eyes Aldebaran gives one twenty-five-thousand-millionth as much light as the sun, but if we were placed midway between them the star would outshine the sun in the ratio of not less than 160 to 1. And yet, gigantic as it is, Aldebaran is possibly a pygmy in comparison with Arcturus, whose probable dimensions were discussed in the chapter relating to Boötes. Although Aldebaran is known to possess several of the metallic elements that exist in the sun, its spectrum differs widely from the solar spectrum in some respects, and more closely resembles that of Arcturus.

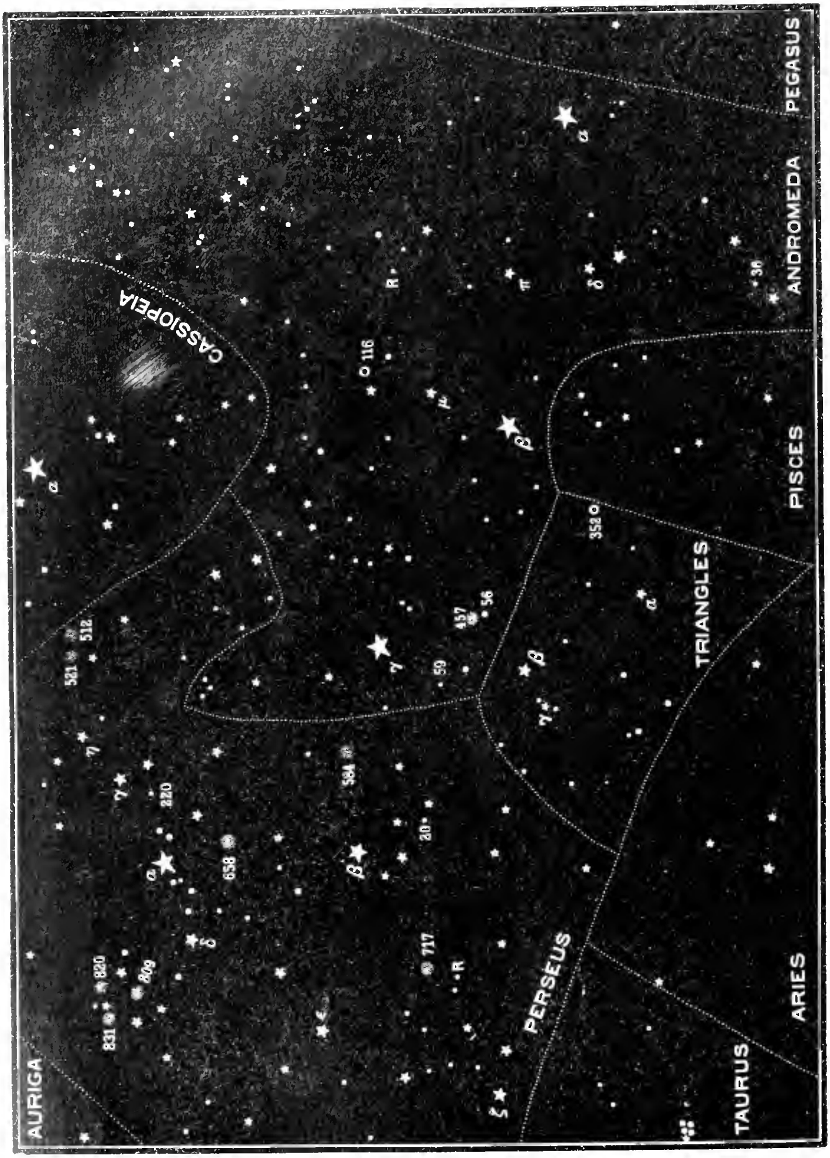
Other interesting objects in Taurus are σ, divisible with the naked eye, magnitudes five and five and a half, distance 7′; Σ 674 double, magnitudes six and nine, distance 10·5″, p. 147°; Σ 716, double, magnitudes six and seven, distance 5″, p. 200°, a pleasing sight; τ, triple, magnitudes four, ten and a half, and eleven, distances 36″, p. 249°, and 36″, p. 60°. The ten-and-a-half-magnitude star is itself double, as discovered by Burnham; star cluster No. 1030, not quite as broad as the moon, and containing some stars as large as the eleventh magnitude; and nebula No. 1157, the so-called "Crab nebula" of Lord Rosse, which our glasses will show only as a misty patch of faint light, although large telescopes reveal in it a very curious structure.

We now turn to the cluster of circumpolar constellations sometimes called the Royal Family, in allusion to the well-known story of the Ethiopian king Cepheus and his queen Cassiopeia, whose daughter Andromeda was exposed on the seashore to be devoured by a monster, but who was saved by the hero Perseus. All these mythologic personages are represented in the constellations that we are about to study. We begin with Andromeda (map. No. 24). The leading star α marks one corner of the great square of Pegasus. The first star of telescopic interest that we find in Andromeda is μ, a double difficult on account of the faintness of the smaller component. The magnitudes are four and eleven, distance 49″, p. 110°. A few degrees north of μ the naked eye detects a glimmering point where lies the Great Nebula in Andromeda. This is indicated on the map by the number 116. With either of our three telescopes it is an interesting object, but of course it is advisable to use our largest glass in order to get as much light as possible. All that we can see is a long, shuttle-shaped nebulous object, having a brighter point near the center. Many stars are scattered over the field in its neighborhood, but the nebula itself, although its spectrum is peculiar in resembling that of a faint star, is evidently a gaseous or at any rate a meteoritic mass, since photographs show it to be composed of a series of imperfectly separated spirals surrounding a vast central condensation. This peculiarity of the Andromeda nebula, which is invisible with telescopes although conspicuous in the photographs, has, since its discovery a few years ago, given a great impetus to speculation concerning the transformation of nebulæ into stars and star clusters. No one can look at a good photograph of this wonderful phenomenon without noticing its resemblance to the ideal state of things which, according to the nebular hypothesis, must once have existed in the solar system. It is to be remembered, however, that there is probably sufficient material in the Andromeda nebula to make a system many times, perhaps hundreds or

THE CHIEF STARS IN THE PLEIADES.

thousands of times, as extensive as that of which our sun is the center. If one contemplates this nebula only long enough to get a clear perception of the fact that creation was not ended when, according to the Mosaic history, God, having in seven days finished "the heavens and the earth and all the host of them," rested from all his work, a good blow will have been dealt for the cause of truth. Systems far vaster than ours are now in the bud, and long before they have bloomed, ambitious man, who once dreamed that all these things were created to serve him, will probably have vanished with the extinguishment of the little star whose radiant energy made his life and his achievements briefly possible.

In August, 1885, a new star of magnitude six and a half made its appearance suddenly near the center of the Andromeda nebula. Within one year it had disappeared, having gradually dwindled until the great Washington telescope, then the largest in use, no longer showed it. That this was a phenomenon connected with the nebula is most probable, but just what occurred to produce it nobody knows. The observed appearances might have been produced by a collision, and no better hypothesis has yet been suggested to account for them.



Map No. 24.

Near the opposite end of the constellation from α we find the most interesting of triple stars in γ. The two larger components of this beautiful star are of magnitudes three and six, distance

10″, colors golden yellow and deep blue. The three-inch shows them finely. The smaller star is itself double, its companion being of magnitude eight, distance when discovered in 1842 0·5″, color bluish green. A few years ago this third star got so close to its primary that it was invisible even with the highest powers of the great Lick telescope, but at present it appears to be widening again. In October, 1893, I had the pleasure of looking at γ Andromedæ with the Lick telescope, and at that time it was possible just to separate the third star. The angle seemed too small for certain measurement, but a single setting of the micrometer by Mr. Barnard, to whose kindness I was indebted for my view of the star, gave 0·17″ as the approximate distance. The brilliance of color contrast between the two larger stars of γ Andromedæ is hardly inferior to that exhibited in β Cygni, so that this star may be regarded as one of the most picturesque of stellar objects for small telescopes.

Other pleasing objects in this constellation are the binary star 36, magnitudes six and six and a half, distance 1″, p. 12°. The two stars are slowly closing and the five-inch glass is required to separate them: the richly colored variable R, which fades from magnitude five and a half to invisibility, and then recovers its light in a period of about four hundred and five days; and the bright star cluster 457, which covers a space about equal to the area of the full moon.

Just south of the eastern end of Andromeda is the small constellation Triangulum, or the Triangles, containing two interesting objects. One of these is the beautiful little double 6, magnitudes five and six, distance 3·8″, p. 77°, colors yellow and blue; and the other, the nebula 352, which equals in extent the star cluster in Andromeda described above, but nevertheless appears very faint with our largest glass. Its faintness, however, is not an indication of insignificance, for to very powerful telescopes it exhibits a wonderful system of nuclei and spirals—another bit of chaos that is yielding by age-long steps to the influence of demiurgic forces.

A richer constellation than Andromeda, both for naked-eye and telescopic observation, is Perseus, which is especially remarkable for its star clusters. Two of these, 512 and 521, constitute the celebrated double cluster, sometimes called the Sword-hand of Perseus, and also χ Persei. To the smallest telescope this aggregation of stars, ranging in magnitude from six and a half to fourteen, and grouped about two neighboring centers, presents a marvelous appearance. As a striking object for an eye unaccustomed to celestial observations it may be compared among star clusters to β Cygni among double stars, for the most indifferent spectator wonders at it. All the other clusters in Perseus represented on the map are worth examining, although none of them calls for special mention, except perhaps 584, where we may distinguish at least a hundred separate stars within an area less than one quarter as expansive as the face of the moon.

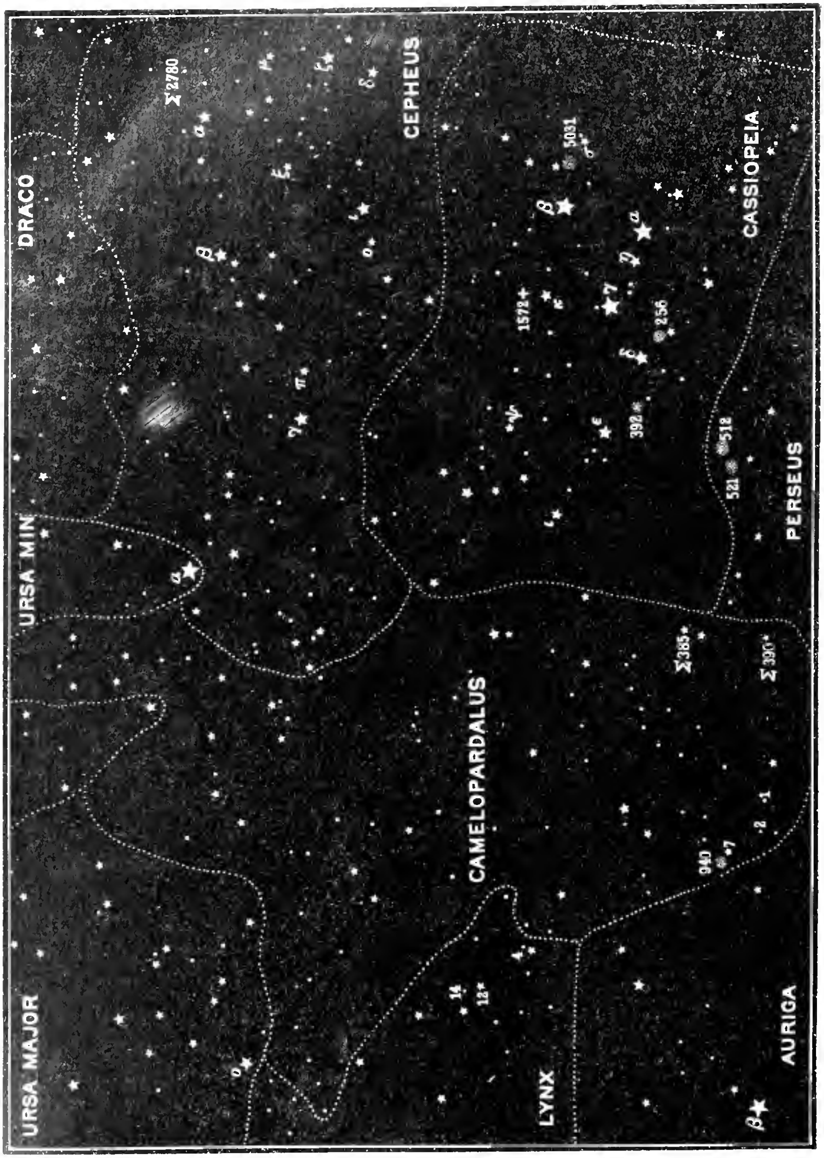
Among the double stars of Perseus we note first η, whose components are of magnitudes four and eight, distance 28″, colors white and pale blue. The double ϵ is especially interesting on account of an alleged change of color from blue to red which the smaller star undergoes coincidently with a variation of brightness. The magnitudes are three and eight, distance 9″, p. 9°. An interesting multiple is ζ, two of whose stars at least we can see. The magnitudes are three, nine, ten, and ten, distances 13″, p. 207°, 90″, and 112″.

The chief attraction in Perseus is the changeful and wonderful β, or Algol, the great typical star among the short-period variables. During the greater part of its period this star is of magnitude two and two tenths, but for a very short time, following a rapid loss of light, it remains at magnitude three and seven tenths. The difference, one magnitude and a half, corresponds to an actual difference in brightness in the ratio of 3·75 to 1. The entire loss of light during the declension occupies only four hours and a half. The star remains at its faintest for a few minutes only before a perceptible gain of light occurs, and the return to maximum is as rapid as was the preceding decline. The period from one minimum to the next is two days twenty hours forty-eight minutes fifty-three seconds, with an irregularity amounting to a few seconds in a year. The Arabs named the star Algol, or the Demon, on account of its eccentricity which did not escape their attention; and when Goodricke, in 1782, applied a scientific method of observation to it, the real cause of its variations was suggested by him, but his explanation failed of general acceptance until its truth was established by Prof. E. C. Pickering in 1880. This explanation gives us a wonderful insight into stellar constitution. According to it, Algol possesses a companion as large as the sun, but invisible, both because of its proximity to that star and because it yields no light, and revolving in a plane horizontal to our line of sight. The period of revolution is identical with the period of Algol's cycle of variation, and the diminution of light is caused by the interposition of the dark body as it sweeps along that part of its orbit lying between our point of view and the disk of Algol. In other words, once in every two days twenty hours and forty-nine minutes Algol, as seen from the earth, undergoes a partial eclipse.

In consequence of the great comparative mass of its dark companion, Algol itself moves in an orbit around their common center with a velocity quite sufficient to be detected by the shifting of the lines in its spectrum. By means of data thus obtained the mass, size, and distance apart of Algol and its singular comrade have been inferred. The diameter of Algol is believed to be about 1,125,000 miles, that of the dark body about 840,000 miles, and the mean distance from center to center 3,230,000 miles. The density of both the light and the dark star is slight compared with that of the sun, so that their combined mass is only two thirds as great as the sun's.

Mention has been made of a slight irregularity in Algol's period of variation. Basing his calculations upon this inequality Dr. Chandler has put forward the hypothesis that there is another invisible body connected with Algol, and situated at a distance from it of about 1,800,000,000 miles, and that around this body, which is far more mssive than the others, Algol and its companions revolve in a period of one hundred and thirty years! Dr. Chandler has earned the right to have his hypotheses regarded with respect, even when they are as extraordinary as that which has just been described. It needs no indulgence of the imagination to lend interest to Algol; the simple facts are sufficient. How did that bright star fall in with its black neighbors? Or were they created together?

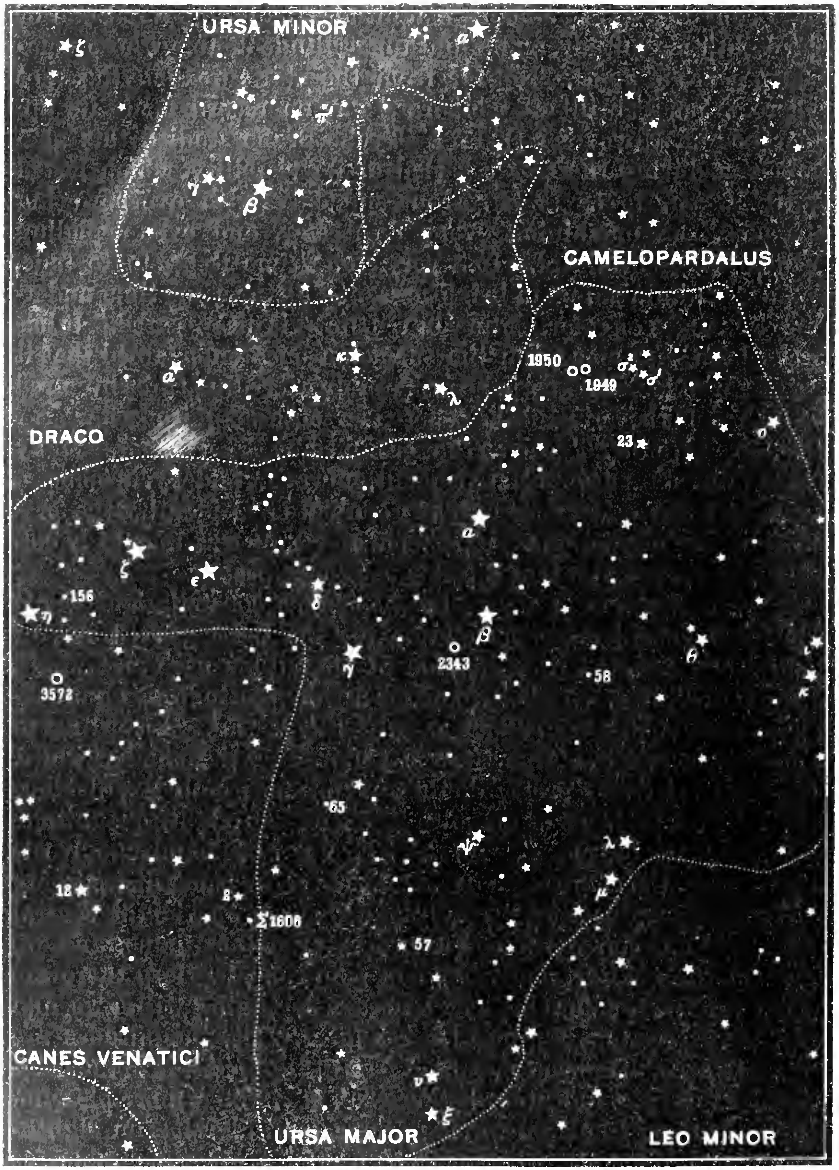
Passing to the region covered by map No. 25, our eyes are caught by the curious figure, formed by the five brightest stars of the constellation Cassiopeia, somewhat resembling the letter W. Like Perseus, this is a rich constellation, both in star clusters and double stars. Among the latter we select as our first example σ, in which we find a combination of color that is at once very unusual and very striking—green and blue. The magnitudes are five and seven, distance $3''$, p. 324°. Another beautiful colored double is η, whose magnitudes are four and seven and a half, distance $5''$, p. 200°, colors white and purple. This is one of the comparatively small number of stars the measure of whose distance has been attempted, and a keen sense of the uncertainty of such measures is conveyed by the fact that authorities of apparently equal weight place η Cassiopeiæ at such discordant distances as 124,000,000,000,000 miles, 70,000,000,000,000 miles, and 42,000,000,000,000 miles. It will be observed that the difference between the greatest and the least of these estimates is about double the entire distance given by the latter. The same thing practically is true of the various attempts to ascertain the distance of the other stars which have a perceptible parallax, even those which are evidently the nearest. In some cases the later measures increase the distance, in other cases they diminish it; in no case is there anything like a complete accord. Yet of course we are not to infer that it is hopeless to learn anything about the distances of the stars. With all their uncertainties and disagreements the few parallaxes we possess have laid a good foundation for a knowledge of the dimensions of at least the nearer parts of the universe.



Map No. 25.

We find an interesting triple in ψ, the magnitudes of the larger components being four and a half and eight and a half, distance 30″. The smaller star has a nine-and-a-half-magnitude companion, distance 3″. A more beautiful triple is ι, magnitudes four, seven, and eight, distances 2″, p. 256°, and 7·5″, p. 112°. Cassiopeia contains many star clusters, three of which are indicated in the map. Of these 392 is perhaps the most interesting, as it contains stars of many magnitudes, including a red one of the eighth magnitude, and a ninth-magnitude double whose components are 8″ apart. Not far from the star κ we find the spot where the most brilliant temporary star on record made its appearance on November 11, 1572. Tycho Brahe studied this phenomenon during the entire period of its visibility, which lasted until March, 1574. It burst out suddenly with overpowering splendor, far outshining every fixed star, and even equaling Venus at her brightest. In a very short time it began to fade, regularly diminishing in brightness, and at the same time undergoing changes of color, ending in red, until it disappeared. It has never been seen since, and the suspicion once entertained that it was a variable with a period considerably exceeding three hundred years has not been justified. There is a tenth-magnitude star near the place given by Tycho as that occupied by the stranger. Many other faint stars are scattered about, however, and Tycho's measures were not sufficiently exact to enable us to identify the precise position of his star. If the phenomenon was due to a collision, no reappearance of the star is to be expected.

Camelopardalus is a very inconspicuous constellation, yet it furnishes considerable occupation for the telescope. Σ 390, of magnitude five, has a companion of magnitude nine and a half, distance 15″, 160°. Σ 385, also of the fifth magnitude, has a ninth-magnitude companion, distance only 2·4″, p. 160°. According to some observers, the larger star is yellow and the smaller white. The star I is a very pretty double, magnitudes both six, distance 10·4″. Its neighbor 2 of magnitude six has an eighth-magnitude companion, distance 1·7″, p. 278°. The star 7 of magnitude five is also double, the companion of magnitude eight being distant only 1·2″. A glance at star cluster 940, which shows a slight central condensation, completes our work in Camelopardalus, and we turn to Ursa Major, represented in map No. 26. Here there are many interesting doubles and triples. Beginning with ι we find at once occupation for our largest glass. The magnitudes are three and ten, distance 10″, p. 357°. In the double star 23 the magnitudes are four and nine, distance 23″, p. 272°. A more pleasing object is σ^2, a greenish fifth-magnitude star which has an eighth-magnitude companion, distance 2·6″, p. 245°. A good double for our four-inch glass is ξ, whose magnitudes are four and five, distance 1·87″, p. 183°. This is a binary with a period of revolution of about sixty years, and is interesting as the first binary star whose orbit was determined. Savary calculated it in 1828. Near by is ν, a difficult double, magnitudes four and ten and a half, distance 7″, p. 147°. In 57 we find again an easy double magnitudes six and eight, distance 5·5″, p. 1°. Another similar



Map No. 26.

double is 65, magnitudes six and eight, distance 3·9″, p. 38°. A third star, magnitude seven, is seen at a distance of 114″ from the primary.

We come now to Ursa Major's principal attraction ζ, frequently called Mizar. The naked eye perceives near it a smaller star, called Alcor. With the three-inch glass and a medium power we divide Mizar into two bright stars brilliantly contrasted in color, the larger being white and the smaller blue-green. Beside Alcor, several fainter stars are seen scattered over the field of view, and, taken all in all, there are very few equally beautiful sights in the starry heavens. The magnitudes of the double are three and four, distance 14·5″, p. 148°. The large star is again double, although no telescope has been able to show it so, its duplicity being revealed, like that of β Aurigæ, by the periodical splitting of the lines in its spectrum.

Ursa Major contains several nebulæ which may be glimpsed with telescopes of moderate dimensions. An interesting pair of these objects, both of which are included in one field of view, is formed by 1949 and 1950. The first named is the brighter of the two, its nucleus resembling a faint star. The nebula 2343 presents itself to us in the form of a faint, hazy star, but with large telescopes its appearance is very singular. According to a picture made by Lord Rosse, it bears no little resemblance to a skull, there being two symmetrically placed holes in it, each of which contains a star.

