THURSDAY, APRIL 3, 1873

## ORIGIN OF CERTAIN INSTINCTS

THE writer of the interesting article in NATURE of March 20 doubts whether my belief "that many of the most wonderful instincts have been acquired, independently of habit, through the preservation of useful variations of pre existing instincts," means more than "that in a great many instances we cannot conceive how the instincts originated." This in one sense is perfectly true, but what I wished to bring prominently forward was simply that in certain cases instincts had not been acquired through the experience of their utility, with continued practice during successive generations. I had in my mind the case of neuter insects, which never leave offspring to inherit the teachings of experience, and which are themselves the offspring of parents which possess quite different instincts. The Hive-bee is the best known instance, as neither the queen nor the drones construct cells, secrete wax, collect honey, &c. If this had been the sole case, it might have been maintained that the queens, like the fertile females of humble-bees, had in former ages worked like the present neuters, and had thus gradually acquired these instincts; and that they had ever afterwards transmitted them to their sterile offspring, though they themselves no longer practised such instincts. But there are several species of Hive-bees (*Apis*) of which the sterile workers have somewhat different habits and instincts, as shown by their combs. There are also many species of ants, the fertile females of which are believed not themselves to work, but to be served by the neuters, which capture and drag them to their nests; and the instincts of the neuters in the different species of the same genus are often different. All who believe in the principle of evolution will admit that with social insects the closely allied species of the same genus are descended from a single parent-form; and yet the sterile workers of the several species have somehow acquired different instincts. This case appeared to me so remarkable that I discussed it at some length in my "Origin of Species;" but I do not expect that anyone who has less faith in natural selection than I have, will admit the explanation there given. Although he may explain in some other way, or leave unexplained, the development of the wondrous instincts possessed by the various sterile workers, he will, I think, be compelled to admit that they cannot have been acquired by the experience of one generation having been transmitted to a succeeding one. I should indeed be glad if anyone could show that there was some fallacy in this reasoning. It may be added that the possession of highly complex instincts, though not derived through conscious experience, does not at all preclude insects bringing into play their individual sagacity in modifying their work under new or peculiar circumstances; but such sagacity, as far as inheritance is concerned, as well as their instincts, can be modified or injured only by advantage being taken of variation in the minute brain of their parents, probably of their mothers.

The acquirement or development of certain reflex actions, in which muscles that cannot be influenced by the will are acted on, is a somewhat analogous case to that of the above class of instincts, as I have shown in my recently published book on Expression; for consciousness, on which the sense of utility depends, cannot have come into play in the case of actions effected by involuntary muscles. The beautifully adapted movements of the iris, when the retina is stimulated by too much or too little light, is a case in point.

The writer of the article in referring to my words "the preservation of useful variations of pre-existing instincts" adds "the question is, whence these variations?" Nothing is more to be desired in natural history than that some one should be able to answer such a query. But as far as our present subject is concerned, the writer probably will admit that a multitude of variations have arisen, for instance in colour and in the character of the hair, feathers, horns, &c, which are quite independent of habit and of use in previous generations. It seems far from wonderful, considering the complex conditions to which the whole organisation is exposed during the successive stages of its development from the germ, that every part should be liable to occasional modifications: the wonder indeed is that any two individuals of the same species are at all closely alike. If this be admitted, why should not the brain, as well as all other parts of the body, sometimes vary in a slight degree, independently of useful experience and habit? Those physiologists, and there are many, who believe that a new mental characteristic cannot be transmitted to the child except through some modification of that material sub-stratum which proceeds from the parents, and from which the brain of the child is ultimately developed, will not doubt that any cause which affects its development may, and often will, modify the transmitted mental characters. With species in a state of nature such modifications or variations would commonly lead to the partial or complete loss of an instinct, or to its perversion; and the individual would suffer. But if under the then existing conditions any such mental variation was serviceable, it would be preserved and fixed, and would ultimately become common to all the members of the species.