The portion of Canes Venatici, represented in map No. 26, contains two or three remarkable objects. Σ 1606 is a close double, magnitudes six and seven, distance 1″, p. 336°. It is a pretty sight with the five-inch. The double star 2 is singular in that its larger component is red and its smaller blue; magnitudes six and eight, distance 11·4″, p. 260°. Still more beautiful is 12, commonly called Cor Caroli. This double is wide, and requires but a slight magnifying power. The magnitudes are three and six, distance 20″, colors white or light yellow and blue. The nebula 3572, although we can see it only as a pair of misty specks, is in reality a very wonderful object. Lord Rosse's telescope has revealed in it a complicated spiral structure, recalling the photographs of the Andromeda nebula, and indicating that stupendous changes must be in process within it, although our records of observation are necessarily too brief to bring out any perceptible alteration of figure. It would seem that the astronomer has, of all men, the best reasons for complaining of the brevity of human life.

Lastly, we turn to Ursa Minor and the Pole Star. The latter is a celebrated double, not difficult, except with a telescope of less than three inches aperture in the hands of an inexperienced observer. The magnitudes are two and nine, distance 18·5″. The small star has a dull blue color. In π' we discover a wide double, magnitudes six and seven, distance 30″, p. 83°.

This completes our survey of the starry heavens.

THE LIFE OF WATER PLANTS.

By M. BÜSGEN.

WHEN we mentally survey the floral dress that variegates the solid crust of our globe, the world of plants appears to be divided into a few large groups. We think of the primitive forest with its mossy trees, the slender vines, and the multiform beauties of the orchids; the steppe comes to our minds with its hard, sharp-cutting grasses; and the moist carpeting of the Alpine flora, with gentian and fragrant herbs. The eye lingers longest on the native group; the colored population of our meadows rises before us, the forest with its berried undergrowth, and possibly the bushy river bank and the undulating insulated plant-covering of a pond. Each of the plant groups we have named bears a special expression distinguishing it from all the others. The members of each have certain common features the aggregation of which constitutes the characteristic of the group. In them are included plants which are not at all connected by natural relationship. Ivy is not related to wintergreen or the strawberry to the huckleberry, and all these, again, are far removed from ferns, mosses, and fungi; yet we are satisfied as to the connection of these plants, so that we regard them as members of a definite group, as is represented by our wood flora. So with the other forms we have named, those of the tropical forest, of the steppe, and of the Alpine fields; the plants constituting them are not grouped by blood relationship. Outer circumstances, the conditions of life, have impressed their special characters upon them. The shadow of the wood, the tropical rains, the short summer of the Alps, the aridity of the steppe—all these are factors which have produced in the plants exposed to them common properties more perceived than defined, because they have had effect upon their outer figure as well as upon their vital processes. Thus these groups of plants are developed by the community of their life conditions. They furnish illustrations of Goethe's saying that the manner of life works powerfully on all forms.

We shall study more closely in this paper one of these communities of life conditions—the plant world of the water—and inquire into the connection existing between its most marked peculiarities and the conditions of life afforded by the water. If we walk along the shore of a large pond sheltering a rich growth of plants, or of a bush-lined stream, the vegetable inhabitants will be divided, at first sight, into three groups—the shore plants on the banks; the floating leaves and flowers of the surface plants; and in the depths, hardly visible to the eye, the submerged flora, composed of a few curiously shaped flowering plants, and many of the lower orders belonging for the most part to the little microscopic world. The shore plants form a transition class between the vegetation of the land and that of the water. Taking root in damp soils, or perhaps under water, they lift the greater part of their stems with their leaves and flowers above the surface, joining the land flora in their methods of growing, respiring, and feeding. Among the shrubbery of the meadow, overtopped by single gray-stemmed alders, rise little forests of rustling reeds, both interspersed with variegated masses of various herbs, among which sharp-edged sedges and round-stalked rushes take the first places, by the side of the fragrant calamus, irises, and the umbel-flowers of the tall water violets. Farther ashore rise the beautiful white panicles of the swamp meadowsweet, with the grayish-green leaves and violet flowers of the bittersweet. We must not overlook the white stars of the willow-leaved aster, signs of the beginning of autumn, and the great bindweed, whose threadlike stems find welcomed support on the hard stalks of the reeds. Altogether a variegated picture, the characteristic points of which are hard to separate from the impression of the whole. This is easier to do with two other forms of shore flora which have been developed under peculiar conditions furnished by our waters—the flora of the sandy sea-beaches and that of the unfathomable, unstable morasses of the mouths of tropical rivers. In the former instance a striking appearance is given to the vegetation by the salt contained in the soil. Plants with usually inconspicuous flowers, and also a pretty blue aster, have adapted themselves to life by the salt water. They are sometimes distinguished by their fleshy leaves, the properties of which stand in so close relation to the presence of salt in their habitat that when one is far from the sea he can judge by their presence whether there is salt in the soil.

Characteristic of the tropical morasses are the mangroves, a group of arborescent plants which stand as if on stilts on long, bracing roots sent out from all parts of their stems. The young shoots are hard, dagger-shaped bodies about a metre long, which finally drop down and bore perpendicularly into the slime so that they shall not be disturbed by the current, and may become fixed in the mud. In both of these shore regions the special forms appear to be developed in connection with the peculiar features of the locality.

These adaptations to special conditions thus easily recognized in the shore vegetation are greatly multiplied in the water plants proper. The better to understand them, we must, before going into particulars, devote a few words to the origin of the water flora. Among them are representatives of various orders and classes. They may be divided into plants that have strayed from the land into the water, and those whose original home is that element. The doctrine of the Greek philosophers, that everything is derived from water, is so far correct for the vegetable world that the first plants that appeared on the earth were water plants. There were probably little microscopic forms inhabiting the barely cooled waters of the primitive seas before there was any land to afford a suitable home for any living beings—formless albuminous masses, like "organisms without organs," which, like some of the bacteria, drew their food from the dead stone. Like their living kindred, the lower *Algæ*, they were of too tender nature to be preserved in the cavities of the sea slime. The first remains seemingly of vegetable character preserved in the oldest strata of the earth's crust are therefore of relatively large fucoids. Their existence justifies our supposing an already richly developed flora of *Algæ* such as is now found in the deepest parts of our lakes. Mosses, ferns, and flowering plants are absent. They appear later, and under conditions which prove that they were produced not in the sea but on swampy land. Geological evidence shows us that only the *Algæ* and the fucoids originated in water and were water plants from the first. The other water plants, especially flowering plants growing in water, were driven into the water by increasing competition among the growing number and variety of the land plants, and assumed the properties that now distinguish them from land plants during their compulsory emigration, and in consequence of their water life. This process is now going on in our sight in a certain plant—the wandering knotgrass—a relative of the small-flowered, spreading swine grass and of the adderwort. This plant grows on the borders of ditches and ponds, often half on land and half in the water; and it can not escape the attentive observer that it presents a quite different appearance in the water from that upon land. Stiffly haired, and having short-stemmed leaves on land, it is in water bald and smooth, and develops very long leafstalks which terminate on the surface in flat, floating expansions. Here there is a plant which only occasionally, and usually only partly, makes its home in the water, and is in a position to suffer such remarkable changes that it is no longer a wonder that plants which have become entirely at home in the water are very little like those of their genus which remain land plants. Of many of them, in fact, it can no longer be determined from what family of land plants they are really derived. Even such well-defined plants as seaweed and duckweed would not at first sight suggest to any one relationship with the *Arum* family. So with the water crowfoot, which we shall take as our starting point in the discussion of the properties of water plants. Well known are its little white flowers, which adorn the ponds and even the swift streams in the summer time.

These little blossoms, thickly massed on the surface of the water, or sitting on long stems, spread out their five petals, which, with their numerous stamens and styles, mark them as relatives of the buttercups. In the other parts we look vainly for resemblances with the ranunculuses. If, for instance, we take one of them which we find floating in running water, out of its element, the whole plant falls together, and we hold in our hand nothing but a bunch of long threads, in which no difference can be perceived between stems and leaves. If we spread a part of the bunch upon a stone, we may discover branching shoots beset with leaf forms; but both organs are widely different from those of their nearest generic relatives. The stems of the ranunculuses of the fields are upright, stiff, skeletonlike, strong enough to defy wind and storm, and able to bear the weight of their leaves, flowers, and fruits. The stems of the water ranunculuses are slack and weak. They are swung around helplessly by the waves, winding hither and thither in the direction toward which the run of the stream carries them. They are stable only in the direction of their length, because in any other case the current would carry them away. In other respects the stem does need cohesive power. The whole plant is pierced with connected air passages, and all its parts are adapted to floating or swimming. The water here takes the burden upon itself which is imposed on the stems of land plants. Floating plants need no skeletons; and dissection and microscopic examination show that all those forms are wanting in their interiors which, like the bones of animals, give stability and tenacity to their structure.

Many water plants lack organs still more closely associated with the life processes. We can not conceive of a higher animal without veins and lymph-vessels. But in water plants we not seldom miss the long and broad ducts of which the vascular system of land plants is constituted. At all events the vessels do not perform so important a part in the vegetable kingdom as the circulation of the life juices in the animal kingdom. Their principal service is to carry water from the roots to the leaves. From this we can understand how organs essential to the life of land plants can be dispensed with in water plants. They do not need a special conducting of water, because they are surrounded by that element on every side. The most marked instance of the absence of internal organs is met in an alga which forms green fields in the deeper parts of the Mediterranean Sea. It has slender, branching, horizontally creeping stems which develop above in the water into leaves and below in the sand into fine thread roots. But the whole plant, often many feet in length, consists only of single gigantic cells. A tough skin incloses its juices, which flow in a continuous stream through the stem, leaves, and roots of the curious growth, here taking up through the skin and assimilating mineral substances, there producing and transforming organic matter, and at the same time advancing the growth and increase of the whole. Not less peculiar than the inner structure and appearance of the stem is the form of the leaves of water plants. Their service to the organism is the same with that of the leaves of other plants. They supply, with the help of the sunlight, matter which the plant needs for building up its body. The conditions under water are not very favorable for this work, for the rays of light suffer considerable loss of intensity in passing through even a thin sheet of water. In connection with this there are leaves growing under the water, as in the floating crowfoot, as a rule not flat or oval or cordate or round, like most other kinds of leaves, but divided into the thinnest threadlike strips, which, with the largest surface development, obstruct the least possible light from one another and easily yield to the current.

The leaves that are destined to live on top of the water are otherwise constructed. They will not overshadow one another, and they are exposed to the full light of the sun. They need only to receive it on as broad a surface as possible, and so to float that the weight of the food-stuff accumulated within them all the day long shall not cause them to be submerged. These leaves consequently do not present divisions or ramifications like the leaves of roses and acacias. They form reniform or oval disks, which lie flat upon the water. Every one will recollect this who has seen the yellow and the white pond lilies. The brownish spawn weed and the beautiful white flowing frog spittle likewise have swimming leaves; and there is a marsh crowfoot which has these and submerged threaded leaves all on the same stalk. In the duckweeds stem and leaf are not distinguished, and the plant is only a flat disk with a few insignificant rootlets on the under side; and in one species these are wanting. The plant is only a little floating leaf, with a pocket for the reception of the scantily endowed flowers.

The floating leaves of the Victoria Regia are beautifully developed. They have the form of flat plates with a narrow, upturned border—a form more favorable to their flotation. The green leaves, a yard or more across, with the pink flowers resembling gigantic lilies scattered among them, present a remarkable spectacle.

One of the most remarkable peculiarities of the floating leaves of our water plants is that they never grow up above the surface of the water. The plant appears to know when that point is reached. As we shrink from sudden contact with cold water, these leafstalks suspend their growth on contact with the air. They grow just long enough for the leaf expansion to reach the surface of the water. There it unfolds itself in the full light, and finally lies flat on the water, protected against the wet by a fine, bright coating of wax. It is wonderful how large masses of organized material a water plant can lay up with the help of these floating leaves. The great Victoria Regia grows to its full size in a single year from a small seed. Nearly its whole mass is prepared during growth in the leaves, which can perform such a work only in the strong light and the warmth of the tropical zone.

Submerged plants, as we have already said, are less well provided as to the reception of light than those with floating leaves. Hence those are chiefly small forms which we find at the bottom of our waters. Of these the *Algæ* are the most numerous. There are, indeed, on the whole earth no wet, only moderately light places where *Algæ* have not established a home. Insensible in a high degree alike to heat and cold, they are capable of growing on the snow of the Alps and on the edges of hot springs. We find them on the stones of rushing mountain torrents, in the plunge of the steepest waterfalls, and in the surf of the seacoast, and again at the bottom of the nearly motionless waters of ditches and ponds. The diversity of their habitats corresponds with the immense multitude of their forms. In the form of microscopic dots they will gradually change all the water of a pond or lake into a disagreeable turbid, green, often rank-smelling fluid; sometimes floating on its surface as green or yellow wads dotted with air bubbles; sometimes they appear at the bottom of the water as thick, roundish bundles of green, tangled threads; sometimes as slippery brown coatings.

The *Algæ* of the sea, or seaweeds, are strikingly rich in coloring. Besides green, there are in the sea black, brown, and red forms, the last, under favorable conditions of light, often attaining great size. They seem to be adapted by their peculiar coloring to the tempered blue light of the deeper strata of water. In the great deeps the plant life of the sea is extinguished for want of light. At a hundred metres beneath the surface only a few *Algæ* are found. These are plants of the shade, needing little light. Some of them continue to grow without interruption through the three months' polar night of Spitzbergen, and develop their invisible flowers and fruits at this season with the temperature of the water below the freezing point. The giants of the *Algæ* seek the enjoyment of uninterrupted sunlight. They grow in the deep waters near the shore, and send up slender stalks which pass at the surface of the water into long, shredded leaf forms. *Algæ* of this kind form, on the Chilian coast, for instance, forests in which specimens may be found more than two hundred metres long.

We return, after this excursion into the curious world of the *Algæ*, to the higher plants, and inquire whether there are not special adaptations to a life in the water in the conditions of their blossoming.

The flower of the phanerogam is adapted in general to life in the air and the light. We find, therefore, that the flowers of many water plants with floating leaves aim to reach the surface of the water. They require for the transfer of the pollen to the ovule the aid of the wind or of the insects which hover thickly over the water. Their emergence is effected with the help of floats of various kinds, of which it is sufficient to recall here a much-cited example. In the *Vallisneria*, the long, grasslike leaves of which form a kind of turf at the bottoms of some of the south European lakes, the inconspicuous male flowers rise in knobby bunches protected by a turgid envelope at the bottom of the water. The female flowers stand singly on very long, threadlike stems which rise to the top of the water. When the pollen has matured, the covering of the male flowers opens and the flowers escape in the form of little balls, which, being very light, rise at once to the surface of the water. Here are unfolded three white leaves, which, to use a figure of Kerner's, float around like pollen-laden canoes, and are so wafted by the wind as to convey their freight to the female flowers. While the fruit is forming, the stems of the female flowers roll up spirally and draw the seeds down into the protecting deeps, to remain there undisturbed till the time of germination. The flowers of many water plants, except for these processes, remain concealed in the deep throughout their lives. They do not there bring all their functions to fruiting, which can be accomplished only in the air. Without color or fragrance, they are inconspicuous; their structure is distinguishable only under close examination, and they are proved to be real flowers only by their pollen-shedding and their formation of seeds. Again arise in water plants special tasks. It is incumbent upon one to spread itself as widely as possible and establish its posterity in new places, where it may obtain room for free development and will not be dwarfed under the shadow of larger plants. The seeds, therefore, must not stay where they have fallen when ripened. They must be scattered, and by all means carried away from the immediate neighborhood of the mother plant. The fruits or seeds of water plants are therefore largely endowed with aids to swimming, by the help of which they can accomplish long distances. They share this provision with many shore plants, the whole existence of which is connected with the water in more than one respect. Among these is the cocoa palm, the gigantic fruits of which are comparatively very light. Filled within with cocoanut milk and cocoa butter, food for the young sprout, they possess a thick hull of loosely woven fibers, which forms a most excellent raft to carry the fruit far over the sea till it is stranded on some island to grow there into a new tree. Hence the cocoa palm is the first settler on all coral reefs that rise above the sea, and becomes the most characteristic element of tropical landscapes.

Other water plants employ animals as means of transport. They are swallowed by fishes, from the intestines of which they pass undigested.

The method of dispersion of many of the *Algæ* is especially interesting. They produce wandering cells which, endowed like the infusoria with free motion, shoot around in the water till they find a point on which they can settle themselves and grow. The lens will show us on a stone in the brook or on a dry limb that has fallen into the water a small group of slender threads, perhaps about a third of an inch high, each of which consists of a row of cylindrical cells set one upon another. If we take the plants home, wrapped with their support in round paper or moss, and put them in a dish of fresh water, we shall often be able in a short time to observe the spectacle of the formation of wandering cells. With a microscope we can see the individual cells breaking up and their contents creeping out of the cleft in the form of oval bodies. At the forward end of these swarms we may observe a number of fine threads which swing rapidly back and forth till they acquire a rotary motion, by means of which they swim spirally forward. The Austrian botanist Unger, who was among the first to observe the formation of wandering cells, believed at the time that he had surprised the plants in the act of becoming animals. The vegetable wanderers are, in fact, wonderfully like minute water animals. Many of them have red spots in front, which some have not irrationally supposed were light-perceiving organs or eyes of the simplest sort.

The question whether plants have a consciousness meets us here more impressively than anywhere else in the vegetable kingdom. As we observe how wandering cells swim toward foodstuffs and avoid poisons, seek moderate light and retire from strong light, and distinguish their own likes from the wandering cells of other plants, we find also really no difference. We have to concede that the same feelings and expressions are apparent in both; and if we ascribe a kind of soul to the animals, we can not deny it to the plants. We can not expect to find thought and reason in these circles of simplest light. Those are the prerogatives of the highest inhabitants of earth. The whole existence of these lower beings consists in the unconscious reception of impressions and the unconscious movements occasioned by it. The vital career of the annual water plants closes with the formation of the seed. They die and fall into decay through the agency of the water bacteria, whose activity carries their substance on to renewed life in the circulation of matter. The vegetation of most of our northern perennial water plants is interrupted during the winter. Some of them, like the pond lily, have long rootstocks, in which superfluous food is deposited as in a storehouse in the course of the summer, to serve in the spring for the formation of the new leafy growth; others form special winter buds which, likewise filled with food, separate from the mother plant, sink to the ground, or are frozen in the ice, till the returning warmth of the sun revives them.

Having sought to uncover the mysteries of the household life of the water plants, we now turn to their relations to other families. No group of organisms has ever been able to develop itself independently of all other living beings. Individuals have to acquire the useful properties we admire in them in constant conflict—plants especially, in conflict with the animal world; and the vegetation of the water is as much subject to it as any other. Besides the fishes, there are the water snails and innumerable crustaceans, large and small, turning to water plants for food. Some plants are protected against these creatures by the presence of substances that give their leaves a bitter taste; some have many pointed prickle cells in the interior of their leafstalks which make it impossible for their enemies to bite through them. Most of the seaweeds are furnished with slimy cell walls, on which the water snails try their teeth in vain. The calcareous *Algæ* of the sea enjoy the best protection in the shape of a knotty or coralline form which has little resemblance to a plant, and through the deposition of carbonate of lime in their cell walls, almost turning them into real stone. Only a few marine animals know how to attack them. Among these is a snail that dissolves the lime by means of a secretion of sulphuric acid. With the same material, as Semon has shown, these snails also make sea urchins and starfish digestible, and are therefore brought in reach of an unusual variety of food, in which they are rivaled only by the lobster with his strong cutting jaws.

There are, besides, animal-catching plants among the water vegetation—as the common bladderwort (*Utricularia*), a yellow-flowering plant, with slender stem and finely dissected leaves, which is abundant in still waters in summer. Its leaves bear on and between their points round bladders, about as large as the head of a pin, which serve as animal traps. The most interesting part is an elastic lid, which opens only toward the interior. A wreath of glandular hairs surrounding the entrance of the bladder secretes a slimy material which entices the smaller water crustacea to their destruction. They swim up greedily and collect at the mouth of the bladder to enjoy their feast. One of the guests ventures to get upon the lid. He remains there at first quietly held; but upon his making a more vigorous motion, the lid opens suddenly, swallows the little animal, and then closes again. The captive struggles awhile to escape from his prison, but gradually his movements become weaker, and he dies at last. Now the hairs clothing the interior walls of the bladder begin their work of imbibing food from the softer parts of the animal. When we reflect that a length of a finger and a half of a branch of the bladderwort can thus entrap two hundred of the little crustaceans, we can easily comprehend how the plant can do without roots, upon which it would otherwise depend for its supply of nitrogenous food.

In view of certain investigations which have been made of water flora and fauna for special purposes, I add a few words on the place of the water flora in the economy of Nature. The lower vegetation is of very great importance, especially the microscopic plants, innumerable plantations of which inhabit extensive tracts of all, and especially of northern, lakes. They move around in the water in masses or singly, changing the deep blue color of the spots destitute of organisms into green or dirty yellow. Most numerous among these minute plants wandering in lakes are the diatoms or siliceous *Algæ*, the richness of the forms of which surpasses all imagining. They consist of a nucleus of living substance inclosed as in a box between two siliceous shells. These shells bear markings so fine that they are used, in the same way as the dust of butterflies' wings, as tests for the delicacy of our best microscopes. The diatoms move through the water by the aid of a peculiar propulsory apparatus till they dying sink to the bottom and there go to help form the slime which is of so great importance in the evolutionary history of the crust of the earth. There are also diatoms in fresh water. They are the principal constituents of the brownish-yellow slippery coating of the stones in the beds of brooks.

The work of these and other similar living beings in the economy of Nature is not therefore lost, because they help with their dead remains to build up the dry land and prepare the ground for future generations. Their existence is thus of benefit to their fellow-creatures. As on the land, so there are plants in the sea which elaborate the unenlivened substances of the air and of the mineral kingdom and convert them into matter to become constituents of the bodies of living beings. Inasmuch as they serve as food, or as animals living upon them fall victims to the larger animals, they are the support of the whole animal life of the ocean. When we consider that twelve million individuals of one species of these sea plants hardly contain a half gramme of organic substance, the endless mass of life that perishes to form the material for a whale, for instance, becomes inconceivable.—*Translated for The Popular Science Monthly from the Deutsche Rundschau.*

STUDIES OF CHILDHOOD.

XI.—MATERIAL OF MORALITY.

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(*b*) UNTRUTH AND TRUTH.

WE may now turn to the other main charge against children, that of lying. According to many, children are in general accomplished little liars, to the manner born, and equally adept with the mendacious savage. Even writers on childhood by no means prejudiced against them lean to the view that untruth is universal among children and to some extent at least innate.*

Here, surely, there is need of discrimination. A lie connotes, or should connote, an assertion made with full consciousness of its untruth and in order to mislead. It may well be doubted whether little children have so clear an apprehension of what we understand by truth and falsity as to be liars in this full sense. Much of what seems shocking to the adult unable to place himself at the level of childish intelligence and feeling will probably prove to be something far less serious. It is satisfactory to note a tendency to take a milder and more reasonable view of this infantile fibbing; and what follows is based upon the excellent recent studies of Dr. Stanley Hall and M. Compayré.†

It is desirable to inspect a little more closely the various forms of this early mendacity. To begin with those little ruses and dissimulations which according to M. Perez are apt to appear almost from the cradle in the case of certain children, it is plainly difficult to bring them under the category of full-fledged lies. When, for example, a child wishing to keep a thing hides it, and on your asking for it holds out its empty hands, it would be hard to say that this was a lie, even though there is a germ of deception in the action. We must remember that children have an early developed instinct to secrete things, and the little dissimulations in these

* See the quotations from Montaigne and Perez given by Compayré, *op. cit.*, p. 309 ff.

† Stanley Hall, Children's Lies, American Journal of Psychology, 1890. Compayré, *op. cit.*, p. 309 ff.

actions may be a mere outcome of this hiding propensity, and the accompanying wish that you should not get the hidden thing. Refusals to tell secrets, or, as C—— called them, "private secrets" (a fine distinction), show the same thing. A child, when badgered, is most jealous in guarding what he has been told, or what his fancy has made a secret. The little ruses or "acted lies" to which I am now referring seem to me at the worst an attempt to put off the scent in what is regarded as a private matter, and to have the minimum of intentional deception.

More distinct marks of mendacity appear when the child comes to use language and offers statements which if he reflected he might know to be false. It may readily be thought that no child who has the intelligence to make statements at all could make false ones without some little consciousness of the falsity. But here I suspect we judge harshly, applying adult tests to cases where they are inappropriate. Anybody who has observed children's play and dramatic talk and knows how readily and completely they can imagine the nonexistent so as to lose sight of the existent, will be chary of using the word lie. There may be solemn sticklers for truth who would be shocked to hear the child in play saying, "I am a coachman," "Dolly is crying," and so forth. But the discerning see nothing to be alarmed at here. Similarly, when a little girl of two years and six months, after running over a pretty long series of sounds devoid of all meaning, said, "It's because you don't understand me, papa." Here the love of mystery and secrecy, aided by the dramatic impulse, *made* the nonsense real talk. The wee thing doubtless had a feeling of superiority in talking in a language which was unintelligible to her all-wise papa.

On much the same level of moral obliquity are those cases where a child will say the opposite of what it is told, turning authoritative utterances upside down. A quaint instance is quoted by Compayré from Guyau. Guyau's little boy (age not given) was overheard saying to himself, "*Papa parle mal, il a dit sevette ; bébé parle bien, il dit serviette.*" Such reversals are a kind of play too ; the child is weary of being told he is wrong, and for the moment imagines himself right and his elders wrong, immensely enjoying the idea.

A graver-looking case presents itself when an "untruth" is uttered in answer to a question. C——, on being asked by his mother who told him something, answered "Dolly." False, and knowingly false, somebody will say, especially when he learns that the depraved youngster instantly proceeded to laugh. But let us look a little closer. The question had raised in C——'s little mind the idea that somebody had told him. This is a process of suggestion, which as we shall see presently, sways a child's mind as it sways that of the hypnotized adult. And there close by the child was Dolly, and the child's make-believe includes, as we all know, much important communication with Dolly. What more natural than that the idea should at once seize his imagination? But the laugh? Well, I am ready to admit that there was a touch of playful defiance here, of childish mischief. The expression on the mother's face showed him that his bold, absurd fancy had produced its half-startling, half-amusing effect; and there is nothing your little actor likes more than this after effect of startling you. But more, it gave him at the same instant a glimpse of the outside look of his fancy, of the unreality of the untruth; and the laugh probably had in it the delight of the little rebel, of the naughty, impish rogue who loves now and then to set law at defiance.

Momentary vivid fancy, the childish passion for acting a part, this backed by a strong desire to startle, and a turn for playful rebellion, seems to me to account for this and other similar varieties of early misstatement. Naughty they no doubt are in a measure; but is it not just that playing at being naughty which has in it nothing really bad, and is removed *toto cœlo* from downright honest lying? I speak the more confidently as to C——'s case, as I happen to know that he was in his serious moods particularly, one might add pedantically, truthful.

A somewhat different case is where the vivid fancy underlying the misstatement leads to a more serious self-deception. The Worcester collection gives an example: "I was giving some cough sirup, and E——, aged three years and two months, ran to me, saying, 'I am sick too, and I want some medicine.' She then tried to cough. Every time she would see me taking the sirup bottle afterward, she would begin to cough. The sirup was very sweet." This looks simply awful. But what if the child were of so imaginative a turn that the sight of the sirup given to the sick child produced a perfect illusion of being herself sick—an illusion strong enough to cause the irritation and the cough? The idea may seem far-fetched, but deserves to be considered before we brand the child with the name liar.

The vivid, fanciful realization, which in this instance was sustained by the love of sweet things, is in many cases inspired by other and later developed feelings. How much false statement—and that not only among little children—is of the nature of exaggeration and directed to producing a strong effect! When, for example, the little four-year-old draws himself up and shouts exultantly, "See, mamma, how tall I am—I am growing so fast I shall soon be a giant," or boasts of his strength, and tells you the impossible things he is going to do, the element of braggadocio is on the surface and imposes on nobody.

No doubt these propensities, though not amounting in the stage of development now dealt with to full lying, may, if not restrained, develop into true lying. An unbridled fancy and strong love of effect will lead an older child to say what it vaguely knows at the time to be false in order to startle and mystify others. Such exaggeration of these impulses is distinctly abnormal, as may be seen by its affinity to what we can observe in the case of the insane. The same is true of the exaggeration of the vainglorious or "showing-off" impulses, as illustrated, for example, in the cases mentioned by Dr. Stanley Hall of children who, on going to a new town or school, would assume new characters which were kept up with difficulty by means of many false pretenses.*

A fertile source of childish untruth, especially in the case of girls, is the wish to please. Here we have to do with very dissimilar things. An emotional child who, in a sudden fit of tenderness for mother, aunt, or teacher, gushes out, "Oh, I *do* love you!" or "What sweet, lovely eyes you have!" or other pretty flattery, may be sincere for the moment, the exaggeration being indeed the outcome of a sudden ebullition of feeling. There is more of acting and artfulness in the flatteries which take their rise in a calculating wish to say the nice, agreeable things. Some children are, I believe, adepts at these amenities. Those in whom the impulse is strong and dominant are presumably those who, in later years, make the good society actors. In all this childish simulation and exaggeration we have to do with the germs of what may become a great moral evil—insincerity—that is, falsity in respect of what is best and ought to be sacred. Yet this childish flattery, though undoubtedly a mild mendacity, is a most amiable mendacity through its charming motives, always supposing that it is a pure wish to please and is not complicated with an *arrière pensée*—the hope of gaining some favor from the object of the devotion. Perhaps there is no variety of childish fault more difficult to deal with, if only for the reason that in checking the impulse we are robbing ourselves of the sweetest offerings of childhood.

The other side of this wish to please is the fear to give offense, and this, I suspect, is a fertile source of childish prevarication. If, for example, a child is asked whether he does not like or admire something, his feeling that the questioner expects him to say "Yes" makes it very hard to say "No." Mrs. Burnett gives us a reminiscence of this early experience. When she was less than three, she writes, a lady visitor, a friend of her mother, having found out that the baby newly added to the family was called

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* Article Children's Lies, p. 67.

Edith, remarked to her: "That's a pretty name. My baby is Eleanor. Isn't that a pretty name?" On being thus questioned she felt in a dreadful difficulty, for she did not like the sound of "Eleanor," and yet feared to be rude and say so. She got out of it by saying she did not like the name as well as "Edith."

These temptations and struggles, which may impress themselves on memory for the whole of life, illustrate the influence of older persons' wishes and expectations on children's statements. It is possible that we have here to do with something akin to "suggestion," that force which produces such amazing results on the hypnotized subject, and which is known to be a potent influence for good or for evil on the young mind. A leading question of the form: "Isn't this pretty?" "Aren't you fond of me?" may easily overpower for a moment the child's own conviction, superimposing that of the stronger mind. Such passive statements coming from a mind overridden by another's authority are not to be confused with conscious falsehoods.

This suggestion often combines with other forces. Here is a good example: A little American girl, sent into the oak shrubbery to get a leaf, saw a snake, which so frightened her that she ran home without the leaf. As cruel Fate would have it, she met her brothers and told them she had seen a "sauger." "They knew" (writes the lady who recalls this reminiscence of her childhood) "a difference between snakes and their habits, and, boylike, wanted to tease me, and said, ''Twas no sauger—it didn't have a red ring round its neck, now, did it?' My heated imagination saw just such a serpent as soon as their words were spoken, and I declared it had a ring about its neck." In this way she was led on to say that it had scars and a little bell on its neck, and was soundly rated by her brothers as a "liar." * Here we have a case of "illusion of memory" induced by suggestion acting on a mind made preternaturally sensitive by the fear from which it had not yet recovered. If there was a germ of mendacity in the case, it must have sprung from the half-conscious shrinking from the brothers' ridicule, the wish not to seem utterly ignorant about these boyish matters, the snakes. Yet who would say that such swift, unseizable movements of feeling in the dim background of consciousness made the child's quick responses lies in the proper sense of the word?

It seems paradoxical, yet is, I believe, indisputable, that a large part of childish untruth comes upon the scene in connection with moral authority and discipline. We shall see by and by that unregenerate child-nature is very apt to take up the hostile attitude of self-defense toward those who administer law and inflict

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* Sara E. Wiltse, The Christian Union, vol. xl, No. 26.

punishment, Even the mother herself, beloved as she undoubtedly is, comes in for this antagonism. When the moral *régime* is severe and something like dread of punishment arises, the problem of self-protection is wont to be solved by well-known devices in the shape of subterfuges. In this way a child will say, "I didn't hear you," when a command is given and not at once obeyed; "*I* didn't make the mess, it was *my hand*," and so forth. Quite young children will find their way to little ruses and deceits of this sort when brought face to face with a sharp-faced threatening authority. Thus a mite of three, having in a moment of temper called her mother "monkey," and being questioned as to what she had said, replied, "I said I was a monkey." In some cases the child does not wait to be questioned. A little girl mentioned by Compayré, being put out at something the mother had done or said, cried "Nasty!" (*vilaine*); then, after a significant silence, corrected herself in this wise: "Dolly nasty" (*poupée vilaine*). The skill with which this transference was effected without any violence to grammar argues a precocious art.

I do not wish to say that these prevarications, these dodges for getting out of obedience, or, if disobedience has been detected, of evading punishment, are not rightly named untruths. With every wish to excuse children's peccadillos one can not but recognize here a rudiment of the wish and intention to deceive.

Yet surely it is a matter deserving of reflection that our modes of governing (or misgoverning) children so frequently develop these tricky prevarications. It is not too much to say that anything in the nature of a brutal and terrifying government drives children to these subterfuges as their only resource. I at least should never blame a child greatly for trying to save himself by an untruth with the terror of the "giant" armed with stick or cane hanging over him.

Our moral discipline may develop untruth in another way. When the punishment has been inflicted and the governor, relenting from the brutal harshness, asks, "Are you sorry?" or "Aren't you sorry?" the answer is exceedingly likely to be "No," even though this is in a sense untrue. More clearly is this lying of obstinacy seen where a child is shut up and kept without food. Asked, "Are you hungry?" the hardy little sinner stifles his sensations and pluckily answers "No," even though the low and dismal character of the sound shows that the untruth is but a half-hearted affair.

There is much even yet to be done in clearing up the *modus operandi* of children's lies. How quick, for example, is a child to find out the simple good-natured people, as the servant-maid or gardener, who will listen to his romancing and flatter him by appearing to accept it all as gospel! More significant is the fact that intentional deception is apt to show itself toward certain people only. There is many a schoolboy who would think it no dishonor to say what is untrue to those he dislikes, especially by way of getting them into hot water, though he would feel it mean and base to lie to his mother or his father, and bad form to lie to the head master. Similar distinctions show themselves in earlier stages, and are another point of similarity between the child and the savage, whose ideas of truthfulness seem to be truthfulness for *my* people only. This is a side of the subject which would repay fuller inquiry.

Another aspect of the subject which has been but little investigated is the influence of habit in the domain of lying and the formation of persistent permanent lies. The impulse to stick to an untruth when once uttered is very human, and in the case of the child is enforced by the fear of discovery. This applies not only to falsehoods foisted on persons in authority, but to those by which clever boys and girls take pleasure in befooling the inferior wits of others. In this way there grow up in the nursery and in the playground traditional myths and legends which are solemnly believed by the simple-minded. Such invention is in part the outcome of the "pleasures of the imagination." Yet it is probable that this is in all cases re-enforced not only by the wish to produce a showy effect, but by the love of power which in the child not endowed with physical prowess is apt to show itself in hoodwinking and practical joking.

Closely connected with this establishment of permanent falsehoods is the contagiousness of lying. The propagation of falsehood is apt to be promoted by a certain tremulous admiration for the hardihood of the lie and by the impulse of the rebel which never quite slumbers even in the case of fairly obedient children. I suspect, however, that it is in all cases largely due to the force of suggestion. The falsehood boldly anounced is apt to captivate the mind and hold it under a kind of spell.

This effect of suggestion in generating falsehood is very marked in those pathological or semi-pathological cases where children have been led to give false testimony. It is now known that it is quite possible to provoke in children between the ages of six and fifteen by simple affirmation, whether in the waking or in the sleeping state, illusions of memory, so that they are ready to assert that they saw things happen which they had never seen.*

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* M. Motet was one of the first to call attention to the forces of childish imagination, and the effects of suggestion in the false testimonies of children. Les faux temoignages des enfants devant la justice, 1887. The subject has been further elucidated by Dr. Bérillon.

So much as to the several manners and circumstances of childish lying. In order to understand still better what it amounts to, how much of conscious falsehood enters into it, we must glance at another and closely related phenomenon—the pain which sometimes attends and follows it.

There is no doubt that a certain number of children experience qualms of conscience in uttering falsehood. This is evidenced in the well-known devices by which the intelligence of the child thinks to mitigate the lie, as when on saying what he knows to be false he adds mentally, "I do not mean it," "in my mind," or some similar palliative.* Such dodges show a measure of sensibility—a hardened liar would despise the shifts—and are curious as illustrations of the childish conscience and its unlearned casuistry.

The remorse that sometimes follows lying, especially the first lie which catches the conscience at its tenderest, has been remembered by many in later life. Here is a case: A lady friend remembers that when a child of four she had to wear a shade over her eyes. One day, on walking out with her mother, she was looking, child-wise, sideward instead of in front, and nearly struck a lamp-post. Her mother then scolded her, but presently, remembering the eyes, said, "Poor child, you could not see well." She knew that this was not the reason, but she accepted it, and for long afterward was tormented with a sense of having told a lie. Miss Wiltse, who tells the story of the mythical snake, gives another recollection which illustrates the keen suffering of a child when it becomes fully conscious of falsehood. She was as a small child very fond of babies, and had been permitted by her mother to go, when invited by her aunt, to nurse a baby cousin. One day, wanting much to go when not invited, she boldly invented, saying that her aunt was busy and had asked her to spend an hour with the baby. "I went," she adds, "not to the baby, but by a circuitous route to my father's barn, crept behind one of the great doors, which I drew as close to me as I could, vainly wishing that the barn and the haystacks would cover me; then I cried and moaned I do not know how many hours, and when I went to bed I said my prayers between sobs, refusing to tell my mother why I wept." †

Such examples of remorse are evidence of a child's capability of knowingly stating what is false. This is strikingly shown in Miss Wiltse's two reminiscences, for she distinctly tells us that in the case of her confident assertion about the imaginary snake with ring and bell she felt no remorse, as she was not conscious of uttering a lie. But these sufferings of conscience point

* See Stanley Hall, *op. cit.*, p. 68 f.

† *Loc. cit.*

to something else—a sense of awful wickedness, of having done violence to all that is right and holy. How, it may be asked, does it happen that children feel thus morally crushed after telling a lie?

Here is a question that can only be answered when we have more material. We know that lying is, among all childish offenses, the one which is apt to be specially branded by theological sanctions. The physical torments with which the "lying tongue" is threatened may well beget terror in a timid child's heart. I think it likely, too, that the awfulness of lying is thought of by children in its relation to the all-seeing God, who, though he can not be lied to, knows when we lie. Possibly the inaudible palliative words added to the lie are specially intended to put the speaker straight with the heart-searching God.

Further inquiry is, however, needed here. Do children contract a horror of a lie when no religious terrors are introduced? Is there anything in the workings of a child's own mind which would lead it to feel, after its first lie, as if the stable world were tumbling about its ears? Let parents supply us with facts here.

Meanwhile I will venture to put forth a conjecture, and will gladly withdraw it as soon as it is disproved.

So far as my inquiries have gone, I do not find that children brought up at home and kept from the contagion of bad example do uniformly develop a lying propensity. Several mothers assure me that their children have never seriously propounded an untruth. I can say the same about two children who have been especially observed for the purpose.*

This being so, I distinctly challenge the assertion that lying is instinctive in the sense that a child, even when brought up among habitual truth-tellers, shows an unlearned aptitude to say what it knows to be false.

I go further and suggest that where a child is brought up normally—that is, in a habitually truth-speaking community—he tends quite apart from moral instruction to acquire a respect for truth as what is customary. Consider for a moment how busily a child's mind is occupied during the first years of linguistic performance in getting at the bottom of words, of fitting ideas to words when trying to understand others, and words to ideas when trying to express his own thoughts, and you will see that all this must serve to make truth—that is, the correspondence of statement with facts—something matter-of-course, something not to be questioned, a law wrought into the very usages of daily life

* Dr. Stanley Hall, when he speaks of certain forms of lying as prevalent among children, is, as he expressly explains, speaking of children *at school*, where the forces of contagion are in full swing.

which he never thinks of disobeying. We can see that children accustomed to truth-speaking show all the signs of a moral shock when they are confronted with assertions which, as they see, do not answer to fact. The child C—— was highly indignant on hearing from his mother that people said what he considered false things about horses and other matters of interest; and he was even more indignant at meeting with any such falsity in one of his books, for which he had all a child's respect. The idea of perpetrating a knowing untruth, so far as I can judge, is simply awful to a child who has been thoroughly habituated to the practice of truthful statement. May it, then, not well be that when a preternatural pressure of circumstances pushes the child over the boundary line of truth, he feels shock, horror, a giddy and aching sense of having violated law—law not imposed by the mother's command, but rooted in the very habits of social life? I think the conjecture is well worth considering.

Our inquiry has led us to recognize, in the case of cruelty and of lying alike, that children are by no means morally perfect; they have tendencies which, if not counteracted or held in check by others, will develop into true cruelty and true lying. On the other hand, our study has shown us that these impulses are not the only ones. A child has impulses of kindness, which alternate, often in a capricious-looking way, with those of inconsiderate teasing and tormenting; and he has, I hold, side by side with the imaginative and other tendencies which make for untruthful statement, the instinctive roots of a respect for truth. These tendencies have not the same relative strength and frequency of utterance in the case of all children, some showing, for example, more of the impulse which makes for truth, others more of the impulse which makes for untruth. Yet in all children probably both kinds of impulse are to be observed. All which means that the child is at first a congeries of uncoördinated propensities, some favorable, others unfavorable, to what we mean by goodness, and that education has to transform this into a moral organism in which the tendencies to the good shall become supreme and act controllingly on the tendencies to the bad.

THE English Chemical Society has conferred its Faraday medal on Lord Rayleigh in recognition of the investigation that has led to the discovery of argon. Chemists have before this made excursions into the domain of physics: but Lord Rayleigh, a physicist and mathematician, has turned the tables upon them by making a discovery of first-rate importance in the domain of chemical inquiry. His work is the more remarkable because it was carried on on purely physical lines. It is curious to reflect that only lack of needful delicacy in measurement delayed for one hundred and ten years the discovery on the threshold of which Cavendish stood in 1785.

HUNTING WITH BIRDS OF PREY.

By M. EDOUARD BLANC.

AMONG the animals that man has in different periods of history forced to serve his purposes, none are now so much neglected in western lands as birds of prey. These creatures, however, at a time which is not yet far away from us, constituted the essential factor of falconry, which was a few centuries ago held in the highest honor. This sport, although it has fallen into decay in Europe, is still practiced in northern Africa and some parts of Asia, chiefly central Asia. Having had occasion to indulge in it much on my own account in both these regions, I am able to speak from personal experience of the manner in which it is practiced there. Falconry in Africa, where it has come down from the Arabs of the middle ages, has been described many times, especially from the picturesque point of view. I shall speak especially of the sport in central Asia, where, while it is less known to Westerners, it is practiced more perfectly than in any other country. It has entered completely into the habits of the people, and it is not there, as in Africa, limited to a small number of wealthy proprietors.

The exhibition at Tashkend in 1891 included a department of the chase, in which the most distinguished falcon teams of Turkistan figured prominently. The Khan of Khiva was an exhibitor, and was represented by his best birds and his most skillful falconers. Instead of allotting the prizes, according to the most usual plan, to the best-looking birds, matches were instituted and the relative merit of the competing birds was determined by the test of what they could do. I had an opportunity on this occasion to make a thorough study of the technical details of a sport which I had already practiced under different circumstances.

Such large birds as the eagle are trained for falconry in Turkistan, and are used for the capture of foxes, gazelles, antelopes, and even, it is said, deer. They are so heavy that the falconer is not able to carry them on his arm alone, and has to support it on a wooden prop, the base of which is attached to his saddle.

According to the Arabian traditions, the training of the falcon to hunt was first accomplished by an inhabitant of Mosul; but the training of the eagle has been practiced by the Chinese and the Mongols from an antiquity much more remote than the Arabian period, and falconry was probably introduced into Turkistan from the north of China, and then into Persia, perhaps by some Hunnish people.

Falconry is so deeply established in Turcoman life that people in modest conditions and even children engage in it. A favorite winter game of the children in the streets of Samarcand and other large cities of central Asia consists in setting in flight crows which are held by long strings tied to the hand, and practicing the exercises of falconry with them.

Female birds are preferred in both Asia and Africa, as being larger and stronger than males, and are more readily trained; but males are also sometimes used. Among the great variety of birds of prey in Turkistan, those which are habitually domesticated are first the falcons and hawks. The common goshawk

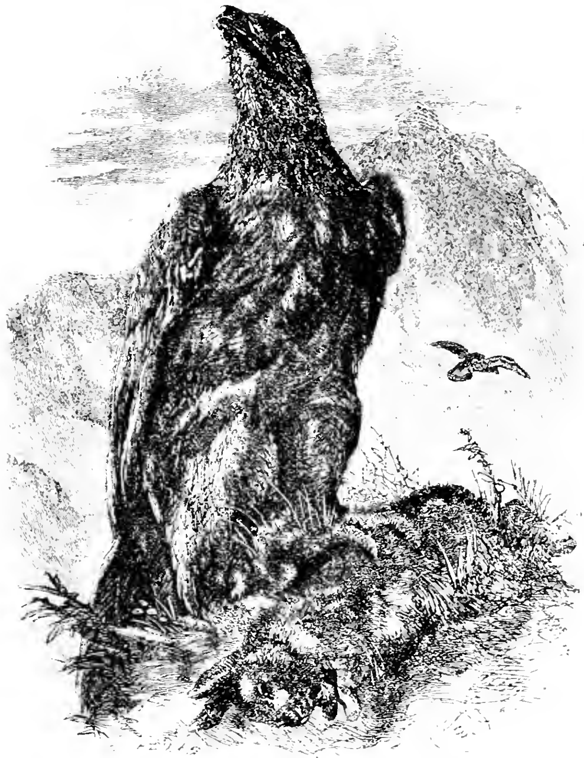


FIG. 1.—GOLDEN EAGLE (*Aquila chrysaëtos*).

(*Astur palumbarius*) and the sparrow hawks (*Accipiter nisus* and *Accipiter virgatus*) are most usually employed and most valued. They are used principally for taking pheasants, partridges, and quails. Most of the buzzards are trained. The kites, which were supposed in ancient European falconry not to be susceptible of training, are used with success. The *Milvus melanotis*, which has been identified by Pallas with the black kite of Europe, but is probably distinct, proves to be quite tractable.

The golden eagle (*Aquila chrysaëtos*), *Aquila daphnea*, and *Aquila clanga* are habitually trained, and are mentioned by travelers, and other varieties or species of eagle are employed. Owls are sometimes trained, but are good only for hunting at night.

Every Turcoman has at least one of these trained birds, of breed and size corresponding with his fortune. They may be seen sitting on their perches in the rear of the bazaars and in the meanest shops, where they are made as much of as any other domestic animal. Whenever their owner goes out for any long distance over the plains, he takes his bird on his wrist or on the horn of his saddle, and if any game crosses his track launches the falcon out against it, as surely as a European or American would shoot at it. The falcon, let loose, flies till it is directly over the game, and then pounces down upon it in a dizzy fall which requires to be directed with the most exact precision, for, with his wings folded, he descends in the perpendicular line, by the sheer force of his weight, and may strike the game or not. If he fails, the hunter draws him in and holds him ready to be sprung at the next victim.

Birds intended to be used in falconry are taken from the nests when very young and trained from the beginning. They are easily found, for, there being no trees in the steppes, they are obliged to nest on the ground or in bushes. Adult birds can also be captured and made useful, and this is done among the Arabs as it formerly was in Europe. One of the methods of catching them is ingenious and curious. Pebbles as large as the bird can swallow without great inconvenience are dipped in blood, which is allowed to curdle on their surface, and are put in places which the hawks frequent. The birds swallow them greedily till they are so weighted down that they can not fly away. The hunters then come up and take them by hand.