The writer of the article also takes up the case of the tumbling of the pigeon, which habit, if seen in a wild bird, would certainly have been called instinctive; more especially if, as has been asserted, it aids these birds in escaping from hawks. He suggests that it "is a fancy instinct, an outlet for the overflowing activity of a creature whose wants are all provided for without any exertion on its part;" but even on this supposition there must have been some physical cause which induced the first tumbler to spend its overflowing activity in a manner unlike that of any other bird in the world. The behaviour of the ground-tumbler or Lotan of India, renders it highly probable that in this sub-breed the tumbling is due to some affection of the brain, which has been transmitted from before the year 1600 to the present day. It is necessary gently to shake these birds, or in the case of the Kalmi Lotan, to touch them on the neck with a wand, in order to make them begin rolling over backwards on the ground. This they continue to do with extraordinary rapidity, until they are utterly exhausted, or even, as some say, until they die, unless they are taken up, held in the hands, and soothed; and then they recover. It is well-known that certain lesions of the brain, or internal parasites, cause animals to turn incessantly round and round, either to the right or left, sometimes accompanied by a backward movement: and I have just read, through the kindness of Dr. Brunton, the account given by Mr. W. J. Moore (*Indian Medical Gazette*, Jan. and Feb 1873) of the somewhat analogous result which followed from pricking the base of the brain of a pigeon with a needle. Birds thus treated roll over backwards in convulsions, in exactly the same manner as do the ground-tumblers; and the same effect is produced by giving them hydrocyanic acid with strychnine. One pigeon which had its brain thus pricked recovered perfectly, but continued ever afterwards to perform summersaults like a tumbler, though not belonging to any tumbling breed. The movement appears to be of the nature of a recurrent spasm or convulsion which throws the bird backwards, as in tetanus; it then recovers its balance, and is again thrown backwards. Whether this tendency originated from some accidental injury, or, as seems more probable, from some morbid affection of the brain, cannot be told; but at the present time the affection can hardly be called morbid in the case of common tumblers, as these birds are perfectly healthy and seem to enjoy performing their feats, or, as an old writer expresses it, "showing like footballs in the air." The habit apparently can be controlled to a certain extent by the will. But what more particularly concerns us is that it is strictly inherited. Young birds reared in an aviary which have never seen a pigeon tumble, take to it when first let free. The habit also varies much in degree in different individuals and in different sub-breeds; and it can be greatly augmented by continued selection, as seen in the house-tumblers, which can hardly rise more than a foot or two above the ground without going head over heels in the air. Fuller details on tumbler-pigeons, may be found in my "Variation of Animals under Domestication," vol. i. pp. 150, 209.

In conclusion, from the case of neuter insects, of certain reflex actions, and of movements such as those of the tumbler-pigeon, it seems to me in the highest degree probable that many instincts have originated from modifications or variations in the brain, which we in our ignorance most improperly call spontaneous or accidental; such variations having led, independently of experience and of habit, to changes in pre-existing instincts, or to quite new instincts, and these proving of service to the species, have been preserved and fixed, being, however, often strengthened or improved by subsequent habit.

With regard to the question of the means by which animals find their way home from a long distance, a striking account, in relation to man, will be found in the English translation of the Expedition to North Siberia, by Von Wrangell. He there describes the wonderful manner in which the natives kept a true course towards a particular spot, whilst passing for a long distance through hummocky ice, with incessant changes of direction, and with no guide in the heavens or on the frozen sea. He states (but I quote only from memory of many years standing) that he, an experienced surveyor, and using a compass, failed to do that which these savages easily effected. Yet no one will suppose that they possessed any special sense which is quite absent in us. We must bear in mind that neither a compass, nor the north star, nor any other such sign, suffices to guide a man to a particular spot through an intricate country, or through hummocky ice, when many deviations from a straight course are inevitable, unless the deviations are allowed for, or a sort of "dead reckoning" is kept. All men are able to do this in a greater or less degree, and the natives of Siberia apparently to a wonderful extent, though probably in an unconscious manner. This is effected chiefly, no doubt, by eyesight, but partly, perhaps, by the sense of muscular movement, in the same manner as a man with his eyes blinded can proceed (and some men much better than others) for a short distance in a nearly straight line, or turn at right angles, or back again. The manner in which the sense of direction is sometimes suddenly disarranged in very old and feeble persons, and the feeling of strong distress which, as I know, has been experienced by persons when they have suddenly found out that they have been proceeding in a wholly unexpected and wrong direction, leads to the suspicion that some part of the brain is specialised for the function of direction. Whether animals may not possess the faculty of keeping a dead reckoning of their course in a much more perfect degree than can man; or whether this faculty may not come into play on the commencement of a journey when an animal is shut up in a basket, I will not attempt to discuss, as I have not sufficient data.