As the purpose of central Asian falconry is different from that which was sought in European falconry in the middle ages, different qualities are prized in the birds. Originally, indeed, the purpose was the same in both regions—namely, to capture game which could not be reached with the imperfect arms in use. But falconry became a fine art in Europe, and the skill acquired in cultivating it caused it to be kept in practice long after firearms became common. It was practiced as a matter of pastime and a method of showing off accomplishments; and there was an æsthetic pleasure in watching the lofty flight of the birds and the precision and swiftness with which they would light upon their prey. Those birds were valued highest which, when they missed their mark, would spread their wings before they reached the ground, and soar up again, trying to recover by the speed of their flight the advance which the game made in the interval, and then dash down again and again until they succeeded or the game got out of their reach. On the other hand, those birds which flew directly from the falconer's hand to the game and seized it were regarded as ignoble and of base flight. The Turcomans, Chinese, and Kirghiz, being more practical in their views, especially esteem these birds of direct flight, and have carried their training to a high degree of perfection. The Turcoman nomad, hunting his game as a matter of business, does not want his falcon to attack it too savagely; that would be a waste. His bird should strike the animal as a bullet or an arrow would, and, if he misses it, should stay upon the ground within reach of his master. In the oases like those of Samarcand and Tashkend, wooded with large trees and intercepted by high walls and wide and deep canals, a bird making long and circuitous flights would be often out of sight and sometimes hard to find. Hence birds that fly low are preferred to those that soar aloft.

Fig. 2.—Goshawk (*Astur palumbarius*).

Under these conditions the manner of dispatching the bird is of considerable importance. It is not usual to dispatch it for the game when it is still, but it is unhooded when the game is first seen and while it is yet in motion, and it should be started in such a way that the game shall be the first thing to attract its attention.

The only special articles in the costume of the falconers are the glove and the bird's hood. The glove is of white goatskin, and is armed with a gauntlet for the lower arm. The hood is a little sack of leather or padded cloth, furnished with a running string at its lower part and a leather or metallic ring on the upper part. To put the cap on, the bird is offered a piece of meat, while the owner holds the hood in such a position that it can be slipped over the bird's head as it stretches it out for the morsel. The meat is not given to the falcon, because if it were he would not be so eager to pursue the game. It might be supposed that the falcon would not be drawn to its master by such deceit, but he comes to know his proprietor very well. Decoys are used in training the birds—a piece of stuffed rawhide so fixed as to resemble a hare or other animal sitting on the ground, or some feathered object which when thrown into the air falls with motions like those of a wounded bird. Falconers further provide themselves with a tambourine to call the bird back, a wooden prop fixed to the saddle and forked at the other end to sustain the arm on which the bird is carried, and perches and cages for use at home.

As a rule, the smaller these birds of prey are, the more ardent and brave they seem to be. Very small sparrow hawks and hobbies will attack ducks six times as large as themselves, while most of the larger falcons are only moderately eager for the hunt. Eagles, notwithstanding their size and strength, have very little interest in the sport, and have to be very hungry before they will attack game, and then the game must not be very far away, else they will simply look at it with a philosophic air calculated to make the hunter frantic.

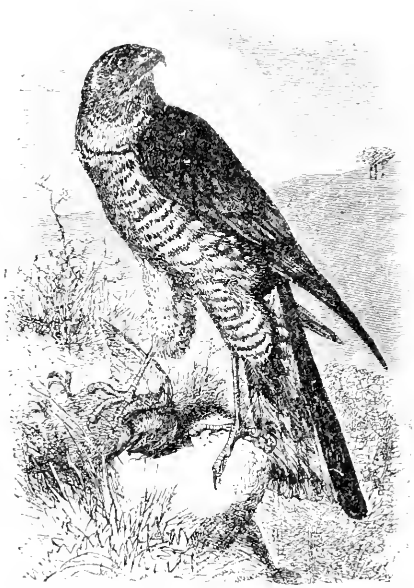


Fig. 3.—Sparrow Hawk (*Accipiter nisus*).

The falcons of Africa are competent to capture chiefly hairy game, while of feathered game they are effective only against small birds and young bustards running along the ground. A good Asiatic falcon, on the other hand, is efficient against every kind of game bird except pigeons. Quails are almost a sure prey to them, and they can catch three fourths of the partridges and half the ducks which they attempt. Ducks, if they are missed at the first descent, often succeed in escaping, either by their cunning or by their power of flight. Pigeons are never taken unless they are surprised or have been wounded. In general, the Asiatic falcons have greater powers of flight than their African congeners; but the African birds are more trusty than the Asiatic. They are in the habit of hunting together, of assisting and re-enforcing one another, and will often answer when their name is called. In chasing a hare, for instance, these birds will fly in a circle, on the lookout for game, in the direction toward which they are dispatched by command, or by the course of the horsemen. When one of them perceives a hare, he aims for it, in order to fall headlong upon it, trying to strike it with his claws or with his beak. If the animal does not remain still and the dash is therefore a failure, the bird reascends and tries his manœuvre over again, calling at the same time to his comrades. They respond, and dash in turn at the game till it is dispatched. If it escapes after it has been missed and succeeds in hiding itself, the birds describe circles as dogs do on similar hunts, and the one which finds it first calls to the others.

The Turkistan birds hunt each on his own account, and are indifferent about seeking game that they have missed. In a few instances, where wealthy proprietors have large packs, the birds have been taught to hunt together and to rally to one another; but such cases are exceptional.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

WAR AS A FACTOR IN CIVILIZATION.

By CHARLES MORRIS.

MAN'S progress toward civilization has been by no royal road. His every step has been met by opposing influences, some of them inherent in Nature, others in the conditions of the social organism, whose action is to prevent any rapid or continuous development. He has, on the other hand, been helped by numerous agencies, some of them such as seem by no means adapted to become aids to civilization. Of these, unlikely as it may appear, the most important and effective has probably been that of war, an agent usually looked upon as simply destructive, but which is, as I hope to show, largely constructive in its effects.

It may seem to many readers absurd to speak of war as a helpful agency in civilization. It is the general impression that a state of profound peace, with its consequent agricultural and mechanical industries, is most conducive to human advancement. Warfare is usually looked upon as simply destructive, and as destitute of any redeeming feature; and yet I venture to claim that all the civilizations to-day existing were in their origin largely the results of ancient wars; and that peace, in the long past of the human race, was almost a synonym for social and intellectual stagnation. The views usually entertained as to the comparative advantages of peace and war apply only to our own enlightened age, and are not wholly correct even now. As applied to the past ages of barbarism and semi-civilization they are far from being correct. Nor will it be difficult, in support of the above assertion, to present instances of long-prevailing peace and of continued warfare, and to show that the latter has had far the most beneficial influence on human progress.

I shall adduce some such instances here as historical evidences in support of my proposition, and afterward consider the causes which lead to such seemingly improbable results. While it may not be possible to name any nations which have existed for a long period in a state of profound peace, there are two very prominent ones which during many centuries have not indulged, or only to an unimportant extent, in foreign warfare. These two possessors of the golden age of peace are China and India. They have had their petty internal combats, but they have not gone abroad as conquerors. They have been conquered, at long intervals apart, by exterior races; but the influx of strange peoples has been like that of the waters of a brook into a lake—the vast masses of the conquered have given color to, instead of receiving color from, their few conquerors. Thus, in these two great nations, the results of long-continued peace have been attained to a more complete extent than elsewhere in the world of civilization.

But when we look at these results we are not strongly encouraged in favor of a golden age of peace. These nations have grown old as many men grow old, their prejudices become rigid, their conceits hardened, their beliefs inflexible. They have reached the limit of their narrow line of development, and crystallized there. Their ideas of industry, of social custom, of law and government, have become fixed and unchangeable. National isolation has removed China from the useful influence of intellectual contact with exterior peoples. Mental isolation has had the same effect in India. Local pride and self-satisfaction have hindered progress, but they have not hindered the deterioration which is sure to set in when progress halts. These nations having, ages ago, lost all active development, and solidified into unchangeable forms, they have become subject to the influences which affect a tree that has ceased to grow. Inevitable decay has supervened. Whole swarms of political, social, and moral delinquencies have crept in and fastened themselves upon the body corporate, which has lacked the vitality to throw them off, and which is being gradually consumed by these eating parasites.

It may be argued, however, that both these nations had attained a considerable degree of civilization before their progress became thus checked. This must be admitted; but it must also be admitted that this progress was chiefly attained during their earlier, warlike stage. Of this we have abundant evidence.

The intellectual growth of the Hindu people was certainly most pronounced in that early period when they were marching southward through hostile realms, and afterward fiercely fighting with the Indian aborigines for a home. It seems to have culminated shortly after this period, and before they sank into their subsequent state of profound peace. Since then they have produced literature, but have not advanced in civilization. In China, also, there is historical evidence of an ancient state of affairs widely different from that now existing. The earlier annals of the Chinese nation present us with a series of separate, independent provinces, among which China proper occupied but a contracted section in the northwest of the present empire. Gradually, through continued aggression, this province extended its borders, brought the others under a sort of feudal allegiance, and finally into complete subjection. During this period civilization was progressing. But since the final establishment of the empire within its present boundaries, and its inauguration of the policy of peace, progress seems to have halted, and mental stagnation to have replaced the ancient intellectual vitality.

If we now come to consider instances of warlike nations, it will be found that a complete parallel can not be made. Warlike nations do not subsist through uncounted generations like those at peace. They conquer and they are conquered; they destroy and they are destroyed; they die and leave their heirs. To consider them properly we must follow them through the long line of their descent, and see how the successive offspring have wrought with the talents of their far-off ancestry. This can not be easily done. Each heir has inherited from several warlike predecessors. There are no entailed estates of human progress, no fixed hereditary successions. The world has gathered up the scattered possessions of its broken peoples and built new empires upon their ruins.

Various examples of marked progress in warlike nations might be adduced from ancient history, particularly in the cases of Greece and Rome. In more modern times we have examples in the history of the Arabians after their proselyting outburst, of Spain after the expulsion of the Saracens, of Europe during the Crusades, and in the infiltration of liberal ideas into the European mind during the Napoleonic wars. But for a more complete illustration, equaling in length the period of the Chinese Empire, the history of western Europe during its whole civilized period must be taken, since, as the former presents us with an instance of almost unbroken peace, the latter yields an example of almost unceasing war. For several thousand years this region has been a theater of conflict: first, between Rome and its barbarian neighbors; second, between the Europeans and their Asiatic invaders;

third, between the several tribes and nations that succeeded Rome. There has been no rest in Europe, no isolation. War has gone on almost unceasingly, between lord and lord, tribe and tribe, nation and nation; and civilization has kept pace with it, developing with a rapidity in marked contrast with the stagnation of China during the same period.

The difference is a striking one. That war was its cause, it is true, may be open to question. Race distinctions may have had much to do with it; but these are certainly insufficient to explain the greatness of the difference, particularly when we remember that during the warlike and advancing period of China the Aryans of Europe were, so far as we are aware, in a state of tribal isolation and stagnation, with no hostilities other than intertribal quarrels. How long they had remained in this condition no one can tell. They broke out of it only when their period of migration and of warlike relations with foreign peoples began, and from that time forward they have steadily advanced from barbarism to high civilization.

If we ask what is the philosophy of this, the answer may not be difficult to reach. Unlike the fixed conservatism of peace, war introduces new conditions, new foundations for human thought, on which the edifice of future civilization may be erected; and, breaking up the isolation of peace, it spreads these conditions throughout the world, making distant nations participants in their influences. The progress of mankind means simply the development of the human mind. Ideas are the seeds of civilization, and under whatever form it appears the idea must be born first, the embodiment must come afterward. In seeking for the causes of advancement, then, we must seek for the sources of new ideas; but, as experience lies at the root of ideas, new ideas can only arise from new experiences. Whence, then, do we derive our experiences? No isolated individual can learn much of himself. His own powers of observation and thought are limited. Our minds can only rapidly develop when we avail ourselves of the experience of others. In this way only can they become storehouses of new thoughts. There is a common stock of such thought abroad in the world, from which we derive the great mass of the ideas which we call our own. And, obviously, that mind will be most developed which comes into contact with and assimilates the greatest number of these thoughts.

The same holds good with nations. An isolated nation is in the same position as an isolated individual. Its experiences are limited, its ideas few and narrow in range. Its thoughts move in one fixed channel, and the other powers of its mind are apt to become virtually aborted. An isolated nation, then, is not likely rapidly to gain new ideas. Yet peace, in all barbarian and semi-civilized nations, seems to tend strongly toward this condition of isolation; and such isolation in its conservative influence is a fatal bar to any wide or continuous progress. The long persistence of one form of government, of one condition of social customs, of one line of thought, tends to produce that uniformity of character which is so fatally opposed to any width of development or breadth of mental grasp. From uniformity arises stagnation. Its final result is a dead pause in mental advancement. Variety of influences and conditions alone can yield a healthy and vigorous growth of thought. The movement of the national mind in any one line must soon cease. Its limit is quickly reached, unless it be aided by development in other directions. China affords us one example of this. There the religion is the worship of ancestors, or the Buddhistic atheism: the learning is the ethics of Confucius; the government is a patriarchal despotism. Religion, learning, and political institutions are thus innately prosaic; there is nothing to arouse the imagination; the mind of the whole people has become hereditarily stagnant through its ages of continuance in this state. In India, on the contrary, the imagination has been fostered at the expense of the reasoning faculties; literature, religion, and political relations are full of an unpruned growth of fancy; and the historical works, which form the basis of the literature of practical China, are unknown in imaginative India.

Such are some of the results of an isolated national development. Progress, in such nations, can not proceed far; for the mind, to attain its best results, must unfold all its faculties together. These strike fire from each other, and produce a genial flame where otherwise would be but smoldering embers. Every separate nation is subject to special conditions. It gains laws, customs, and possessions in accordance therewith. A number of isolated nations is equivalent to a number of separate individuals, each content with his own range of experiences and stock of ideas, and refusing, through prejudice or bigotry, to accept those of others. But when once individuals intimately mingle, and begin to compare thoughts and interchange ideas, a rapid mental growth takes place in each. A similar mental contact is not easy between nations. Isolation and national prejudice form barriers over which thought can but slowly make its way. Yet, evidently enough, were nations, after attaining the limit of progress in their special lines, to be thoroughly mingled, each falling heir to the mental growth of all the others, a sudden and rapid intellectual progress might well be achieved, hosts of new ideas arising from this grand influx of new experiences. In barbarian and semicivilized communities such an intermingling proceeds but slowly in times of peace. A certain degree of intercommerce and of emigration may exist. But emigration under barbarian conditions does not usually bring peoples into contact, except it be the harsh contact of war. The only peaceful contact is the commercial one. Merchants, undoubtedly, in early times penetrated foreign tribes and nations, and brought home, in addition to their wares, stories of what they had seen and learned abroad. But the merchants were too few, too ignorant and prejudiced, and too little given to observation, to spread much useful information in this way; and their peoples were too self-satisfied to give up any customs and beliefs of their own for those thus brought them.

How, then, could any effective result from national contact be produced? In primitive times the only effective agency must have been that of war. Destructive as this is in its results, it has the one useful effect of thoroughly commingling diverse peoples, bringing them into the closest contact with each other, and forcing upon the attention of each the advantages possessed by the other. The caldron of human society must be set boiling before its contents can fully mingle and combine. War is the furnace in which this ebullition takes place, and through whose activity human ideas are forced to circulate through and through the minds of men.

But there is a special cause that renders war peculiarly effective in this direction. In every war there are two peoples to be considered, the invaders and the invaded. The latter remains at home, on the defensive, its government intact, its prejudices condensed by hatred of the invaders, its people strongly bent on both mental and material resistance. The invaders, on the contrary, not only leave their country behind them, but they leave its laws and conditions as well. They march under new skies, over new soils, through new climates. They come into the closest contact with new customs, laws, and conditions. And their local prejudices only partially march with them. The laws of the peaceful state are abrogated in the army. Its members are brought under other laws and disciplines. Religious influences weaken. A sense of liberty fills the mind of the soldier; expectancy arises; new hopes and fears are engendered; the old quiet devotion to law becomes a tendency to license.

Thus the mind of the soldier is in a state essentially unlike that of the peaceful citizen. The one is heated where the other is cool; expectancy in the one replaces the fixed prejudice of the other; a tendency to license and insubordination in the one replaces the law-abiding disposition of the other. The intellect of the soldier is therefore in a state rendering it a quick and ready solvent of new experiences. All its fixity of ideas is broken up, the deep foundations of its prejudices are shaken, it is in a receptive condition; fresh thoughts readily pass the broken barriers of its reserve, it is freely open to ideas which it would have sternly refused in its cold, unsolvent, peaceful stage.

For this reason we find races which have dwelt long in self-satisfied barbarism suddenly leaping into civilization when they assume the rôle of conquerors. The savage hordes of Timur developed, in a few generations, into the comparatively civilized Mogul people of India. From the Saxon pirates who conquered England an Alfred the Great soon arose. The Norman invaders of France quickly threw aside their barbarism and emerged into chivalry.

This rapid change in mental conditions is not displayed by conquered nations. They remain sullen and obstinate. Though conquered physically, they continue mentally on the defensive. Yet the mental resistance of a subject people to their conquerors is only temporary. There is nothing more difficult than to raise fixed barriers in the mind against the influx of thought. The conquerors force on their subjects new social customs and new political institutions. No one can hinder himself from thinking and comparing, and the mind involuntarily opens to take in the advantageous ideas which may be thus presented to it. It is usually religious infusion that is longest resisted. Yet this, too, makes its way rapidly if there is a strong effort to enforce it. Witness the quick outflow of Mohammedanism through the conquered nations of Asia and Africa.

The results of invasion in this direction depend largely on the comparative civilization of the conquerors and the conquered. If a barbarous people overflows a civilized, the mental level of the conquerors is sure to be raised, but that of the conquered is very likely to be lowered. Yet the result is not a mean between the two grades of advancement; for ideas are hard to kill out. Unlike material possessions, they are capable of unlimited duplication. An idea is the one human possession that can be at once kept and given. Thus the ideas of the conquered infuse themselves irresistibly into the minds of their barbarian conquerors, becoming the mutual property of both peoples. If the conquering race be the most advanced, the process is somewhat different. They are likely to avail themselves of all the good they can obtain from the subjected people, and usually endeavor to force upon them their own form of mental discipline and social organization. Resistance to this influence is ineffective if the subjection be long continued. Roman thought and Roman civilization followed Roman conquest over half the ancient world. And when Rome was finally overflowed by barbarians, the persistent Roman thought exercised its lifting force on these conquering tribes, gradually reproducing the downtrodden civilization.

Another consideration naturally flows from the above review of war as a civilizing agency. This is, that the greater the diversity in conditions between two warring nations, the greater is their mutual benefit. Civil wars usually yield but small results in this direction. Few new experiences are gained. It is but the commingling of two similar fluids. Yet in a case like that of our American civil war, where the existence of widely different conditions in two opposed sections of the country is the determining cause of the war, very important advantages to civilization may be gained. It would have taken many years of peace to produce as strong a feeling of the moral obliquity of slavery as was produced in four years of war. The heated minds of our people received the doctrine of abolitionism as a river of new thought, where before it had been but a trickling rivulet. And the overflow of this new thought is gradually making itself felt in the South, despite the fact that the conquerors have left them to their previous isolation.

Thus it is not only the soldier's mind that is heated and receptive; the same condition, in a lesser degree, exists in the nation for whose benefit the army is fighting. The souls of the people march, if their bodies do not, with the army. They are excited, hopeful, eager to participate in its booty, and ready to be influenced by its experiences. And when the conquerors return with spoils in their hands, and new thoughts, beliefs, and aspirations in their minds, they mingle intimately with a people eager to participate in their gains, and in a mental condition highly receptive to their new ideas. The more diverse these from the previous mental state of the people, the greater is the warping influence upon the national mind, and the more decided are the new conceptions attained. Nor in any such case does the conquering race simply lift itself toward the level of the conquered. If we cause oxygen and hydrogen to combine, the result is not oxygen or hydrogen, but water. And, in like manner, the mingling of two diverse grades of thought yields a compound that resembles neither of its constituents, but is a new phase of civilization, a positive step forward in progress.

Thus the world progressed through its long ages of partial civilization. The combined experiences of the members of a tribe yielded a certain degree of advancement, and there stopped. Each tribe differed from all others to the extent that its experiences and their resulting ideas differed. During peace the tribes repelled each other and remained intact, each with its special form of mental progress. In war they overflowed each other, greatly diversified thoughts and habits were brought into intimate contact, new ideas were engendered from the mixture, new forms of civilization arose. And as war was almost incessant, so these new products of thought were constantly brought into existence.

Nomads became agriculturists through conquest; but the habits and ideas gained in a nomadic life mingled with those of the conquered agriculturists, and yielded a new and superior result—superior because based on a wider range of experiences and bringing a greater number of elements into the problem of social development. Mountaineers brought down their ideas to combine them with those born of the plain. Deserts and river valleys poured their common thought results into new and more comprehensive minds. The great ebullition went on. East mingled with west, north with south, mountain with plain, seashore with interior; men's thoughts fused and boiled incessantly; new compounds constantly appeared; the range of ideas grew wider and higher; and mental development steadily advanced—though over the ruins of empires and through the ashes of man's most valued possessions.

It was a destructive process. Life vanished, wealth perished, nations disappeared. But mind remained, and mind infused by every invasion with new ideas. The raw material of progress continued undestroyed. Material production is only inorganic substance poured into the mold of an idea. Its loss is no permanent deprivation while the idea remains. Its destruction is a positive gain if it has aided in yielding a crop of fresh and superior ideas.

The considerations above taken seem to prove that war has been an efficient civilizing agent, despite its cruelty and destructiveness. Nor has its good influence been physical and intellectual only; it has been moral as well. In truth, intellectual development can not go far without instigating moral advancement. But war has a more immediate ethical influence through its influence in combining tribes into nations, nations into empires. It widens human sympathies, brings greater bodies of people under the softening influence of fellow-citizenship, extends more widely the sentiment of human brotherhood, and overcomes that feeling of hostility with which tribesmen are apt to regard all mankind beyond their narrow borders.

War would therefore appear to have benefited man in the past alike physically, mentally, and morally. It can not be claimed to be a necessary agent for these purposes in the enlightened nations of the present. It has been replaced by more efficient civilizing agencies, whose character we now need to consider. In modern times nations have learned how to avail themselves of each other's advantages without going to war for them. Commerce, travel, and emigration have gone far to overcome national isolation, and a peaceful commingling of peoples has taken the place of warlike invasion.

Commerce lay at the foundation of Grecian enlightenment.

The interchange of products is necessarily accompanied, to some extent, with an interchange of ideas. The feeling of curiosity reached a high point of development among the Greeks. It was the thirst *to know* which sent old Herodotus into the heart of hostile nations, and which is sending thousands to-day, in quest of knowledge, through the highways and byways of the world. Greece first fairly set in train this mental commerce. But the peaceful interchange of thought has grown immensely since the Grecian days, the whole world is being ransacked for old ideas and new experiences, and the thought stock of the several nations is gradually becoming a general thought stock, the freehold property of the world.

It is unquestionable that trading nations which have reached a certain degree of mental advancement are efficient agents in propagating civilization. There are several instances of this in the history of the past, but in most of such cases commerce was aided in its effects by colonization. It was not the movement of a few isolated merchants, but of extensive colonies, that produced the commingling of thought, with its useful results. The Phœnicians were the first great trading nation of whom we have any record; and they were the first to emerge into civilization under peaceful influences. The Greeks followed them in this field, and the lofty enlightenment of Athens is more to be ascribed to its commercial activity, its colonizing spirit, and its free reception of the best minds from other nations than to its warlike vigor and success. In more modern times we have had successively the Venetians, the Genoese, the Spaniards, the Portuguese, the Dutch, and the English advancing into commercial activity and, with it, into phases of enlightened energy in close accordance with the width and character of their commerce.