I am tempted to add one other case, but here again I am forced to quote from memory, as I have not my books at hand. Audubon kept a pinioned wild goose in confinement, and when the period of migration arrived, it became extremely restless, like all other migratory birds under similar circumstances; and at last it escaped. The poor creature then immediately began its long journey on foot, but its sense of direction seemed to have been perverted, for instead of travelling due southward, it proceeded in exactly the wrong direction, due northward.

CHARLES DARWIN

## *UNIVERSITY OARS*

### II.

WE resume our remarks at the point at which we left off last week, *i.e.* the uncomfortable one of the killed and wounded in the great annual battles on the Thames.

Of the 294 men who rowed in the 26 races taking place between the years 1829 and 1869 (both inclusive), 39 men have died, or rather we should say 40, for one other death has occurred, apparently since the introductory portion of the work was written, and the tables in the appendix were compiled, and we are assured on the authority of elaborate statistics and the logic of averages, that, in comparison with other portions of the civil community, this is a very moderate death-rate. Of the diseases which have carried off in youth or early manhood these 40 men, we will only instance one kind, as being the only one with which boat-racing can presumably be connected, namely consumption, "and other diseases of the chest:" to these perhaps may be added "heart affections." Of the former there are 9, of the latter 3, in all 12.

We are assured, again, that this percentage is a moderate one, that these ailments are still more exacting, not only with other portions of the "civil community," but also with the seamen of the Royal Navy, and with the men who fill the ranks of the army, and notably so of the Guards; it being notorious that men of tall stature are more liable to be attacked by, and less able to resist, diseases of this nature than men of more compact build. But here we must confess that this portion of the book does not leave upon our minds quite so comfortable an impression as we could desire. It is felt throughout that the parties compared have little in common in the essentials that make such comparisons valuable. True the University Oars as a rule are tall, above the average height even of men in their own rank of life; but they are "picked" men—picked for strength as well as stature—picked for physical power already proved—whose whole life from infancy up to manhood has been one varied series of all that art, nature, and science could bring to bear favourably upon their growth and development. While on the other side do we not find the reverse of these conditions prevailing? does not the author himself, elsewhere, describe with painful emphasis the wretched forms, stunted frames, unhealthy occupations and debasing habits of a large portion of the "civil community;" and is it not notorious that soldiers in regiments where height of stature is the chief requisite, were probably throughout their growing time subject to privations in food and clothing and housing, which coupled with rapid growth, and their surroundings after enlistment, presented the very conditions most favourable to the development of the diseases in question?

While expressing an opinion of qualified satisfaction with the comparisons instituted, we can in no way question the accuracy of the figures given; but we must record our feeling, which we believe will be one generally felt, that such evidence fails in accomplishing the purpose for which it was advanced.

We have stated our belief that, could the truth be ascertained, as many or more injuries would be found to have occurred in the same space of time (a similar number of men having been so engaged) in hunting, at foot-ball, or at cricket; probably too as many of these injuries would have proved fatal. But in stating this we are brought face to face with the fact that, in all instances of hurt or of injury so sustained, they would arise from *accidents*. But this is not the case with the injuries which spring from Boat-racing; here, be they trifling or be they severe, be they few or be they many, they seem to be the natural outcome of the exercise itself; not a hurt, in a sense in which we commonly use that word, of bruise, or break, or strain, and to which we may apply support or remedy, but an unknown evil, unfelt, unsuspected, at the time, but to which existence has been given—to be developed in after-life, when we least suspect it, and are least able to cope with its advances. Now the question which presents itself here to us, and must present itself to any one who cares for the continuation of this favourite exercise and yet would free it from this grave drawback—is this: Are these injuries, these evils inevitable? Yes, we answer, at once, and without reservation or qualification, to two points of misconception only is hurt or injury in these contests to be attributed: correct these and this exercise will stand out at once, relieved from all let or hindrance, free, freer than any other, because it is exempted from the *accidents* that lie in the path of others. Correct these, and the tripartite list which Dr. Morgan has supplied of *benefited*, *uninjured*, and *injured*, would be transformed into one uniform list of the first-mentioned only, for every one would be benefited who pursued this pastime.

In the contest which took place on the Thames last week the points which would probably strike an ordinary spectator most forcibly would be these:—first, the length of the course (four and a quarter miles), and second, the shortness of the time in which the boats covered the distance (not quite 20 minutes), and he would probably think that the first was too long, and if he did not actually think that the second was too short (for who admits that a race can be run or rowed too quickly?), he would marvel all the same at its performance, and wonder how men *could* propel a boat over such a long course in such a short space of time. Whether the course could be shortened with advantage, and yet sufficiently test the crews, we will not here discuss, although we think it is open to discussion; and how it is possible to propel a boat over it in the above-mentioned time, is only to be explained by one means, *i.e.*, by a critical examination of the boat itself, and, let us add, a glance at its crew. In the latter he will see eight as fine young men as he probably ever saw in his life before; in the former he will see a machine bearing no resemblance to anything he ever saw afloat, either on river, lake, or sea, or possessing in shape, or size, or bulk, or weight, any of the proportions which other boats possess: so slim for its length, so straight, so sharp! constructed at all points to cleave the water like a knife-blade! fitted out at all points to save every fraction of weight in rowing or steering gear, to utilise and concentrate every ounce of propelling power exerted by the oarsmen from stroke to bow.

Now although the perception of this may to some extent explain the extraordinary rapidity of the race, it will not remove from the spectator's mind the idea of its severity. To him it will still appear that the work will have been tremendous, and he is right: the work *was* tremendous, though not perhaps in the manner or of the kind which he imagines, or of what is commonly understood when the word *work* is used.

"In rowing, as in some other exercises, where the voluntary muscles of the trunk and of the upper limbs are engaged, the breath is "held" in the lungs during the muscular effort, in order to keep the chest distended, or firm, or as it is technically called, "fixed," that these muscles may have firm and unyielding points of attachment during the contractile efforts—fixed fulcra for their levers; and when this is prolonged or repeated over any considerable space of time, it becomes a highly disturbing influence to respiration, and doubly so if the exercise be one which greatly augments the respiratory requirement; for the act of fixing the chest is accomplished by retaining the chest at its point of expansion, when in the natural order of respiration it would be collapsing. And while in ordinary effortless breathing, or in exercises where the lower limbs are solely or chiefly employed, such as walking or running, the inspiration and expiration follow each other in uninterrupted succession—each occupying about the same space of time as the other, and the two constituting the entire process—in rowing, both these acts are hurried over during that time in which the muscles are relaxed, *i.e.*, towards the close of the stroke, and on the rapid forward dart of the body preparatory to another; when the breath is again held and the chest fixed during the muscular effort. Now in ordinary breathing the rate is, to a full-statured man, from 16 to 20 inspirations per minute, while the racing pace is 40 per minute, or more, and we have seen that the breathing is regulated by the stroke, a breath for each, and these are at 40 a minute! But we have also seen that although there is a breath for every stroke, still the double process of inspiration and expiration does not occupy the whole of even this brief space of time, being accomplished during the momentary muscular relaxation towards the end of the stroke and the forward reach of the body preparatory to another, greatly augmenting the rate at which this double process is performed." Truly the spectator was right in thinking a boat-race to be tremendous work, for so it is, as regards heart and lungs, at any rate.