We no longer have to fight our way into the thoughts of the world. Every step of mental development made by an exterior people is becoming our own without need of its being taken by violence. We pick and choose at will throughout the races of mankind, digest what we thus consume, assimilate the good, avoid the evil, and widen our minds continually in the process. If it is something to learn what good exists unknown to us, it is also something to know what evil exists. A knowledge of good and evil alike is essential to human progress. And this process is in no sense a destructive one. In war not only possessions are destroyed, but to some extent ideas as well. It is only the remnants that enrich the conquering race—the methods of material production, the religions and philosophies, the rigid laws and customs among which they settle down and which they are forced to assimilate.

Modern progress is not gained by the gathering up of the relics of a conflagration. It is a whole, healthy, and complete development, a method full of infinite possibilities. Yet it has its apparent drawbacks. The minds of people working peacefully at home are not in the recipient state of that of the soldier, who has broken the chains of law and habit and grown singularly porous to the reception of new ideas. Local prejudices dwell at home with localized people. Knowledge has to fight its way through a thick crust of self-satisfied home partisanship. Men must come into contact with each other if conservatism is to be eliminated. They are fortunately coming more and more into peaceful contact with each other. Modern facilities are rendering habits of travel more general. There is as much peaceful movement now as there was warlike movement of old. The stay-at-home society is yearly losing membership.

And this process is wonderfully aided by another instrumentality. Men's bodies on longer need to touch for their ideas to come into contact. Ideas themselves are on their travels. The whole world, in a contracted sense, lies before every man at his breakfast table. The newspaper, aided by the telegraph, is a most powerful civilizing agent. In books not only the thought of the existing world, but a condensed epitome of the thought of all the past, is placed before the reading public. The library is the great granary of ideas. The press is the brain of the world, the grand receptacle of its thoughts.

Thus, in a wider sense than ever before, we travel and learn. Our souls travel while our bodies are at rest. The whole world is harvesting all the experiences and ideas gained by any portion of mankind. It is not the destructive harvesting of war, but the careful harvesting of peace. And prejudice—the mental isolation which has succeeded to national isolation—is breaking down before it. We are growing more and more receptive. The world's mind is becoming strikingly porous to new thought. We are cut ting loose from fixity of belief, rigidity of custom, and devotion to authority, and growing mentally flexible, inquiring, and rebellious against bigotry. The reign of faith is giving way to the reign of reason.

And in this modern mode of development ethical evolution comes actively into play. Human progress has its three phases—the physical, the intellectual, and the moral. The last, the highest of all, was but imperfectly provided for in the old civilizing agencies. War has a brutalizing tendency. Only in peaceful development can moral progress fully display itself. As the highest moral advancement of mankind has seemed to keep pace, perhaps necessarily, with the highest intellectual development, it was undoubtedly to some extent favored by war. Certainly, in the warring nations of Europe morality has reached a far higher stage than in the peaceful nations of eastern Asia, essentially, no doubt, through the influence of Christianity, but largely through the development of the intellect, the disappearance of local prejudices, and the extension of human sympathy arising from the formation of great nations.

War still exists, but it has largely lost its function as a civilizer so far as enlightened nations are concerned. New and superior agencies are at work, and the injury done by war now looms far above any good it is likely to accomplish. Yet its active power in the spread of ideas continues, as in the notable instance I have already named—that of the rapid growth of abolition sentiment in the North during the American civil war. Possibly future useful effects in the same direction are still reserved for war, though it is to be hoped that man may henceforward rest content with the more desirable, if slower, results of peace.

SKETCH OF DAVID HOSACK.

In the early part of the nineteenth century no citizen of New York was held in higher honor than was De Witt Clinton. Closely associated with Clinton in the leadership of the civic life of the day, but holding rigidly aloof from politics, was Dr. Hosack. "It was not infrequently remarked by our citizens," said his pupil and associate, John W. Francis, "that Clinton, Hosack, and Hobart were the tripod on which our city stood." Dr. Hosack was one of the founders of the New York Historical Society and its president from 1820 to 1828. He was also instrumental in founding an art society, was prominent in various scientific, literary, and humane undertakings, and, if his lead had been followed, New York would have to-day a botanic garden equal to any in a European metropolis.

David Hosack was the eldest of seven children, and was born August 31, 1769, in the house of his maternal grandfather, No. 44 Frankfort Street, New York. His father, Alexander Hosack, was a native of Morayshire (Elgin), Scotland. Having entered the British army, he was, at the age of twenty-one, serving as an officer in the artillery. He came to America in the force under General Sir Jeffrey Amherst, and was at the retaking of Louisburg. April 1, 1768, he married in New York Jane, daughter of Francis Arden. Her father's family came from England, while that of her mother belonged to that valuable contingent of Huguenot citizens which America received as a consequence of the revocation of the Edict of Nantes.

Young David, after receiving the ordinary elements of education, was placed at fourteen or fifteen years of age in the academy of the Rev. Dr. Alexander McWhorter, of Newark, N. J., where he pursued the study of Latin and other usual branches and began to learn Greek. But as Dr. Peter Wilson, of Hackensack, was a more distinguished teacher of the latter tongue than Dr. McWhorter, David was transferred to his academy in 1785. The next year he entered Columbia College, remaining in that institution until the middle of his junior year. He had also private tutors in the classics and the French language. In the beginning of the junior year, finding his time not fully occupied, he took up the study of medicine as a private pupil under Dr. Richard Bayley. "He had scarcely begun his studies," writes his son,* "before the celebrated 'Doctors' Mob' occurred, which threatened serious results to those concerned; it arose in consequence of the imprudence of some of the students carelessly pursuing dissection in the building upon the site since occupied as the New York Hospital. This mob caused many of the professors to absent themselves from the city and others to seek shelter in the city jail. Mr. Hosack, with the rest of the students interested, learning that the mob had seized upon and demolished the anatomical preparations found in the lecture room above referred to, repaired immediately to Columbia College,† with the view of saving such specimens as were to be found in that institution. Before reaching the college, however, and when on his way in Park Place, he was knocked down by a stone striking him on the head; he would in all probability have been killed had it not been for the protection he received from the neighbor of his father, Mr. Mount, who was passing at the time and took care of him."

In the fall of 1788 young Hosack entered the senior class of the College of New Jersey at Princeton in order that he might the sooner complete his collegiate course and devote his whole attention to the study of medicine, to which he had become ardently attached. "Having finished my course at Princeton," he says in some memoranda that he left for the benefit of his children, "I returned to New York and resumed my favorite medical studies, to which I now gave my undivided attention, availing myself of every advantage which the city at that time presented. I attended the lectures on anatomy and physiology delivered by Dr. Wright Post, those on chemistry and practice of physic, by Dr. Nicholas Romayne, and the valuable course on midwifery and the diseases of women and children, by Dr. Bard.

* Dr. Alexander E. Hosack, in a biography contributed to the Lives of Eminent American Physicians and Surgeons of the Nineteenth Century, edited by Samuel D. Gross, M. D. From this biography most of the facts for the present article have been drawn.

† Then in College Place.

I also attended the practice of physic and surgery at the almshouse, which then offered the only means of clinical instruction in this city; they were, however, very ample, the house being daily visited by Dr. Post, Dr. William Moore, Dr. Romayne, and Dr. Benjamin Kissam."

There was then no institution in New York empowered to grant the degree in medicine, the medical faculty of Columbia, formerly King's College, having been broken up by the Revolution. So, after a year of private study, Hosack proceeded to Philadelphia and enrolled at the medical school of the University of Pennsylvania, where Drs. Shippen, Rush, Kuhn, and Wistar were then among the professors, and in the summer of the succeeding year obtained his medical degree. In the same year he married at Princeton Miss Catharine Warner, a young lady of great worth, to whom he had become attached while pursuing his collegiate studies.

By the advice of Dr. Rush and others whom he consulted, Dr. Hosack settled first at Alexandria, Va., which place he believed was to be the capital of the United States. The practice that he acquired here, although considerable, was not satisfactory to him, and after a year's residence he returned to New York. He now determined to supplement his medical studies abroad. "Observing the distinction," to quote his own words, "which our citizens at that time made between those physicians who had been educated at home and those who had had additional instruction from the universities of Europe, and knowing how little property I had reason to expect from my parents, I found that my chief dependence was upon my own industry and increasing attention to the profession I had chosen as the means of my subsistence: my ambition to excel in my profession did not suffer me to remain insensible under such distinction. Although it was painful for me to think of leaving my family, consisting then of a wife and child, I accordingly suggested to my father the propriety of my making a visit to Europe, and of attending the medical schools of Edinburgh and London. He at once, with his characteristic liberality, acquiesced in my views and wishes. In August, 1792, leaving my family to the care of my parents, I took passage for Liverpool."

After spending a few days in Liverpool he proceeded to Edinburgh, where he attended the medical lectures at the university during the following winter. In the spring, after a visit to his father's birthplace, where he met two uncles and other relatives, and to some other places in Scotland, he repaired to the metropolis and entered as a pupil of St. Bartholomew's Hospital. He also frequently visited other hospitals when any important surgical operations were performed, surgery being the favorite subject of his pursuit; he nevertheless did not neglect the collateral branches of medical science.

It was during this stay abroad that his interest in botany sprang up. "Having," as he says, "upon one occasion—while walking in the garden of Prof. Hamilton, at Blandford in the neighborhood of Edinburgh—been very much mortified by my ignorance of botany, with which his other guests were familiarly conversant, I had resolved at that time, whenever an opportunity might offer, to acquire a knowledge of that department of science. Such an opportunity was now presented, and I eagerly availed myself of it. The late Mr. William Curtis, author of the Flora Londinensis, had at that time just completed his botanic garden at Brompton, which was arranged in such a manner as to render it most instructive to those desirous of becoming acquainted with this ornamental and useful branch of a medical education. Although Mr. Curtis had for some time ceased to give lectures on botany, he very kindly undertook, at my solicitation, to instruct me in the elements of botanical science. For this purpose I visited the botanical garden daily throughout the summer, spending several hours in examining the various genera and species to be found in that establishment. I also had the benefit once a week of accompanying him in an excursion to the different parts of the country in the vicinity of London. Dr. William Babbington, Dr. Thornton, Dr. (now Sir) Smith Gibbs, Dr. Hunter, of New York, the Hon. Mr. Greville, and myself composed the class in these instructive botanical excursions, in the summer of 1793.

"By Mr. Dixon, of Covent Garden, the celebrated cryptogamist, the '*maximus in minimis*,' as Mr. Curtis has very properly and facetiously denominated him, I was also initiated into the secrets of the cryptogamic class of plants. In the spring of 1794 I also attended the public lectures of botany delivered by the President of the Linnæan Society, Dr. (now Sir) James Edward Smith; and by the kindness of the same gentleman I had access to the Linnæan Herbarium. I spent several hours daily for four months examining the various genera and the most important species contained in that extensive collection." The acquaintance thus begun with Sir James Edward Smith ripened into an affectionate friendship, and a correspondence was begun that ended only with Smith's life.

In the course of the winter of 1793–'94 Dr. Hosack embodied certain Observations on Vision in a paper which he communicated to the Royal Society. It was published in the society's Transactions for 1794, and brought him, after due examination by a committee, the thanks of the society. A theory was in some vogue at the time that the power of accommodation in the eye resided in the crystalline lens. Hosack maintained the opposing theory that it depended upon the external muscles. His paper contained many original views, and its statements were supported by experiments that he had made upon himself and others.

He returned to New York in 1794 by the ship Mohawk, the passage lasting fifty-three days. On the voyage typhus fever made its appearance and became very general, particularly among the steerage passengers. Dr. Hosack being the only physician on board, was called upon to attend the stricken ones, and was wonderfully successful, not losing a single case. His services were duly appreciated by all, as was evinced by the unsolicited vote of thanks published in the daily papers when the ship reached port.

Taking up his residence in New York city, Dr. Hosack, at the age of twenty-five years, began again the practice of his profession under the most favorable auspices. Mr. Thomas Law, who had been a fellow-passenger on the Mohawk, introduced him to many of his acquaintances, among whom were General Hamilton and Colonel Burr. He soon became the family physician to these distinguished persons. In 1795 he was appointed Professor of Botany in Columbia College, for which position his diligent application to this science in London had admirably fitted him. At the end of his first course he published a syllabus of his lectures, afterward inserted in his Medical Essays. In 1795, also, the yellow fever reached New York, and the violence of the epidemic afforded ample opportunity to young medical men to distinguish themselves. Dr. Hosack at this time attracted the especial attention of Dr. Samuel Bard, one of his former preceptors, who soon after took him into partnership. This was a preparatory step to Dr. Bard's retiring from the profession, which he did three or four years later, leaving Dr. Hosack in the enjoyment of an extensive and profitable practice.

Having lost his infant son during his absence in England and his wife not long after his return, Dr. Hosack married, December 21, 1797, Mary, daughter of James and Mary Darragh Eddy, of Philadelphia. By this marriage he had nine children.

Upon the death, in 1797, of Dr. William Pitt Smith, his chair of Materia Medica in Columbia College was assigned to Dr. Hosack, in addition to the one of Botany already held by the latter. He continued to fill these two professorships until 1807, when the College of Physicians and Surgeons of the State of New York was established, in which he was chosen Professor of Surgery and Midwifery. He soon, however, relinquished this chair for that of the Theory and Practice of Physic and Clinical Medicine. The Analectic Magazine for 1814 contained a notice of an introductory lecture given in the last-named chair, which had been published. It says that, after an opening statement on another matter, "Dr. Hosack proceeds to point out what he deems the proper method of cultivating the science of medicine. He recommends the inductive system of philosophizing as the only sure means of acquiring correct methods in science, and enforces the same by the celebrated examples of Bacon, Boyle, and Newton in physics, of Reid, Bentley, and Stewart in metaphysics, and of Hippocrates, Sydenham, and Boerhaave in medicine."

Meanwhile Dr. Hosack had become prominently known for his success in the treatment of yellow fever, which had visited New York in four successive summers, beginning with 1795, and afterward in 1803, 1805, 1819, and 1822. On many occasions, when disease suspected to be yellow fever broke out, he was called upon by the Board of Health of New York for a report as to its real nature, for if the fears of his fellow-citizens were groundless his statement would be sure to allay them.

Of Dr. Hosack in the professorial chair, Dr. Minturn Post, one of his pupils, has said: "In no respect was Dr. Hosack more remarkable than as a lecturer; gifted with a commanding person and a piercing eye, of an ardent temperament and of strong convictions, his manner of treating the various subjects connected with his professorship was at once bold, impressive, and eloquent. . . . His great object was to direct the student to the importance of the subject under examination, to lead him by his eloquence, and to rivet his attention by his earnestness, and no man ever succeeded better as a public lecturer in attaining these results. . . . Dr. Hosack was gifted with a fine, sonorous voice, great play of expression, and a remarkable vivacity of manner—qualities which, being as it were contagious, begat in his youthful auditory a kindred sympathy." In closing his account above quoted Dr. Post remarks: "He lived in memorable times, before the great men of the Revolution had passed away; had seen and conversed with the most eminent of the age; had listened to the inspired song of Burns, tuned to sweet cadence, from his own lips; was intimate with Rush, and Gregory, and Sir Joseph Banks, and was the friend of Clinton and Hamilton." The friendship of Hamilton was probably won for the most part by his success in saving the life of a son of the general sick with scarlet fever, whose case for a time was deemed hopeless. This friendship was conspicuous on every occasion, and was terminated only on that day when Dr. Hosack accompanied Hamilton across the Hudson River to his fatal duel with Colonel Burr.

Dr. Hosack is often mentioned as one of the leading promoters of science of his time. "His love of botanical science," says his son, "induced him to found the Elgin * Botanic Garden, which

* So named after the village in Scotland where his father was born.

he did at his own individual expense, as early as 1801. It was situated about three miles and a half from the city of New York. It consisted of about twenty acres of land on the middle road.* It was selected from its varied soil as peculiarly adapted to the cultivation of the different vegetable productions. The grounds were skillfully laid out and planted with some of the most rare and beautiful of our forest trees. An extensive and ornamental conservatory was erected for the cultivation of tropical and greenhouse plants, as well as those devoted to medical purposes, more especially those of our own country.

"At this time there were under cultivation nearly fifteen hundred species of American plants, besides a considerable number of rare and valuable exotics. To this collection additions were made from time to time from various parts of Europe as well as from the East and West Indies. It was the intention of the founder of this beautiful garden, had his means been more ample, to devote it to the sciences generally, more especially those of zoölogy and mineralogy. This, however, he was compelled from want of fortune to relinquish, hoping that the State of New York would at some future day be induced to carry out the plan as suggested by him similar in all respects to that of the Garden of Plants in Paris; but in this he was disappointed. The State purchased the garden from him, but, like many other public works unconnected with politics, it was suffered to go to ruin. While it was in his possession it afforded him many a pleasant hour of recreation, and served to abstract him from the cares and anxieties of an arduous profession." Frederick Pursh, author of the Flora Septentrionalis, was for several years curator of this garden.

A jail society, which had existed in New York to supply provisions to prisoners for debt, was developed by Hosack into the Humane Society, with broader aims and means. The City Dispensary received no less his care and attention. He vigorously advocated a separate hospital building for contagious diseases, the strict enforcement of quarantine regulations, the substitution of stone piers for wooden ones, and urged that the city's sewers should discharge at the outer ends of the piers instead of at the bulkhead line.

His friends often wondered that Dr. Hosack found time to contribute so much as he did to the literature of his profession. At an early period he began the publication of the Medical and Philosophical Register, a quarterly journal, in which Dr. John W. Francis was associated with him. He afterward published

* The location is given in Mrs. Lamb's History of New York as lying between Fifth and Sixth Avenues and stretching from Forty-seventh to Fifty-first Streets.

three volumes of his Medical Essays, containing occasional addresses, introductory lectures to his regular courses, many practical papers on medical subjects, etc. He also published an extensive appendix to a work on the Practice of Medicine, by Dr. Thomas, of Salisbury, England. Adopting the nosological arrangement as a system best calculated to illustrate diseases, he was induced to prepare a work on that subject, which ran through several editions.

Botany was not the only branch of science in which he became interested while abroad. To quote from a sketch of his life by a friend: "He attended in the winter of 1793–'94 the first course of lectures on mineralogy that was delivered in London by Schmeisser, a pupil of Werner. With this additional knowledge of mineralogy, which Dr. Hosack had begun to study at Edinburgh, he continued to augment the cabinet of minerals which he had commenced in Scotland. This collection was brought by him to the United States, and was, we believe, the first cabinet that crossed the Atlantic; it was afterward deposited in Princeton College, in rooms appropriated by the trustees, but fitted up at the expense of the donor, similar to those at the *École des Mines* at Paris. To render this donation immediately useful, it was accompanied by a collection of the most important works on mineralogy."

Having a large circle of friends and acquaintances, and being fond of company, Dr. Hosack used to set apart his Saturday evenings for entertaining them. "Surrounded by his large and costly library, his house was the resort of the learned and enlightened from every part of the world. No traveler from abroad rested satisfied without a personal interview with him; and, at his evening *soirée*, the *literati*, the philosopher, and the statesman, the skillful in natural science and the explorer of new regions, the archæologist and the theologue met together, participators in the recreation of familiar intercourse." Many a distinguished American and many a foreign visitor, coming with a letter from some European friend of Hosack, has left on record his delightful experience in a visit to the doctor, either at his city house or his place in the country.

Of the scientific honors most prized by Americans in his day—membership in European societies—Dr. Hosack had a goodly share. He also received the honor of having a genus of plants named for him. The various species of *Hosackia*, of which there are some thirty, are herbs and shrubs growing in the Southern and Southwestern States and in Mexico.

His second wife having died, Dr. Hosack married Mrs. Magdalena Coster, widow of the Holland merchant, Henry A. Coster. Some time after this event he retired from his profession and spent the rest of his life, except the winter months, on the beautiful estate at Hyde Park, on the banks of the Hudson, which he had owned for a number of years. Here he devoted himself to agriculture and to growing plants of botanical interest. "He carried with him," his son remarks, "the same ardor and zeal which had been so characteristic of him in his professional career. He introduced into the country many of the finest breeds of cattle, sheep, and swine, which he imported at great expense from abroad. The grounds were cultivated in the best possible manner, and the most esteemed fruits and vegetable productions of the country were made to thrive in the greatest luxury possible."

In the autumn of 1835 Dr. Hosack removed as usual to his city residence, and a few weeks after was seized with apoplexy which terminated his existence. One morning in December he went out and did some business errands, and on his return home found he was paralyzed in his right arm. His speech was also affected. He received immediate attention from his son, Dr. A. E. Hosack, and later from several of his professional friends. But their efforts were of no avail. His symptoms became worse, and four days after the attack, on December 22d, he passed away. His body was placed in the family vault in the marble cemetery in Second Street.

One of the surest ways in which an eminent man can cause his influence to live after him is in training up younger men to lives of usefulness. This Dr. Hosack was constantly doing. "I can scarcely recollect the time," says his son, "when he was without some such *protégé*." At one time it was the son of a New York carpenter, who unfortunately fell a victim to his devotion to yellow-fever patients in the epidemic of 1798. At another it was a young Frenchman, who without means, had come to America to study its flora, his family having been forced to leave France on account of the Revolution there. Dr. Hosack took him into his family and educated him as a physician. He returned to France and became eminent as a botanist. This was Prof. Delile, who accompanied Napoleon to Egypt as the botanist of his scientific corps, and was afterward superintendent of the *Jardin des Plantes* at Montpellier. Among Dr. Hosack's regular pupils at the College of Physicians and Surgeons was John Torrey, and many other students who heard his lectures at the medical school or at Columbia College had whatever of inclination toward botany they possessed greatly quickened by the enthusiasm and eloquence of Dr. Hosack.

EDITOR'S TABLE.

SCIENCE AND NESCIENCE.

IT is a very long time since the discovery was first made that the processes of human thought are only valid within limits; and it might be supposed that all the consequences which could properly be deduced from that fact had long ago been drawn and reduced to their true value. Yet every now and again it seems to strike some thinker with new force that the human mind is not all-comprehending; and it is a singular thing that, when this happens, we are nearly always asked to take back some view or doctrine which we had previously discarded, or at least laid aside, as destitute of proof and not in harmony with the general body of our knowledge. In other words, because we can not understand or measure everything, we must consider that there is a door perpetually open into some fourth dimension, as it were, through which may freely enter beliefs of the most fantastic kind, and such as, judged by the laws of our own familiar three dimensions, we should utterly refuse to accept. No other than this is the lesson which Mr. Balfour attempts to teach in his much-discussed work, The Foundations of Belief. He proves, most unnecessarily, that science can not reach the absolute origin of things, and that, when we get back to such ultimate conceptions of matter and force as we are capable of forming, we do not discover those finished products of human evolution, moral authority and the sense of beauty. His work is described on the title-page as being "introductory to the study of theology," and the author makes it plain that what he would have us do is, on the ground of the insufficiency of human reason, to accept a system of theology, preferably the Christian, which, while carrying us back to the origin of all things, will provide a basis for those moral beliefs and sentiments which are essential at once to the dignity of the individual and the cohesion of society, but which science, as he holds, can neither explain nor justify.

Now, we have no objection whatever to Mr. Balfour's conclusion that people should cherish some form of religious belief, but we think he is ill advised in trying to prove that, because science is weak, theology (*his* theology) is probably strong. Whatever weakness attaches to science attaches to it by virtue of the limitations of the human mind, which, as Matthew Arnold says,

> "A thousand glimpses wins,
> But never sees the whole."

Science, as we have often said in effect, is simply the product of the striving of the mind after exact knowledge; and by exact knowledge we mean knowledge brought more and more into conformity with the totality of human perceptions. If Mr. Balfour could convict science of using illegitimate processes or of endeavoring to stereotype unverified or imperfectly verified doctrines, he might very properly bid us look elsewhere for guidance; but this he nowhere does. He is well aware that civilization is rich to-day with the garnered results of a score of separate sciences, and that men are coming and going and living their lives in a well-grounded assurance that, in the main, what science teaches as true is true, and that work done on scientific principles will stand.