And now with reference to the second aspect of boat-racing, its demands upon the muscular energies of the body, the aspect which probably the spectator had in view when impressed by the probable amount of "work" of the race. Now will he be relieved or will he be disappointed to learn that the work to be done, the muscular exertion to be undergone, is very slight indeed,—certainly not more than, if so much as, was undergone by any one of the thousands who ran the distance shouting on the banks. Perhaps his examination of the boat and boating gear has prepared him for some such revelation, perhaps it has not, but we can assure him that its accuracy has been proved, not only by our own long personal observations of its mode of action and consequent results upon the frames of the men themselves, but by practical and theoretic tests of the most searching kind, instituted by men of unquestionable ability for the office, and of unquestionable freedom from prejudice or bias.

We have doubted whether this would be a relief or a disappointment to the ordinary spectator; nor have our doubts been restricted to him. Others whose practical knowledge of the art and exercise of rowing is great have also found it embarrassing how to receive this announcement. For ourselves, we regard it as an evil, although not one without a remedy. But not only is the muscular effort altogether disproportionate to that of the organs of circulation and respiration, but inadequate in its amount to develop and sustain to their full capacity the frames of the men engaged therein, when rowing is practised for exclusive exercise: it is found that this muscular exertion, inadequate as it is, is also very irregularly and partially divided, very unequally distributed among the several portions of the body. Thus, we quote again from our former source:—

"A little examination will prove, I think, what at first may not have been surmised, that the legs have the largest share of the work in rowing, for while all other parts employed, back, loins, and arms, act somewhat in detail and in succession, the legs act continuously throughout the stroke, and the individual efforts of each, and the concentrated efforts of all the other parts of the body employed are transmitted through them to the point of resistance—the stretcher. . . . . It will be found also that the stroke is nearly finished before the contractile efforts of the arms are in any degree engaged, namely, when the trunk reaches the vertical line, and they are called in to finish the stroke, and to turn and run out the oar on the forward reach of the body preparatory to another. Rowing thus gives employment to a large portion of the back, more to the loins and hips, and most of all to the legs; but it gives little to the arms, and that chiefly to the fore-arm, and least of all to the chest."

At this point Dr. Morgan's views and our own do not run quite parallel, but the divergence is not so great as at first sight may appear, and almost seems the expression of the impatience of the Oarsman at anything which might be construed as a hint that rowing had a fault or a defect of any kind whatever, than the decision of the Physician on a question which he had considered. It may be a loss sometimes, perhaps, to have more qualifications than one for judging or writing on a given subject. Thus we recognise the physician when he admits the importance of the development of the chest by muscular exertion, admits that in so doing we do not merely increase its muscular coverings, but actually expand the walls of the thoracic cavity, giving ample space for the organs contained therein to perform their all-important functions, nay, that these organs themselves are endowed with increased bulk, vigour, and power by the same means: but here the oarsman crops up, and he contends that all these good things are to be obtained by practice at the oar, for that rowing *does* give this invaluable muscular exertion to the chest. Again, we recognise the physician, acknowledging the substantiated facts of physiological inquiry when he admits that the chest receives its muscular action through the arms; but again the oarsman contends that in rowing the arms *do* have energetic work to perform adequate to this task; nay, that in his own experience, when captain of his college boat, "he has seen the biceps expand and the forearm increase in girth;" the latter probably, but the former—well, they must have rowed in very bad style to cause this development! But scarcely is this avowal made when some doubt as to the propriety of the admission seems to be felt, and the subject is disposed of by the following remark. "This is an inquiry which I do not mean to inflict upon my readers. It is of more interest to the student of anatomy than to the general public," probably this is the case, possibly it is not of great interest to either, but how about the rower? It is with him we are now concerned, and we opine it is to him of very great importance indeed.