Science might perhaps conveniently be defined as the kind and extent of knowledge which the constitution of the human mind permits us to have; and, so viewing it, we certainly fail to see what theology can do for us in the way of bringing knowledge or rational belief within our reach that science can not do. Will it be said that, while science reflects the limitations of the human mind, theology does not do so? History would certainly not confirm such a contention. Science uses imagination, but keeps it, or tries to keep it, under control; theology, if we judge by the systems that have held sway in the past, has used imagination, has hardly even tried to control it, and has often been completely overmastered by it. In ancient Egypt, according to Erman, "we find a mythology with myths which are absolutely irreconcilable existing peacefully side by side; in short, an unparalleled confusion (which) . . . became ever more hopeless during the three thousand years that, according to the pyramid texts, the Egyptian religion flourished." Yet the books in which this religion was set forth were so sacred that "even the gods themselves were supposed to wash seven times" before reading them. "The lively Grecian," as we know,

> "In a land of hills,
> Rivers and fertile plains and sounding shores,
> Under a cope of variegated sky,
> Could find commodious place for every god";

but the myths he wove about those gods were of so doubtful a moral tendency that Plato was opposed to allowing them to enter into the education of youth. Of the sacred rites of the Etruscans the historian Mommsen says that "their prevailing characteristics are a gloomy and withal tiresome mysticism, a ringing the changes on numbers, soothsaying, and that solemn enthroning of pure absurdity which at all times finds its own circle of devotees." The Latin religion, the same high authority tells us, had a respectable origin in the attempt to spiritualize and generalize the phenomena of Nature and the duties and functions of everyday life; but, by a gradual process of change, it "sank into a singular sobriety and dullness, and early became shriveled into an anxious and dreary round of ceremonies."

If science therefore can not lead us into all truth, it is tolerably clear that theology, as the world has heretofore known it, can not save us from all error, but on the contrary is exposed to all the perversions which an unchecked use of imagination can entail. The task to which Mr. Balfour has committed himself is to show that the particular system which he would recommend is free from the imperfections and, so to speak, organic weaknesses of all other systems, and that it stands forth as an unimpeachable authority in all those matters upon which science is incapable of instructing us. The accomplishment of this task, it is needless to say, will be watched with much interest by every reader of Mr. Balfour's recent volume.

We may remark before concluding that we are not nearly as much troubled as Mr. Balfour evidently thinks upholders of "naturalism" ought to be, by the knowledge that the primary data of science do not afford any hint of the moral law or of the highly developed human emotions that are associated therewith. Neither does the atomic theory or molecular chemistry afford any hint of the wonders of organic life, which yet depend on molecular association. We might know all that is to be known in regard to the elements as elements without discovering the secret of the rose or of the tiniest "flower in the crannied wall." But are we to abandon or disparage what we know about the chemical composition of the rose because there is that in its synthesis which eludes us? Or are we to refuse our admiration to the flower because its original elements promised no such revelation of beauty?

"The world is what it is, for all our dust and din";

and the part of wisdom is to make the best of it. If there are those who think they discern a flaw in the title of the moral law, and on that account propose to trample it under their feet, all we can do is to keep our eye on such and see that the moral law is duly re-enforced by material sanctions. A writer of more than literary authority has described "the law" as "a schoolmaster" (literally, pedagogue or child-conductor) to bring us to the true source of instruction; and we may rightly infer that the external precepts which have more or less governed mankind in the past, by whatever authority promulgated, have had for their function to bring men to a recognition of the intrinsic moral quality of actions, and to incline them to choose good in preference to evil. The course of human evolution has brought us a developed moral sense; and the important question for us now is not whether that supreme faculty was foreshadowed in the preorganic world, or whether it can be read into the atomic philosophy; but whether it is a living fact to-day, whether it is useful for guidance and whether obedience to it is an essential condition of happiness. The search for title-deeds is very well within limits; but there was a time when title-deeds were not, simply because the conditions did not call for them. The moral law is in possession, and will remain in possession, because it has become part of the constitution of human nature.

THE PATH OF SCIENTIFIC ADVANCE.

In an excellent article on the late Prof. Huxley, contributed by the eminent Professor of Physiology at the University of Cambridge to Nature, and reprinted in this number of the Monthly, we read that the "note" of the "new morphology," of which Huxley made himself so earnest and successful an apostle, was "not to speculate on guiding forces and on the realization of ideals, but to determine the laws of growth by the careful investigation, as of so many special problems, of what parts of different animals, as shown, among other ways, by the mode of their development, were really the same or alike." The result of the prosecution of research along this line, Prof. Foster says, has been the acquisition since the year 1850 of "a body of science touching animal forms both recent and extinct of which we may well be proud," and that altogether apart from the special discoveries which may be traced directly or indirectly to the influence of the Darwinian theory of natural selection.

We have thought it worth while to cite this dictum of the Cambridge professor as bearing somewhat closely on a recent discussion in these columns. A contributor who was dissatisfied with certain references we had made to the doctrine of design, put forward his own opinion to the effect that the time had now come for making design the Why?—the guiding principle—of research. Such is manifestly not Prof. Foster's opinion, or else, while commending Huxley for throwing in his lot with the "new morphology," he would certainly have hinted that there was a yet newer morphology, destined to lead to still greater results, and the note of which was, specifically, speculation on "guiding forces and the realization of ideals." Of course, this newer morphology would only be the old pre-Darwinian speculation back again; and we think it is tolerably safe to conclude that such a reintroduction is not contemplated by the leaders in science to-day, and is in no wise a probable event.

The comparative study of animal forms resembles more or less all other comparative studies. It does not lead to the discovery of ideals in any sense, any more than does the comparative study of myths. We are merely led back from more developed to less developed forms, indicative of simpler conditions of life and a less varied play of the action of natural selection. We are no nearer to any "Why" when studying amœbæ than when investigating the structure of the highest vertebrates. The whole result of comparative biological study is to show us the order, and to some extent, the conditions of development of animal and vegetable structures, and to establish connections, affiliations, and homologies where, apart from the comparative method, no resemblances or correspondences of any kind could be detected. As our knowledge in any field of investigation attains a certain completeness, the imagination is impressed more and more with the wonderful unity of plan which prevails throughout the works of Nature; and at times we thrill as we catch, or seem to catch, the pulsations of universal life. These emotions come to us not in the search for ideals, but in that humbler search for facts and co-ordinating principles which some would have us forsake, as being altogether too humble and below our high prerogative as intellectual and moral beings. To us the world and humanity furnish an ample school for the training of our highest faculties, the religious not excluded. All depends on the spirit in which knowledge is pursued. Without grappling with problems that are in their nature insoluble, we may seek to adjust ourselves progressively to the highest knowledge we can attain, and thus to reach the highest and best self-development. If we do this, the path of knowledge will be for each one of us a path of ascent, and we shall find that, without any investigation of the Why, we have solved life's problem in the best possible manner.

THE AMERICAN ASSOCIATION AT SPRINGFIELD.

The meeting of the American Association for the Advancement of Science this year was characterized by a calm studiousness which was promoted by the quiet but thrifty environment in which it was held. The address of the retiring president, although confined to the one science in which Dr. Brinton has won his chief eminence, was a model for such addresses, in that the whole of it could be "understanded of the people," while at the same time furnishing food for thought to the man of science. It is no doubt easier for an anthropologist to prepare such an address on his science than for the specialist in some other fields, for the science of man is no foreign ground to any intelligent human being. This was demonstrated by the continued interest and large attendance at the sessions of the Anthropological Section. The addresses of most of the vice-presidents dealt with broad aspects of the several sciences. That of Mr. F. H. Cushing, on The Arrow, was more like a special paper, but the expressions of interest on the part of his hearers showed that they found no fault with him on that score. The public has often been told what great benefits industry receives from labors in pure science. It was a happy thought for Mr. William McMurtrie to point out to a scientific audience the benefits that the science of chemistry has derived from industrial operations. Those who listened to Vice-President William Kent's address on The Relation of Engineering to Economics carried away several valuable ideas, one being that the invention of machines has been of more economic importance than the division of labor of which the old economists made so much; another that America is far behind the Old World in the art of wasting human labor; and another that improved methods inflict more temporary loss on capital by destroying the value of machinery and appliances than upon labor by displacing workmen. Mr. B. E. Fernow, addressing the Section of Economic Science, ventured upon the debatable ground of governmental functions, but probably most of his audience accepted what he said in regard to the conservation of our forests and other natural resources. The papers read gave evidence of diligent research and had been in the main well sifted, although occasionally some newly fledged professor or garrulous veteran consumed more time than he should have. Time limits rigidly enforced by the several presiding officers might be worth trying in order to give more snap to the proceedings and increase the value of the association to the best workers. The only remarkable discovery announced in the course of the meeting was the finding of another implement in the glacial gravels, which strengthens the view that man lived in America either during or immediately after the Glacial period. The implement was exhibited and described by Prof. G. F. Wright, who has become the leading exponent of this view. The attendance was an average number, and probably included a smaller proportion of sightseers and a greater one of workers than when the meetings are held in larger cities.

Next year the association will hold its fourth meeting in Buffalo, further strengthening the precedent of a decennial visit to that city, and Prof. E. D. Cope will preside. The vice-presidents elected are: (A) Mathematics and Astronomy—William E. Story, of Worcester; (B) Physics—Carl Leo Mees, of Terre Haute, Ind.; (C) Chemistry—W. A. Noyes, of Terre Haute, Ind.; (D) Mechanical Science and Engineering—Frank O. Marvin, of Lawrence, Kan.; (E) Geology and Geography—Benjamin K. Emerson, of Amherst; (F) Zoölogy—Theodore N. Gill, of Washington, D. C.; (G) Botany—N. L. Britton, of New York city; (H) Anthropology—Alice C. Fletcher, of Washington, D. C.; (I) Social Science—William R. Lazenby, of Columbus, Ohio.

Prof. F. W. Putnam remains Permanent Secretary. The following are the other officers: General Secretary, Charles R. Barnes, of Madison, Wis. Secretary of the Council, Asaph Hall, Jr., of Ann Arbor, Mich. Secretaries of the Sections: (A) Mathematics and Astronomy—Edwin B. Frost, of Hanover, N. H.; (B) Physics—Frank P. Whitman, of Cleveland, Ohio; (C) Chemistry—Frank P. Venable, of Chapel Hill, N. C.; (D) Mechanical Science and Engineering—John Galbraith, of Toronto, Canada; (E) Geology and Geography—A. C. Gill, of Ithaca, N. Y.; (F) Zoölogy—D. S. Kellicott, of Columbus, Ohio; (G) Botany—George F. Atkinson, of Ithaca, N. Y.; (H) Anthropology—John G. Bourke, United States Army; (I) Social Science—R. T. Colburn, of Elizabeth, N. J. Treasurer, R. S. Woodward, of New York, N. Y.

LITERARY NOTICES.

The Female Offender. By Prof. Cæsar Lombroso and William Ferrero. The Criminology Series, edited by W. Douglas Morrison. New York: D. Appleton & Co. Pp. 313. Price, $1.50.

The scientific study of anthropology, which has risen to prominence within the last few years, bids fair to yield knowledge of much practical value. The anthropologists of several countries, and especially those of Italy, have been investigating the criminal class—trying to see if criminals *are* a distinct class, and what peculiarities mark them off from moral persons. When a basis of exact knowledge concerning criminals has been obtained, it will doubtless be possible to construct upon it much better modes of dealing with them than are now in vogue. Some results of this investigation have been made known to a limited circle through contributions to scientific journals and occasional volumes, but now the quantity of information collected has seemed to warrant the publication of a series of books devoted to criminology. As editor of the series the publishers have secured W. Douglas Morrison, M. A., of her Majesty's Prison, Wandsworth, England, a devoted student of the subject, and one who has had exceptional opportunities for observation. It is fitting that the series should begin with a book by Prof. Lombroso, who has devoted a laborious life mainly to criminal anthropology, and is the recognized leader of the Italian school in this branch of science. Associated with him as joint author is one of his most rapidly rising juniors—William Ferrero. As a result of their investigations, the authors regard as a complete type of the criminal woman one wherein exist four or more of the characteristics of degeneration. The criminal type in the female sex is rare as compared with the male. The reason is that women are generally occasional rather than habitual offenders. When a born offender, a woman is, in the majority of cases, an adulteress, a calumniator, a swindler, or a mere accomplice—offenses which require an attractive or at least a normal personal appearance. Atavism is regarded by our authors as the key to female delinquency. "The primitive woman was rarely a murderess, but she was always a prostitute"; hence the modern woman who degenerates atavistically takes to prostitution rather than to crimes of violence. The authors have given much attention to anthropometry, and present in this volume a large number of measurements of the skull, bodies, and limbs of female delinquents, also studies of brains, tests of senses, etc. The subject of suicide and the influence of hysteria and epilepsy on crime are considered. Tattooing, which is so common among male criminals as to become a special characteristic, is extremely rare in female delinquents. The discussions of the several topics treated are illustrated and fortified by many histories drawn from criminal records, and by portraits of French, German, and Russian subjects. The work is a valuable contribution to a new and much-needed science.

Mental Development in the Child and the Race. Methods and Processes. By James Mark Baldwin, M. A., Ph. D., Stuart Professor of Psychology in Princeton University. New York and London: Macmillan & Co. Pp. 496. Price, $2.60.

In this work Prof. Baldwin appears as an observer, experimenter, theorizer, and critic, in short, as a maker of science, in which rôle he is quite as interesting and instructive as in that of expositor. The first event which led to the publication of this book was the birth of a daughter in 1890, whose mental unfolding was watched with unfailing attention. When she reached her ninth month he undertook to experiment with her to find out the exact state of her color perception. The account of his procedure, of the results reached, and his criticisms thereon, is given in Chapter III, entitled Distance and Color Perception by Infants. Chapter IV, on The Origin of Right-Handedness, describes the experiments undertaken to gain light upon the facts and conditions of left-handedness that had not before been closely observed. After discussing in the earlier chapters the general condition of the responsive movements of infancy and pointing out special problems, he enters in Chapter V upon a description of experiments concerning the rise of more complex movements. In 1892, at the birth of a second daughter, he continued his observations and planned new experiments, enlarging the scope of his inquiries, and testing with her the inferences drawn from his experience with his first-born. There were two other infants under his observation at the time, though not so constantly and uninterruptedly as were his own children. In pursuing these studies Prof. Baldwin was led on to an enlargement of view concerning the mode and order of unfolding of mind in infancy, and the genesis of mind itself, and it is to this enlargement of view that we are indebted for the present work. It was while studying the child's imitations and their relation to volition that there came to him such a revelation concerning the function of imitation in the evolution of mind that he resolved to work out a theory of mental development embodying this new insight; and he soon saw that no consistent view of mental development in the individual could be reached without a doctrine of the race development of consciousness. With this conviction he undertook to make a synthesis of the biological theory of organic adaptation with the conception of infant development he had already reached. The work, he says, is a treatise upon this problem—an attempt to form a system of "genetic psychology." We can not give a fair account of Prof. Baldwin's theory in the limits of a book notice. But we will say, briefly, that he bases it upon the law of dynamogenesis, "which current psychology and biology agree in accepting as a well-established principle of the manifestations of organic and mental life. The principle of contractility, recognized in biology, simply states that all stimulations to living matter—from protoplasm to the highest vegetable and animal structures—if they take effect at all, tend to bring about movements or contractions in the mass of the organism. It is now also safely established as a phenomenon of consciousness that every sensation or incoming process tends to bring about action or outgoing process." It should be remarked here that the rise of hypnotism in late years has opened the way to an entirely new method of mental study. And it is now understood that "suggestion by idea, or through consciousness, must be recognized to be as fundamental a kind of motor stimulus as the direct excitation of a sense organ." Some idea of the importance of suggestion in modern psychology may be gained by noting the headings Prof. Baldwin has given to the sections in the long chapter upon this subject. They are (1) General Definition; (2) Physiological Suggestion; (3) Sensori-motor Suggestion; (4) Ideo-motor Suggestion;* (5) Subconscious Adult Suggestion; (6) Inhibitory Suggestion; (7) Hypnotic Suggestion; (8) Law of Dynamogenesis.

In attempting to reach some kind of formula of dynamogenesis, Prof. Baldwin found the definitions of "suggestion" in the psychologies very conflicting, and he therefore adopted the most general description of suggestive reaction—i. e., "that it always issues in a movement more or less closely associated in earlier experience with the particular stimulus in question." This definition constitutes suggestion a phenomenon of *habit*; but many suggestions issue in movements not exactly like those before associated with these stimuli. Many of them beget new movements, by a kind of adaptation of the organism, which are an improvement upon those the organism has formerly accomplished. This kind of adaptation Prof. Baldwin names *Accommodation*, and one of the main subjects discussed in the book is this theory of accommodation. The chapter upon suggestion closes with these words: "So far as we have gone we have a right to use the principle of suggestion as a principle of dynamogenesis whenever we mean to say simply that action follows stimulus. But when we come to ask what kind of action follows in each case each special kind of stimulus, we have two possibilities before us. A *habit* may follow or an *accommodation* may follow. Which is it? And why is it one rather than the other? These are the questions of the theory of organic development to which our next chapters are devoted." These nine chapters are upon The Theory of Development; The Origin of Motor Attitudes and Expressions; Organic Imitation; Conscious Imitation (begun); The Origin of Memory and Association; Conscious Imitation (continued); The Origin of Thought and Emotion; Conscious Imitation (concluded);

* Prof. Baldwin observed his children during their first two years to discover, if possible, whether ideo-motor suggestion is a normal thing, and the section upon this subject has absorbing interest.

The Origin of Volition; The Mechanism of Revival—Internal Speech and Song; Origin of Attention; Summary: Final Statement of Habit and Accommodation. These titles, as well as those given above of the sections of an earlier chapter, are very attractive, and we assure our readers that the text well sustains the interest excited by the headings, while the liveliness and earnestness of the style will be found pleasant accompaniments of the author's command of his subject. Of the scope and importance of this study Prof. Baldwin well says: "The study of children is generally the only means of testing our mental analysis. If we decide that a certain complex product is due to a union of simpler mental elements, then we may appeal to the proper period of child life to see the union taking place. The range of growth is so enormous from the infant to the adult, and the beginnings of the child's mental life are so low in the scale in the matter of instinctive and mental endowment, that there is hardly a question of analysis now under debate which may not be tested by this method." To the questions, what constitutes child study, and why we have so little of it, he replies that only the scientific specialist by the acutest exercise of his discriminative faculty can observe children or experiment upon them with profit. "Back of the question, What did the infant do? is the more difficult question, What did his doing that mean? And how can people who know nothing of the distinction between reflex and voluntary action, or between nervous adaptation and conscious selection, analyze the child's actions and arrive at a true picture of the mental condition that lies back of them? Even Preyer's experiments to determine the order of rise of the child's perceptions of different qualities of color, depending as they did upon word memories, are vitiated by the single fact that speech is acquired long after objects and some colors are distinguished." And if Preyer can thus misinterpret appearances, Prof. Baldwin may well say, "No child's deeds should be given universal value without a critical examination, before which even the most competent psychologist might well quail."

But notwithstanding these warnings, there is a brief popular section written in a somewhat homiletic strain in the chapter on conscious imitation, entitled How to Observe Children's Imitations. He begins with the statement that "nothing less than the child's personality is at stake in the method and matter of its imitation." The observer is told at length that he must take account of the personal influences which have affected the child; its relations to brothers and sisters and to other children, its chums and friendships in the school and home, and especially its games. The section closes with these words: "Finally, I may be allowed a word to interested parents. You can be of no use whatever to psychologists—to say nothing of the actual damage you may be to the children—*unless you know your babies through and through*. Especially the fathers! They are willing to study everything else. They know every corner of the house familiarly except the nursery. A man labors for his children ten hours a day, gets his life insured for their support after his death, and yet he lets their mental growth, the formation of their characters, the evolution of their personality, go on by absorption—if no worse—from common, vulgar, imported, and changing, often immoral, attendants! Plato said the state should train the children, and added that the wisest man should rule the state. . . . We hear a certain group of studies called the *humanities*, and it is right. But the best school in the *humanities* for every man is his own house." We have been much impressed by another strain of remark in the same section upon an only child. We have had for some time under our sympathetic observation a little boy whose brothers and sisters are grown, and the truth of the following statement is forcibly brought home to us: "An only child has only adult 'copy.' He can not interpret his father's actions, or his mother's oftentimes. He imitates very blindly. He lacks the more childish example of a brother or sister near himself in age. And this difference is of very great importance to his development. He lacks the stimulus, for example, of games in which personification is a direct tutor to selfhood. And while he becomes precocious in some lines of instruction, he fails in imagination, in brilliancy of fancy. The dramatic in his sense of social situations is largely hidden. It is a very great mistake to isolate children."

We close our notice with the sense that we have done this thoughtful book but scant justice.

Proceedings Commemorative of the One Hundred and Fiftieth Anniversary of the Foundation of the American Philosophical Society. Philadelphia: MacCalla & Co. Pp. 647.

An impressive commemoration of the origin of this pioneer scientific society was held in May, 1893. The exercises of the occasion, which extended over five days, are recorded in this handsomely printed volume, and include addresses of welcome and congratulation, the proceedings of the meetings, scientific papers presented, etc. The address by the venerable Frederick Fraley, president of the society, is followed by letters of greeting in French, German, and Latin, read by representatives of universities and foreign scientific societies, after which come telegrams from foreign bodies that were unable to send delegates. The second day's proceedings were also opened by an address by President Fraley, who was followed by Profs. Alpheus Hyatt and Hubert A. Newton. On the third day, President Gilman, of Johns Hopkins, and the Rt. Rev. John J. Keane, President of the Catholic University of America, delivered addresses, that of the latter only being printed. The exercises of the fourth day are especially interesting. They include addresses on Benjamin Franklin—printer, patriot, and philosopher, by Dr. Samuel A. Green; The Philosophy of Art, by Prof. J. M. Hoppin; and The Nature and Design of the Historical Societies of Our Country, by Dr. John B. Morris. On the last day a paper in German, On Determination of Gravity by Means of a Pendulum Apparatus, by R. von Sterneck, was read by Chevalier Rousseau d'Happoncourt, of the Austrian navy, who represented the Imperial Royal Academy of Vienna. Dr. Isaac Roberts then addressed the society on Recent Progress in Astronomical Science, illustrating his remarks by photographs which he presented to the society in behalf of the Royal Astronomical Society of England, which he represented. Prof. George F. Barker read a paper on Electrical Progress since 1743, dealing mainly with the work of Franklin, Hare, Henry, Saxton, Rittenhouse, and Bache. A few remarks on Magnetism, by Mr. Wharton, were followed by the closing address of the president. The scientific papers presented include one of eighty pages on Tertiary Tipulidæ, by Prof. Samuel H. Scudder; one of three hundred pages on Phylogeny of an Acquired Characteristic, by Prof. Alpheus Hyatt, and ten briefer ones by various authors. The volume is illustrated by a number of fine plates, including portraits of the officers of the society, views of the interior of its building, reproductions of the photographs presented by the Royal Astronomical Society, and figures illustrating the papers by Scudder, Packard, and Hyatt.

Theoretical Chemistry, from the Standpoint of Avogadro's Rule and Thermodynamics. By Prof. Walter Nernst, Ph. D. Translated by Prof. Charles Skeele Palmer, Ph. D. London and New York: Macmillan & Co. Pp. 697. Price, $5.

A few years ago it was said with truth that all the advances being made in chemistry were in the field of organic chemistry. This condition has been changed, however, by the fruitful researches of Ostwald, van't Hoff, Thomsen, Berthelot, and others, which have given us what may be called the new physical chemistry. Prof. Nernst has prepared a guide to this newly developed branch of the science, taking as its leading principles Avogadro's law and the doctrine of energy. Taking up first the universal properties of matter, he sets forth in succession those characteristic of the gaseous, liquid, and solid states of aggregation. The properties of physical mixtures and dilute solutions are also discussed. The theory of the atom and the molecule forms the second division of the work, this doctrine being tested and exemplified by the phenomena of refraction, polarization, magnetism, color, dissociation of gases, and the behavior of both colloids and crystalloids in solution. The transformation of matter and the transformation of energy are the two remaining divisions, the former embracing the laws of chemical statics and chemical kinetics, while the latter is concerned mainly with thermo-chemistry, though touching upon the chemical action of light and electricity. Two appendixes are added, the first comprising some important developments in theoretical and physical chemistry since the German edition of this work appeared, and the second being a valuable synchronistic table of chemical periodicals. The index is divided in the clumsy German fashion.

The Dynamo: Its Theory, Design, and Manufacture. By C. C. Hawkins and F. Wallis. New York: Macmillan & Co. Pp. 520.

Nothing need be added to the title of this book to indicate its field, and the authors claim no originality in the matter presented, except as to the construction of the equations for magnetic leakage, for the heating of dynamos, or the E. M. F. of alternators. "Yet we do claim," they say, "a certain novelty in our method of treatment by which these facts are presented. It has seemed to us that a systematic and methodical analysis of dynamos—of the causes and reasons why they have assumed their present shape—if only it be complete and accurate, so far as its scope extends, would still be sufficiently novel to merit attention. Starting with a simple inductor cutting the lines of a magnetic field, such an analysis would gradually evolve in natural sequence the various combinations of inductors which constitute the windings of armatures and the typical forms which the complete machine is thence compelled to take, until, finally, the whole should culminate in the description of actual machines as manufactured, and the practical design of one or more dynamos for given outputs. This scheme we have endeavored to carry out." The authors have taken pains to unite practice and theory in this treatise and to avoid mathematics and technicalities that were avoidable. There are one hundred and ninety illustrations, including cuts of a number of typical dynamos.

Descriptive Inorganic General Chemistry. By Paul C. Freer, Ph. D. (Munich). Boston: Allyn & Bacon. Pp. 550.

This book has been written for college students, and assumes some elementary knowledge of chemistry in those who are to use it. The author first gives a short chapter to the atomic theory, which he holds should not be presented in an elementary course, and then proceeds to describe the elements and their inorganic compounds. Oxygen is the first element described, hydrogen, the halogens, and the oxygen family following in succession. "In discussing chemical changes," Prof. Freer says, he has "endeavored to present the various topics, not as a series of isolated facts, but as so connected, the one with the other, that there is scarcely any one of the numerous phenomena which are mentioned in this work which does not find its analogon in some other portion of the field of chemical study. The attempt has been made especially to call attention to the influence exerted by the nature of the elements which make up a chemical compound upon the character of that compound itself." In his treatment of the latter subject he is aware that he may have been led into some speculation, but bespeaks at least a hearing for the new arguments he has ventured upon. His views on valence and the use of structural formulæ are conservative. In the application of physical methods in the study of chemistry he has followed Ostwald and Lothar Meyer, and in regard to the double halides, fluosilicic acid, and similarly constituted bodies he has adopted the views advocated by Prof. Remsen. There is an appendix of some forty pages of laboratory notes, which is "not intended as a laboratory manual, but mainly as a guide to both teacher and pupil in compiling a list of experiments."

Churches and Castles of Mediæval France. By Walter Cranston Larned. New York: Charles Scribner's Sons. Pp. 236, with Plates. Price, $1.50.

This book, the author says, is a record of a traveler's impressions of the great monuments of France, published in the hope that it may bring others to visit them. "It is easy for the student to get accurate information about them; but nevertheless it may be of some use to tell what effect they produce upon one who does not wish to study deeply into all their history and the minute details of the building of them, but who does love their beauty and cares about the place they hold in the history of the French people." We read the systematic accounts of these things and get vague ideas about them as something shadowy and far distant; then, as a lady remarked on seeing the antiquities preserved in Winchester Castle and Cathedral, we go and look at them and find that they are all real. Next to seeing them for ourselves is reading the mind-pictures of them of one who has seen them intelligently, and of the emotional effects they have wrought upon him—with the guide-book information left out. A historical monument in France is defined by the author as meaning "a church, or a castle, or a town that has been thought worthy either of restoration or preservation at the expense of the French people. There is a tax levied to provide the money necessary for these purposes, and it is astonishing how much the French are willing to pay to preserve or restore whatever has to do with their history as a nation." More than thirty works, cathedrals, churches, castles, etc., of historical or architectural interest, are described in this book in the manner we have indicated.

The Animal as a Machine and Prime Motor. By R. H. Thurston. New York: John Wiley & Sons. Pp. 97. Price, $1.

This is a comparison of the animal as a piece of mechanism for the conversion, application, and utilization of energy with the various machines which man has constructed for the same purpose. The introductory chapter is a discourse on some of the more important physical laws and the efficiency of the most economical machines whose construction is based upon them. In the next chapter, The Animal as a Prime Motor, the various vital processes, the efficiency of vital machines, intensity of muscular effort, and the uses of food are among the most important headings. The third and concluding chapter considers some of the unsolved problems of the animal machine, such as the source of the firefly's glow and the animalcule's phosphorescence.

The Land Birds and Game Birds of New England. By H. D. Minot. Second edition, edited by William Brewster. Boston: Houghton, Mifflin & Co. Pp. 492. Price, $3.

It has been often remarked that a teacher who is only a few lessons ahead of his class has an important advantage in that he can better appreciate the difficulties of his pupils than one who is further removed in attainments. On this account, as well as for his happy manner of imparting knowledge, Mr. Minot should be ranked as one of the most acceptable guides to the amateur ornithologist. His book is a remarkable production for a youth of seventeen. It gave substantial promise of important scientific and literary work which was left unfulfilled by the ill health that turned the author aside to a different profession and by his untimely death in a railroad collision. The book contains errors, and its statements as to range are deficient, but the editor has set sufficient danger signals against the former, and has duly supplemented the latter. It is not complete, but this does not prevent its being highly useful. Its descriptions comprise the external appearance of the species, its habits, range, appearance of its nest and eggs, and its song. An introduction contains directions for collecting birds and eggs, and for studying the birds at liberty. The illustrations are some twenty-odd outline drawings by the author and a frontispiece portrait.

A Tabular Review of Organography has been prepared by Prof. *A. L. Benedict* for the use of the classes in botany of the Department of Pharmacy in the University of Buffalo. In it each point has, so far as possible, been exemplified by some common plant; and each page of the manual is provided with a blank side to be filled in by the student himself. It is thus intended to adapt the little work especially for use as a guide in field study. An apology for hasty preparation at a season when the notes could not be verified by reference to wild plants is hardly in place in a scientific manual. With another summer affording the means desired, there should be no occasion for it to remain in another edition.

The papers of *Charles Robertson*, of Carlinville, Ill., upon the *Mutual Biological Relations of the Entomophilous Flora and the Anthophilous Insect Fauna* of his county of Macoupin are valuable to botanists and entomologists, and to all persons interested in horticulture.

In a little book on *Condiments, Spices, and Flavors*, a brief account is given by Dr. *Mary E. Green* of the substances classed under those heads, in the hope that it may lead to a more intelligent use of them in cookery. In it are included the flavoring herbs known in our gardens; spices, etc., from abroad; condiments prepared from animal foods, mixed sauces like the Worcestershire, and ketchups and pickles. The author believes that these things, properly used, are aids to digestion. (Published by the Hotel World, Chicago.)

Of the *Eighteenth Annual Report of the Connecticut Agricultural Experiment Station*, for 1894, Part II contains papers on the availability of organic nitrogen, fungous diseases and their treatment, and injurious insects; Part III, Studies on the Proteids of Rye and Barley and on the Chemical Nature of Diastase; and Part IV on subjects relating to the dairy and on tobacco. The publications of the station are sent free to every citizen of the State who applies for them.

Under the title *Bread from Stones* a translation of some of the writings of Julius Hensel on fertilizers has been published by A. J. Tafel (1011 Arch Street, Philadelphia, 25 cents). Hensel declares that the current theory of fertilizing is wrong. Too much potash, phosphorus, and nitrogen, he says, are supplied to plants, and not enough lime, magnesia, silica, sulphur, or fluorine. The normal soil consists of weathered rocks. This is the best soil for plants, producing not only vigorous growth, but also edible parts of firm texture, resisting insects, and valuable and wholesome for food. He therefore advocates the use of finely pulverized stone-meal as a fertilizer, and gives testimony as to its efficiency.

The Senile Heart, by *George William Balfour*, M. D. (Macmillan, $1.50), is quite a comprehensive consideration of this and allied conditions in the other organs of the body to which the aged are especially prone. In the introductory chapter some space is given to a consideration of why we get old and why we so rarely die of old age, and this is followed in Chapter II by an examination of the direct effects of age on the heart muscle. There are twelve chapters, the last four of which deal with therapeutics. A chapter is given to gout, and also one to angina pectoris. The book contains some interesting sphygmographic records.

The consolidated school law of 1894 made a number of important changes; but as published it is a pamphlet of one hundred and thirty-five pages, the legal phraseology and verbiage of which obscures the meaning in many places. A *Handbook for School Trustees* (Bardeen, 50 cents), by *C. W. Bardeen*, which arranges the law by subjects and gives the minor details only in notes, ought to prove valuable to teachers and other school officers. The differences in law between the district and union schools are pointed out, and directions are given for the establishment of an academic department under the Regents of the University.

In a little volume, half prose half poetry, entitled *The Supremacy of the Spiritual* (Arena Publishing Company, 75 cents), Edward Randall Knowles, LL. D., undertakes to show that the ether is spiritual rather than material.

John A. Kersey has written down under the title *Ethics of Literature* a part of what he would like to say about books and authors—a part only, for on page 570 he states that he is about to close without having finished (the author, Marion, Ind.). "I propose to inquire," he says in his preface, "what some great literary luminaries have done, and to show in some instances what were better left undone for the enlightenment of mankind. And in this retrospect we will observe the acknowledged Titans engaged in Herculean labors to establish truths which, in the nature of things and of *mind*, are either self-evident or unprovable. We will observe minds which have given the world some of the most superb thought, grouping the rarest gems in clusters with the veriest *peter-funk*." Other instructive observations are also promised to the reader.

A neat little forty-cent edition of *Defoe's History of the Plague in London* is just issued by the American Book Company. While there is much fiction mixed up with the description, Defoe being only four years old at the time of the plague, there is enough of actual fact to give the work a historical value, and the less well authenticated portions add much to its readableness.

Roman Life in Latin Prose and Verse is the title of a book of selections from Latin writings, made by *Harry Thurston Peck* and *Robert Arrowsmith* (American Book Company). It is intended to be used either as the chief book for a short course in reading Latin or as a volume for sight-reading, and may also serve as a series of specimens of Latin literature from the early popular songs down to the hymns of Christian Rome. The selections have been made with a view to exhibiting the life, manners, opinions, amusements, and dissipations of the Romans. The more difficult words are translated at the bottom of the page, and there are notes at the end on matters of allusion, style, and construction. The volume is illustrated.

In the *Orations on Bunker Hill Monument, the Character of Washington, and the Landing at Plymouth* (American Book Company, 20 cents), we have the three best oratorical efforts of *Daniel Webster*. His simplicity of diction and perfect mastery of pure idiomatic English render them excellent models for the pupil who would perfect himself in the use of the English tongue.

PUBLICATIONS RECEIVED.

Agricultural Experiment Stations—Reports and Bulletins. Connecticut: The Elm-Leaf Beetle; The San José Scale. Pp. 16.—Cornell University: Cherries. By L. H. Bailey and O. H. Powell. Pp. 32.—Massachusetts (Hatch Experiment Station): Commercial Fertilizers. Pp. 8.—Michigan: Crimson Clover, etc. Pp. 40; Fertilizer Analysis. Pp. 16.—Nebraska: Annual Report of the Botanist. By Charles E. Bessey. Pp. 24.—New Jersey: Report of the Botanical Department. By Byron D. Halsted. Pp. 140.—New York: Feeding Laying Hens. Pp. 18.—The Lutovka Cherry. P. 1.—North Dakota: Second Annual Report of the Weather Service. Pp. 28.—Weather and Crop Service, June and July. Pp. 16 each.—Ohio: Noxious Weeds along Thoroughfares and their Destruction. Pp. 8.—Purdue University: Commercial Fertilizers. Pp. 8, with Chart.

American Journal, The, of Sociology. Albin W. Small, Editor. Vol. I, No. 1. July, 1895. Chicago: University of Chicago Press. Pp. 112. 15 cents. $3 a year.

Ashley, Charles S. The Financial Question. Toledo, Ohio. Pp. 103.

Astronomical Society of the Pacific. Publications. Vol. VII, No. 43. Pp. 20, with several Plates.

Bay, J. Christian. Investigations concerning the Ætiology of Smallpox. Pp. 10.

Beal, F. E. L. Preliminary Report on the Food of Woodpeckers; and the Tongues of Woodpeckers. By F. A. Lucas. U. S. Department of Agriculture. Pp. 40, with Plates.

Carus, Paul. The Gospel of Buddha, according to Old Records. Chicago: Open Court Publishing Company. Pp. 275. $1.

Clare, L. Pierce, M. D., Middletown, Conn. Some Observations on an Epidemic of Typhus Fever. Pp. 27.—The Flechsig Method in the Treatment of Insane Epileptics. Pp. 24.

Committee of the Royal Medical and Chirurgical Society of London. Report on the Climates and Baths of Great Britain. Vol. I. Macmillan & Co. Pp. 640. $6.50.

Crosby, W. O. Tables for the Determination of Common Minerals. Boston: The Author. Pp. 106.

Daniell, Alfred. A Text-book of the Principles of Physics. Third edition. Macmillan & Co. Pp. 783. $4.

Donaldson, Henry Herbert. The Growth of the Brain. London: Walter Scott. Pp. 374.

Doyle, A. Conan. The Stark Munro Letters. New York: D. Appleton & Co. Pp. 385.

Eliot, Henrietta R., and Blow, Susan E. The Mottoes and Commentaries of Friedrich Froebel's Mother Play. New York: D. Appleton & Co. Pp. 319.

Frei, G. D., Editor. The Public Schools. Vol. I, No. 5. Clarksville, Tenn.: W. P. Titus. Pp. 16. 5 cents.

Green, Mason E. Are we losing the West? Boston: Charles E. Brown & Co. Pp. 31. 10 cents.

Harrop, H. B., and Wallis, Louis A. The Forces of Nature. Columbus, Ohio: Harrop & Wallis. Pp. 159. $1.25.

Holbrook, Dr. M. L. Hæmatoblasts and Blood Platelets. Pp. 10.

Hussey, W. J. A Study of the Physical Characteristics of Comet Rordame. Pp. 24.

Iowa Health Bulletin. J. F. Kennedy, Editor. August, 1895. Des Moines. Pp. 16.

James, Joseph F. Washington, D. C.: Fossil Fungi. Pp. 5.—Remarks on the Genus Anthrophycus, Hall. Pp. 5.—Daimonelix, or "Devil's Corkscrew," and Other Fossils. Pp. 10.—The St. Peter's Sandstone. Pp. 20.—The Genus Fucoides. Pp. 20. All with Plates.

Jarvis, Josephine, Translator. Friedrich Froebel's Pedagogics of the Kindergarten. New York: D. Appleton & Co. Pp. 337, with Plates.

Mace, William H. A Working Manual of American History for Teachers and Students. Syracuse, N. Y.: C. W. Bardeen. Pp. 297.

Michigan Mining School, Houghton. Prospectus of Elective Studies. Pp. 50.

Morgan, Thomas J. Patriotic Citizenship. American Book Company. Pp. 367. $1.

Old South Leaflets. The English Bible. (Extracts from Different Versions.) Pp. 20.

Polytechnic Institute of Brooklyn. The Course in Practical Chemistry. Prospectus. Pp. 24.

Quinn, Rev. D. A., Providence, R. I. Stenotypy, or Shorthand for the Typewriter. Second improved edition. Pp. 55.

Revue Franco-Americain. New York: E. T. Gurchy, 63 Fifth Avenue. Pp. 123. $1 a copy; $10 a year.

Roark, Runic N. Psychology in Education. American Book Company. Pp. 312. $1.

Scientific Alliance of New York. Fifth Annual irectory. Pp. 54. 25 cents.

Singleton, M. T. Gravitation and Cosmological Law. Atlanta, Ga. Pp. 23.

Starr, Frederick. Summary of the Archæology of Iowa. Pp. 124.—Comparative-Religion Notes. Pp. 53.

Syms, L. C. First Year in French. American Book Company. Pp. 128. 50 cents.

Thompson, W. Gilman. Practical Dietetics, with Special Reference to Diet in Disease. New York: D. Appleton & Co. Pp. 802.

Tennessee State Board of Health Bulletin. Nashville, August 20, 1895. Pp. 16.

Udden, Prof. J. A. A Geological Section across the Northern Part of Illinois. Pp. 32.

United States Coast and Geodetic Survey. Notice to Mariners. (Chart Corrections.) Pp. 8.

United States Geological Survey. Fourteenth Annual Report of the Director, J. W. Powell. Part I. Pp. 321; Part II. Accompanying Papers. Pp. 597, with Maps.—Mineral Products of the United States. Chart.

Ward, Lester F. The Nomenclature Question. Pp. 20.

Watkins, James L. Production and Price of Cotton for One Hundred Years. U. S. Department of Agriculture. Pp. 20.

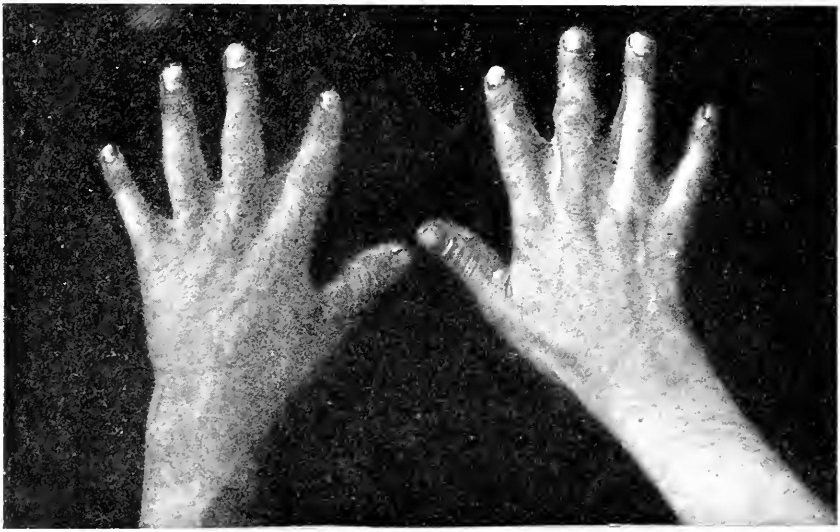
White, Frances Emily. The American Medical Woman. Pp. 16.

White, Francis A. Outline Studies in the History of the United States. American Book Company. 30 cents.

Willis, Bailey. The Northern Appalachians. American Book Company. Pp. 32. 20 cents.

POPULAR MISCELLANY.

An Instance of Webbed Fingers in Man.—(Communicated by F. E. Lloyd and F. L. Washburn.) The subject of this sketch, now about twenty-five years of age, was born near Smyrna, Iowa. He now resides in eastern Oregon, and is attending one of the State schools, where, though slow, he is proving himself fairly efficient in some lines of work. little finger of each hand are provided with only two movable joints or phalanges. On the fourth finger we find an enlargement at the point where the lower or distal end of the first joint should be. This rigidity, therefore, seems to have been brought about by a growing together or anchylosis of the first and second joints. The first joint or first phalanx of the little finger, however, although equal in length to two normal joints, is perfectly smooth and cylindrical. As if to compensate for this stiffness, the terminal joints of these two fingers can be bent to make a perfect right angle with the longitudinal axis of the finger. The toes are also webbed, but not so strikingly as the fingers. All of the following measurements have been made from a line passing through the distal end of the metacarpal bones; in other words,



Of large, powerful frame, he is a welcome adjunct on the football field, though ordinarily awkward in his movements. According to his statement, he has never suffered any special inconvenience from the abnormal condition of his hands, and feels disinclined to undergo a surgical operation for their betterment. When but a few days old, the webs were cut, but the operation was badly performed, and apparently their growth was not checked. The scars resulting from the operation may yet be seen. An interesting fact to be noted is, that the fourth finger and from the point where the bones of each finger unite with those of the hand. A centimetre is practically equivalent to two fifths of an inch.

To tip of second or index finger...	10·8 ctm.
" " third or middle finger...	12·4 ctm.
" " fourth finger..........	11·4 ctm.
To angle of web between second and third fingers...........	7·6 ctm.
To angle of web between third and fourth fingers	5·2 ctm.
To end of first joint of second index finger...............	5·7 ctm.

To end of first joint of third finger		7·3 ctm.
" " " " " little "		7·1 ctm.
" " " " " fourth "		6·4 ctm.
" " second " " " "		9·8 ctm.

The last two are the anchylosed phalanges mentioned above. The subject under discussion has one brother similarly affected, whose webs are decidedly larger than in the present instance. This brother has but one stiff joint on each hand. The father has hands somewhat webbed. A second brother has no webs, nor has the mother, nor the paternal or maternal grandparents.

How Stone Arrowheads were Made.—The guiding principle of Mr. F. H. Cushing's fruitful researches in anthropology has been "Put yourself in his place." When he wished to learn how stone arrowheads were made he became an arrow-maker himself. As a result of his labors and researches he was able to tell, in his address to the Anthropological Section of the American Association at Springfield, how primitive men made their arrows. They first sought the material, he said, mined it arduously from buried ledges, with fire, mauls, and skids, or preferably sought it in banks of pebbles, digging such as were fit freshly from the soil, if possible, and at once blocking out from them blanks for their blades by splitting the pebbles into suitable spalls. This was done by holding the pebbles edgewise on a hard base, and hitting them sharply and almost directly on the peripheries, but with a one-sided twist or turn of the maul or battering stone. At each deft stroke of the maul a spall was struck off—sometimes twenty from a single cobble or block of moderate size. These were, with almost incredible rapidity, trimmed to the leaf-shaped basis of all primitive chipped tools, by knapping them with a horn, bone, or very soft, tough, granular stone hammer, mounted in a light handle. For this the spall was placed flatwise on the knee, or on a padded hammer-stone, so called, and held down by the base of the thumb of one hand, and rapidly struck along the edge transversely and obliquely to its axis, lengthwise, with the outwardly twisting kind of blows used in the splitting. The blanks thus formed were then carried home for leisurely or opportune finishing; and carefully buried in damp soil, not to hide them, as has been usually supposed, but to keep them even-tempered, uniformly saturated or full of sap and life, as these ancients thought — whence the so-called "caches" of numerous leaf-shaped blades which are now and then found throughout old Indian ranges. To show that making arrowheads is not such a slow and laborious process as many have supposed Mr. Cushing stated that he had succeeded from the time he found a suitable pebble of fine grained, ringing, cold and fresh quartzite, in making seven finished knife and arrow blades in exactly thirty-eight minutes; and he had often made from obsidian or glass a very small and delicate arrow point—the most easily made—in less than two minutes.

Chemistry advanced by the Industries.—In showing how pure science had been promoted by industrial operations and requirements, which was the theme of his vice-presidential address before the American Association, Mr. William McMurtrie cited an interesting example from Hoffmann, who says, "It is not generally known that the theory of substitution owes its source to a *soirée* in the Tuileries." Dumas had been called upon by his father-in-law, Alexandre Brongniart, who was director of the Sèvres porcelain works, and, as Hoffmann says, in a measure a member of the royal household, to examine into the cause of the irritating vapors from candles burned in the ballroom, a demand to which Dumas readily acceded, because he had already done some work upon the examination of wax which could not be bleached and was therefore unmerchantable. He was readily led to the conclusion that the candles used in the palace had been made with wax that had been bleached with chlorine, and that the vapors were hydrochloric acid generated in the burning of the candles. But examination of the wax of the candles showed that the quantity of chlorine found was greater than could be accounted by for its presence as a mechanical impurity, and from it Dumas was led to experiments which showed that many organic substances when heated with chlorine have the power to fix it, and from these results he was in turn led to the further generalization concerning the law of substitution. It was an incident similar to that already described that brought Dumas to the reaction whereby hydrogen sulphide may be oxidized to sulphuric acid. He found the walls of one of the bath rooms at Aix-les-Bains covered with crystals of calcium sulphate, which could have no other source than the vapors liberated from the hot water.