While we are engaged in fault-finding we will go as far as the paragraph following that from which we have just quoted, and in which we find the same kind of partial reasoning. He proceeds to say:—

"Let us then consider in what way the chest is affected by bodily labour, when the muscles are called into activity, whether in rowing, or running, or in such a course of gymnastics as is now wisely required for young recruits. We find that, in the first place, the parts more especially exercised acquire additional bulk, grow both larger and stronger; and secondly, we observe that the circumference of the chest is increased, it becomes wider and deeper. I have looked over numerous statistics so tabulated as to show the physical value of gymnastic instruction, and these tables all agree in showing that there is under such circumstances a coincident development both of muscle and of chest."

No doubt "the statistics so tabulated" give the results which the author has seen, for are not such statistics, after being inspected by the medical officers of the army, regularly forwarded to the Adjutant-General of the forces for his information? but what has this to do with boat-racing or running? These three exercises are as different in character and as different in their demands upon the physical energies of the human body in their practice, and in the results of their practice, as it is possible to conceive; and who that had investigated these three modes of muscular exertion would thus run them together for the purpose of showing their value or the results of their practice on the development of the chest? If the development of the chest is mainly due to the muscular exertions of the arms, how can running develop it, unless a man run upon "all fours?" When organising this "course of gymnastic instruction for recruits," we held ever before us a principle precisely the opposite to that which regulates either good running or rowing. In these, *sameness* of action, from the start till the close of the exercise, prevails; in the gymnastic course it is *variety*, the course embracing several hundreds of exercises, requiring different degrees of effort, executed at different rates of speed, employing every portion of the frame, and notably the upper limbs and trunk of the body—exercises all tested and proved to accomplish given results, on thousands of men, and over many years of careful observation, long before they were embodied by us in our military system. These three exercises should be estimated each by itself, and allowed to stand on its own feet. No real or permanent advantage can accrue to any of them by being thus lumped together, the more especially as they are in their nature so dissimilar.

ARCHIBALD MACLAREN

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## THE EARTH

*The Earth: a Descriptive History of the Phenomena of the Life of the Globe.* 2 vols., with numerous maps and illustrations.

*The Ocean, Atmosphere, and Life.* Being the Second Series of a Descriptive History of the Phenomena of the Life of the Globe. 2 vols., with numerous maps and illustrations. By Elisée Reclus. Translated by the late B. B. Woodward, M.A., and edited by Henry Woodward, British Museum (Chapman and Hall 1871 and 1873.)

I.

IT is at length beginning to be acknowledged on all hands that no system of education can be pronounced perfect without a recognised position being assigned to the study of science. It cannot, of course, be supposed that in the ordinary *curriculum*, say of a university education, the various subjects of scientific study can obtain that exclusive attention which is required, in order to master them; but it is of the highest importance that, by the introduction and use of suitable text-books, the mind of the youthful and ardent lover of Nature in her various phases should be directed and prepared for entering upon those more minute studies and exhaustive researches in reference to particular subjects in the wide field of scientific inquiry, by which alone he can hope to force Nature to disclose her secrets.