Range of the Human Voice.—In discussing a paper read before the Section of Physics of the American Association, Prof. W. Le Conte Stevens remarked that the lowest recorded tone of the voice is that of a basso named Fischer, who lived during the sixteenth century, and who sounded F_0, about forty-three vibrations per second. Mr. Stevens himself, without possessing a bass voice, has sounded as low as A_0, fifty-three and a third vibrations per second, when his vocal cords were thickened by an attack of catarrh. This, however, is under abnormal conditions. The highest note hitherto recorded in the books was attained in singing by Lucrezia Ajugari. At Parma in 1770 she sang for Mozart several passages of extraordinarily high pitch, one of which included C_6, two thousand and forty-eight vibrations per second. She trilled in D_5, eleven hundred and fifty-two vibrations, and was able to sing as low as G_2, one hundred and ninety-two vibrations, having thus a range of nearly four octaves and a half. Ajugari's upper limit has been attained by Ellen Beach Yaw, of Rochester. Mr. Stevens has often estimated, by comparisons with a tuning fork, the pitch of a child's squeal while at play, which has been repeatedly found to be in excess of twenty-five hundred vibrations per second, in one case as high as G_6, about three thousand and seventy-two vibrations. The total range between these extremes is in excess of six octaves.

Criminal Anthropology.—Among reasons for including anthropology among the preparatory studies for medicine, Mr. Havelock Ellis refers to special branches of practice in which knowledge of it is of great assistance—such as practice abroad among different races, and practice among the insane at home, and in dealing with the phenomena of crime. Numbers of criminals inherit their qualities and transmit them, and constitute a distinct class. Their increase must be prevented by dispersing them and checking the reproduction of their kind. In the light of these principles, Lombroso has constructed his system of criminal anthropology. The Lancet says that in Paris medical experts are appointed to examine the persons arrested overnight, and to send to asylums those whom they find to be troubled with brain disease, whereby they are secured from association with criminals and soon may be restored to soundness. Dr. Benedikt, of Vienna, has done great service in this line of practice in his studies of criminals of different types. Three factors are named by Dr. Clouston which should be taken cognizance of in criminal anthropology, viz.: The heredity of the criminal; his brain, with its reactive and resisting qualities in each case; and the criminal's surroundings, immediate and permanent. The first takes account of the past history of the criminal's family, and the transmission of its inherited diseases into other diseases in offspring. The second factor, involving the receptivity and reactive power of the brain, its resources in self-control, especially in withstanding pain, fear, temptation, and other trials of the moral sense, concerns a wide field and presents great difficulties to the investigator. The third factor includes the mental and social atmosphere in which the subject of criminal anthropological inquiry has been brought up, and must comprise early companionship, moral and religious influence, and whatever contributes to motive in its less healthy tissues. "Those tracts of the brain cortex organized for mental processes are the field in which the future character of the individual—criminal or non-criminal—germinates and grows; they are, as Dr. Clouston well puts it, 'the fullest of hereditary qualities, the most powerful, yet the most notable, by far the most physiologically valuable part of man,' and the question that confronts the student of criminality he formulates thus: 'Have we among us men and women whose mental cortex is of such quality that in its ordinary environment the conduct of its possessors must necessarily be anti-social and lawless? and if so, what anatomical, physiological, and psychological signs are there to distinguish this criminal cortex and its possessor?'" The Italian and some of the German school assert that such signs exist, and are not difficult to recognize; or, that the criminal was a criminal potentially before he was one actually. The chief problem of dealing with crime fundamentally is, then, one of taking it at this stage; and it is here that medical anthropology can make itself most useful.

Explorations in Labrador and Alaska.—Of the geographical explorations on the American continent during 1894, Prof. Angelo Heilprin, in the Bulletin of the Geographical Club of Philadelphia, mentions as most noteworthy those of Messrs. Tyrrell and Low, on British territory. To the former we owe the exploration of a large portion of unknown region lying to the west of Hudson Bay—a region that for at least six hundred miles was totally unknown—and the rectification of much of the western contour of the bay. A peculiarity of the region traveled over by Mr. Tyrrell is the total absence of timber. "All the wood that was gathered in the course of this six hundred miles' journey, it is said, would not have been sufficient to give the material for a single boot-peg. On the other hand, even in this most treeless area, game of at least one kind is described as being most unmanageably abundant. Over an area of three square miles or more the reindeer were so thick as almost completely to shut out from view the ground." To Mr. Low belongs the honor of having made the first crossing of Labrador. Beginning at Lake Mistassini on the east, and terminating at Ungava Bay on the north, he crossed the height of land of the region, a rugged and forbidding country, partly timber-covered, and in the main devoid of inhabitants. No specially marked physiographic features were discovered, no great mountain ridges or peaks, and no large streams, "but the accessions of general knowledge to a region are always welcome, and particularly when it is so little known as is Labrador." A third exploration on our continent is that of the joint Anglo-American Alaska Boundary Commission. The statements in the newspapers that the surveys of this commission would remove Mount St. Elias from the United States to British America is "perhaps premature," and Mr. J. C. Russell, who first definitely determined the position of the mountain, is quoted as authority for saying that no basis exists for the assumed necessary transfer. Two other peaks, however, possibly higher than Mount St. Elias, have been observed, unquestionably on British soil.

Snow-coloring Insects.—An interesting communication has been published from Dr. Vogler de Schaffhouse concerning red snow-insects. An excursion of a Vaudois society to the Great St. Bernard in August, 1893, at an altitude of twenty-six hundred metres, near the col de Fenêtre remarked in a little *combe* at the left of the path a well-defined rose-red spot on the snow. One of the excursionists, M. Théodore Bottinger, found by the aid of a glass that the red color was due to little jumping insects, of which thousands were distributed on the surface of the melting snow. There were such prodigious numbers of them at the bottom of the combe that they formed a compact mass an inch thick in spots, like a bed of orange-red sawdust. The insect, called in French a *podurelle*, is a new species of the *Lipura* of Burmeister—the *Anurophorus* of Nicolet, hitherto undescribed. The red and black colorations of snow are usually ascribed to an alga (*Protococcus nivalis*), which turns black from red in the course of its growth. M. J. Brun observes, in an article he has published on the subject of coloration, that he has met the podurelle of Benedict de Saussure (*Desoria glacialis*) in innumerable masses, and believes that the existence of the podurelle is connected with that of the protococcus, and that the insects owe their color to the black spores on which they feed. It appears, then, that the coloration of the snow is chiefly due to the presence of the lower vegetation, but that the existence of the podurelles being connected with that of the protococcus, those insects may under some circumstances contribute by their number to form colored spots.

Power of Petty Superstitions.—The force of superstition, the London Spectator observes, in an article on that subject, is rarely felt by the cultured Englishmen, because their superstitions are usually unimportant, it not signifying much whether you pass under a ladder or not, or whether you are for a moment alarmed because you have broken a mirror; but among a great portion of mankind, including a section of the poor of enlightened countries, the smaller superstitions make up a real and heavy burden. They keep up a permanent distrust in the goodness of Providence, and a watchfulness to avoid evils from unknown forces which is most enfeebling. A French or Italian peasant will do nothing that is opposed to certain apothegms registered in his mind as dogmas, and an Asiatic peasant is bound hand and foot by a whole system of beliefs in omens which cramp his energies as much as even the rabbinical views of the law as to anise and cummin cramped the energies of the Jews in the time of Christ. There is not an Asiatic in the world who would dare go dead against the warnings of his horoscope, and very few Europeans of the Continent would stride forward resolutely in an undertaking the beginning of which has been marked by a stumble or a failure. Even in England this special idea about omens has amazing influence, as have also the other beliefs in premonition or presentiment. We all know the annoyance to which the belief in the superstition about thirteen subjects English dinner-goers, while on the Continent it is difficult, and in Paris impossible, to let a house with the number thirteen on the door. Even the iron logic of French functionaries gives way before that belief, and proprietors of rows are permitted to register the thirteenth house as 12 B.

Heavy Rainfall and Ship Canals.—The best series of rainfall observations in Central America, according to Prof. M. W. Harrington, is that taken at San José, Costa Rica, by Prof. Enrique Pettier. Several other series are nearly as good. The greatest hourly rainfall observed there was 1·9 inches, or at a rate of forty-six inches—or nearly four feet—per day. "The results of such enormous falls of rain have often been described and can easily be imagined. The dry stream beds or *quebradas*, very common on the plateaus, are rapidly filled; the water comes down in a wall several feet high; the camping place, two or six feet above the water, is overflowed, and soon the new camping place, hastily sought in the dark and several feet higher, is also overflowed. In such a country as Mosquitia dry stream beds become rivers, marshes change to lakes, and the natives temporarily take to the trees or to their boats. While all this is striking, it is by no means unparalleled in the temperate regions. . . . The difference between such falls of rain in the tropics and in the temperate zones is chiefly that in the latter they are occasional, while in the tropics they are customary. These conditions are especially interesting from the standpoint of the possible ship canals in Central America. . . . It must be acknowledged that the conditions at Suez, Sault St. Marie, and the Welland Canal are in this respect very favorable, for in them the question of sudden floods does not enter. It enters in the case of the great ship canal of St. Petersburg-Cronstadt and of those of the Ganges-Brahmaputra Delta; but in these cases there are no changes of level sufficient to make the use of locks necessary. Indeed, the use of locks on ship canals where feeders are subject to sudden and violent floods appears to present a new engineering problem, first met in the Panama Canal."

House and Room Ventilation.—Draughts in houses may be defined, Dr. G. V. Poore says, as currents of air rushing in at the many places through channels that have insufficient area. The only way to cure draughts is to place inlets of sufficient area in proper positions. When building a house, one might place louvre ventilators in the walls between room and passage at a height of six and a half feet above the floor. The alteration of a door panel into a ventilator costs only a trifle. In the author's experience it is a most excellent way of ventilating a room, always provided that the air of the passages be wholesome. Windows should extend to within a few inches of the ceiling, and should open at the top. If the room be twelve or thirteen feet high, and the windows go to the top, then the window becomes unmanageable from its height, and the opening at the top, though theoretically possible, is seldom put in practice. The wholesomeness of a room depends very much upon the rapidity with which the air within it can be renewed—the facility, in short, with which one can give it a blow-out. This depends upon the relation of window area to entire capacity. Windows should be so constructed that they can be easily manipulated by a child. The louvre window ventilator, such as is common in churches, will be found very valuable for the admission of a constant but comparatively small supply of air. Relatively low rooms, with big, mullioned windows going to within a few inches of the ceiling, are far more wholesome than lofty rooms in which the tops of the walls are inaccessible to the housemaid, and the window sashes are too weighty for her to move them without difficulty. For wholesomeness and comfort the author believes a height of ten feet is sufficient for any domestic living room and nine feet for a bedroom. Provided the windows go to the top and can be easily opened, it is very doubtful if there is any object, from the purely sanitary point of view, in having rooms more than nine feet high. Facility for cleaning should be ever in the mind of both builder and furnisher. The modern boudoir, hung with dabs of mediæval rags and stuffed with furniture and knickknacks, is often not very cleanly, and when the daylight is excluded, lest fading should take place, and the sun's rays never have a chance of disinfecting the dust on and behind the curios, it can not be very wholesome.

Tepee and Other Buttes.—The term butte is ordinarily applied to steep-sided hills with narrow summits. More rarely it has been employed to designate mountains, but this is probably obsolescent. The tepee buttes described by Messrs. G. K. Gilbert and F. P. Gulliver in their paper on that subject are so called on account of their resemblance to the lodges, or tepees, of the Sioux Indians. They are constituted around limestone masses in the Pierre shales of Colorado, higher than wide, and in all dimensions of a size to be measured by feet or yards, which, resisting erosion much better than the shales, stand above the general surface. Their fallen fragments protect sloping pedestals of shale, and their positions are marked in the landscape by conical knolls. These limestone masses may be called *tepee cores* and their material *tepee rock*. They are found scattered irregularly over a considerable district within the Pierre group, in places so thickly set that hundreds may be seen from one point, while elsewhere they are solitary or in groups of two or three. The tepee rock is of coarse texture, breaking with rough fracture, of light, warm gray color, and full of fossil marine shells (*Lucina*), imbedded in a matrix composed of fragments of shell, water-worn grains of calcite, foraminfera, and clay. Allied phenomena are found in Canada, of "great spongy and cavernous masses," forming islets which the Indians call wigwams and the caverns doors. Other forms of butte mentioned by the authors are the butte marking the site of a volcanic neck, which differs from the tepee butte in the nature of the core; the dike, or elongated butte, having a vertical plate rather than a cylinder for a core; the cylinder butte, which does not owe its form to a hard core, though it may have one, and when freshly formed has a crater at the top; the spring butte, formed by deposition from the water of geysers or other springs; and the *mesa* butte, which is the remnant of a tabular outlier, and is carved, like the tepee butte, from a greater mass, but has a hard cap instead of a hard core, and hence a flat-topped instead of a conical form.

Scientific Work of the Franklin Institute.—A historical sketch of the Franklin Institute, Philadelphia, compiled by Mr. Wahl, the secretary, contains a full and only just account of the work it has done during the seventy years of its existence for the advancement of science and the useful arts. Among the most prominent of the works in which it has been engaged, the first of general public importance was the investigation of the various forms of water wheels for giving economical value to water power. Following this, and in the same line of practical usefulness, was an investigation of the cause of the explosion of steam boilers. Closely connected with these experiments was an inquiry into the strength of materials used in construction. These investigations, the results of which were published in the Journal of the Institute, formed a contribution of great value to manufacturers of steam machinery, architects, and builders. At the instance of the Government, the Institute made an investigation and report on the suitability of various building stones, with special reference to the construction of the Delaware Breakwater. At the request of the Legislature of Pennsylvania it examined and reported on our system of weights and measures, providing the basis of the present State law. In 1843 it secured an appropriation for the equipment of stations for the systematic observation and collection of meteorological facts—probably the earliest instance in this country of such an appropriation. This work was begun, extended, and carried on under the direction of the committee of the Institute for several years, and the collection of weather data by the observers it has enlisted was continued afterward. The Institute suggested, in 1887, the institution of the present State weather service. In 1864 it obtained a report on the shape and proportions of screw threads used in machine construction, which gave the basis for the standard now universally current in this country. It participated, through its committee, in 1875, in the inquiry concerning the present and future water supply of Philadelphia. Its investigation, in 1878, of the efficiency of the dynamo-electric machine for arc lighting appears to have been the earliest intelligent inquiry into the relative merits of the several types of these machines. In 1884 a more elaborate report was issued on the same subject, and another on the Life-Duration and Efficiency of Incandescent Electric Lamps. Allied to these investigations was its report on The Conditions of Safety in Electric Lighting, published in December, 1881, which formulated for the first time a number of the conditions to be observed in the wiring of buildings and the running of circuits, which have since become incorporated in the regulations of the Fire Underwriters' Association.

North Nyassa Superstitions.—Connected with the superstitions of the people of the region north of Lake Nyassa, in Africa, are the sacred groves or burial places of their ancestors. The undergrowth in them is so thick that the sun's rays seldom penetrate. In their days of trouble the priests resort there to pray to the spirits of their fathers. In them the prophets deliver their messages. No other living creature is allowed to enter. Should war or disease visit the tribe, the priest kills a bull, and offers the blood and the head of the animal. The people firmly believe in the spirit of evil. He is "Mbasi." In one place Mbasi is a person—an old man—who exercises extraordinary power. He speaks only at night, and to the head men of the tribe, and during the interview every other voice must be silent and every light extinguished. In Wundale the people believe in such a person, who has the power to make lions, and who employs them as messengers of evil. His house is surrounded with long grass, in which he keeps his lions, as other men keep dogs. If a man has a dispute with a neighbor who refuses to come to terms, these lions may be hired to destroy his cattle. Dr. D. Kerr-Cross was much struck to find that all over the north end of Lake Nyassa the people regularly perform a *post-mortem* to the dead. Death in war is the only exception. One of the elderly men takes a strip of bamboo, and, making an incision in the abdominal wall below the ribs, carefully inspects the viscera. They bury immediately outside the door of the house, and in a sitting posture. In Wundale, about a year after the decease, and at dead of night, the friends lift the bones and cast them into certain clumps of trees found all over the country. These groves are full of human bones.

The Vitality of Seeds.—Discussing the vitality of seeds, Mr. W. Botting Hemsley first speaks of the infinity of variety in the behavior of seeds under different conditions. Neither under natural nor under artificial conditions will some seeds retain their vitality more than one season. Others will hold their life for a time that has not yet been defined. The scarlet-runner bean loses its germinative power on exposure to comparatively slight frost, the degree depending upon the amount of moisture in it; yet it will retain its vitality for an almost indefinite period under favorable artificial conditions In both this seed and the acorn germination would naturally follow as soon after maturation as the conditions allowed. The seeds of the hawthorn are incased in a hard, bony envelope, in addition to the proper coat or *testa*. Committed to the earth, and under the most favorable conditions, these seeds do not germinate till the second year, and often not so soon. Prolongation of vitality is probably due in some measure to the protective nature of the shell inclosing the seed. The primary condition to the preservation of vitality in a seed is perfect ripeness. Unripe seeds of many kinds will germinate and grow into independent plants if sown immediately after removal from the parent. This may be readily observed in wheat, and the same property is found occasionally in various other plants. Sometimes the seeds of pulpy fruits germinate in the fruit. The vitality of certain seeds is not impaired by floating and being partially submerged in sea water for as long as a year. Plants are growing at Kew from seeds that have been thus exposed. Some seeds will bear immersion in boiling water for a short time; but seeds of all kinds will bear for a considerably longer period a much higher dry temperature than they will soaking in water of the same temperature. Dry grain is equally impervious to cold. Some of the fir trees, especially of North America, bear the seed vessels containing quick seeds of many successive seasons; and only under the influence of forest fires or excessive drought do they open and release the seed. The unopened cones of thirty years have been counted on some fir trees; and it is averred that the seed vessels of some proteaceous trees do not open to shed their seed, under ordinary conditions, until the death of the parent plants. The stories of the germination of "mummy wheat" have not been confirmed; but kidney beans taken from the herbarium of Tournefort are said to have grown after having been thus preserved for at least a hundred years. Wheat and rye are said to have preserved their vitality for as long a period. Seeds of the sensitive plant germinated at the Jardin des Plantes, Paris, when sixty years old. If seeds retain their vitality for so long periods under such conditions, it is quite conceivable that seeds buried deep in the earth, beyond atmospheric influences and where there is not excessive moisture, might retain their germinative power for an indefinite period.

Cultivation of Dates at Tafilet.—The cultivation of dates and leather work form, according to Mr. Walter B. Harris, the sole industries of Tafilet, Morocco. The water for irrigating purposes is brought by many canals from the Wad Biz to the palm groves. The soil under the trees is carefully dug, and divided by low raised banks into squares from ten to twenty yards in extent. Into these, by removing a small part of the bank into which the water flows—for the canals are raised above the general level of the soil—a connection is formed with the canal and the land flooded, the water being allowed to proceed from square to square by removing portions of the dikes. The object of this irrigating of the patches separately is to avoid waste, only the portion which actually requires water receiving it; these squares are cultivated with lucerne, wheat, and barley where the shade of the palms is not excessive, and maize and palms, the latter of which are not so common as in other parts of the desert, for the dates take their place as the staple article of food of the people. Besides the palm supplying the people with provision, the coarser species of dates are employed for fodder, and constitute the chief food of such cattle as there are, and of horses and donkeys. The finer qualities are exported to Fez and Morocco City by caravan, the pack animals bringing in return wheat and European manufactures and rough iron. About ninety per cent of the export of Tafilet dates from Morocco go to London.

NOTES.

In the construction of the new speedway at High Bridge, New York, a bed of quicksand was encountered, which much impeded the work. The difficulty was obviated by the artificial refrigerating process. A row of four-inch pipes was sunk a few feet apart to the depth of forty feet. These pipes were capped at the bottom, and inside them were inserted smaller pipes open at the bottom. Cold air was forced fom a condenser through the smaller pipes into the larger and thence returned to the condenser. The air was cooled by expansion to a temperature of about $-45°$ C., thus freezing the surrounding mud and wet sand, and checking the flow into the excavation.

A Mr. Bickesten, of Liverpool, proposes to avoid the hardship of having—in the future—to remove from the marine service persons who may be found defective in vision by making the tests for their admission more stringent. He therefore suggests new rules providing that no boy or man shall be allowed to enter the service until his form vision and color vision have been tested and found sufficient; that their certificate of eyesight be exhibited by seamen before they are permitted to sign articles; that color-blindness and defective vision be made in themselves reasons for breaking indenture engagements; that officers affected in their vision be given shore employment; and that certain specified improvements be introduced into the method of testing for defects of vision.

The way changes are produced in the configuration of the country in a region of lakes by the action of the water is illustrated in a recent lecture by R. H. Mill. Taking certain English and Scotch lakes, Loch Tay has been gradually silted up during the last thirty years; a stony peninsula is building up at the foot of Ullswater; the rush of the waves is slowly eating away the eastern shore of Windermere; the affluent rivers are filling Haweswater with stones and rubbish, and a delta has been formed which nearly cuts the lake in two—a process which has been completed in certain lakes that are specified. The famous floating island of Derwentwater is probably a piece of the moat of waterweed that covers the floor of some parts of the lake, raised to the surface by the gas given off by its own decomposition.

Thoreau says in his Early Spring in Massachusetts, speaking of a class of books which have not yet gone out of fashion: "A good book is not made in the cheap and offhand manner of many of our scientific reports, ushered in by the message of the President communicating it to Congress, and the order of Congress that many thousand copies be printed with the letters of instruction from the Secretary of the Interior (or rather exterior), the bulk of the book being a journal of a picnic or sporting expedition by a brevet lieutenant-colonel, illustrated by photographs of the traveler's footsteps across the plains, and an admirable engraving of his native village as it appeared on his leaving it, and followed by an appendix on the paleontology of the route by a distinguished *savant* who was not there; the last illustrated by very finely executed engravings of some old broken shells picked up on the road."

Of a limited study of dietaries, mostly in New England, acknowledged to be imperfect, the results, as summarized by Prof. W. O. Atwater, decidedly confirm the general impression of hygienists that our diet is one-sided and that we eat too much. The food which we actually eat, leaving out of account that which we throw away, has relatively too little protein and too much fat, starch, and sugar. This is due partly to our large consumption of sugar and partly to our use of fat meats. The rejection of so much of the fat of meat at the market and on our plates at the table is not mere willfulness. It is in obedience to Nature's protest against a one-sided and excessive diet. How much harm is done to health by our one-sided and excessive diet no one can say. Physicians tell us that it is very great.

A successful demonstration was given in April to a meeting of medical men in London by Mr. S. Schöntheil, of the most modern and scientific method of training the deaf and dumb so as to enable them to use articulate speech and give them a full command of language. Several pupils were introduced who were subjected, with highly satisfactory results, to exercises in pronunciation, lip-reading, dictation, recitation, reading, and answering miscellaneous questions.

It is now generally recognized in Great Britain, ex-President Teall, of the Geological Section of the British Association, says, that there is no important difference in structure or composition between the rhyolites, andesites, and basalts of the Palæozoic and of the Tertiary periods. Identity of structure and composition in this case implies identity in the physical conditions under which the rocks were produced. Hence we may sum up the case of the bearing of volcanic rocks on the theory that, so long as observations are confined to a limited area, doubts may arise as to the truth of the uniformitarian view, but these doubts gradually fall away as the area of observations is extended. There are still some outstanding difficulties, but, as many similar ones have been overcome in the past, it is improbable that those that remain will prove formidable.

OBITUARY NOTES.

The death of Prof. Valentine Ball, of Dublin, is a serious loss to the scientific circles of that town. He contributed much to the literature on precious stones, and published several books of travels. Although of fine physique, he died at the age of only fifty-one.

The death is announced of Prof. Baillon, Director of the Botanical Laboratory of the faculty of medicine at the Sorbonne. He was one of the most distinguished of the French botanists and a very prolific writer. He was born at Calais, November 30, 1827.

Dr. Friedrich Tietjen died on June 21, 1895. He was Professor of Astronomy at Berlin University and editor of the Astronomischen Jahrbuch. He was born in 1834. His most important labors lie in the region of astronomical computation.

Dr. Friedrich Wilhelm Gustav Spörer, chief observer in the Astrophysical Observatory at Potsdam, died on the 7th of July of heart disease. He was born in Berlin, October 23, 1822. He took his degree from the Berlin University in 1843. He did a large amount of valuable astronomical work, being especially interested in sun spots, his work on these making his name known to the scientific world.

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