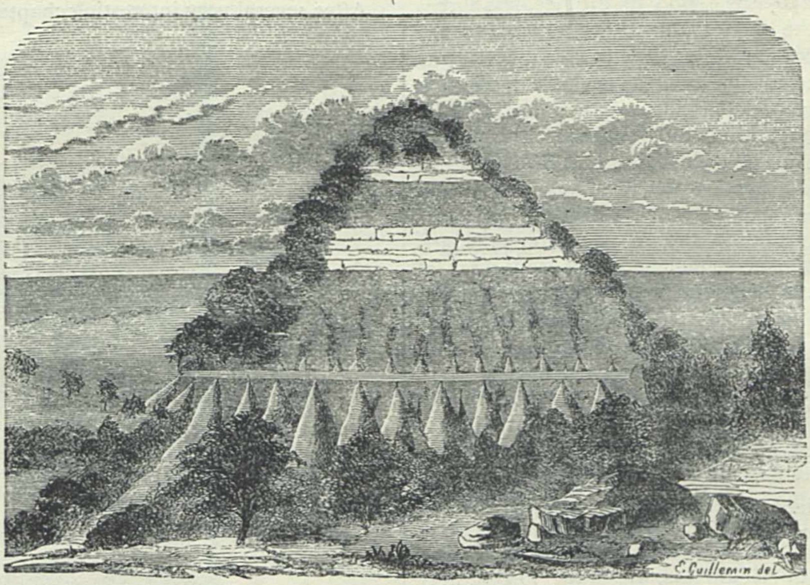

FIG. 1.—The Pyramid Mountain

Such a text-book we have in the work now before us—for these four volumes really form one entire work—a most admirable translation of a treatise on the earth and its phenomena by the eminent French *savant*, M. Elisée Reclus, the result of more than fifteen years' careful study, travel, and research. The translation is by the late Mr. B. B. Woodward, the Queen's librarian at Windsor Castle, and edited since his death by his brother, Mr. Henry Woodward, of the British Museum. Notwithstanding the editor's apology, the work suffers but little from its appearance in an English dress; in fact, the translation has been carried out with such remarkable success, that it possesses all the merits of an original English work. The constitution and phenomena of the planet in which we live are subjects of the deepest interest and importance to us all, and, to the earnest and thoughtful seeker after knowledge, present marvels on a scale of grandeur and magnitude far beyond the comprehension of the mere superficial observer. As M. Reclus says:—

"True enough that the earth is nothing but an almost impalpable grain of dust to the vision of the astronomer scanning the nebulæ in the field of his telescope, but it is, nevertheless, quite as much worthy of study as any other of the heavenly bodies. If it does not possess magnitude of dimensions, it presents an infinite variety in all its details. Whole generations, living one after the other upon its face, might pass their lives in studying its phenomena, without comprehending all their full beauty. There is not even any special science, having for its aim some portion of the terrestrial surface, or some particular series of its products, which does not present to our *savans* an inexhaustible field of inquiry."

The two first volumes of the work, to which alone we must at present confine our attention, consist of four main divisions—(1) on the earth as a planet, (2) on the land, (3) on the circulation of water, and (4) on subterranean forces. The first division treats of the form, structure, and motion of the earth, explaining with great lucidity the different theories respecting its formation.

M. Reclus then proceeds to give an outline of the geological history of the earth as exhibited by the stratification of rocks. In places where the strata have remained undisturbed by the action of the sleepless forces ever at work upon the earth's crust, it is possible to see the strata in their regular order of succession, giving, as it were, an abstract of the earth's geological history. Probably the most remarkable instance in point is to be found in the "Pyramid Mountain," the sketch of which is taken from the famous "Pacific Railroad Report."

The second division treats of the form and distribution of the continents, and points out the wonderful harmony and analogy which prevail in the configuration of continents and oceans, the arrangement and peculiarities of mountain ranges, the origin of valleys, ravines, gorges, and other depressions of the earth's surface. The question of the origin of mountains and valleys is still, generally speaking, an open one amongst geologists; but, nevertheless, with regard to valleys and ravines, one can in many cases distinctly perceive that their formation is due to the ceaseless action of water through countless ages, mountain torrents cutting their way even through vast mountain chains. Nothing can convey a more impressive idea of the tremendous power of water as a natural agent, than the wonderful cañons of Mexico, Texas, and the Rocky Mountains, where the torrent may be seen rushing along through the incision it has cut out for itself in the hard rock at a depth of several thousand feet between perpendicular walls. The greatest of these cañons, that of the Colorado, is 298 miles in length, and its sides rise perpendicularly to a height of 5,000 or 6,000 feet. Valleys at their commencement usually assume the form of amphitheatres in a degree more or less marked. The most regular in form are to be seen in the Central Pyrenees. "The most remarkable, on account of their vast dimensions and the snow-clad terraces which surround them, are the *oules* (boilers) of Garvarnie, Estaubé, and Troumouse, which the slow action of centuries has hollowed out in the calcareous sides of the mountains of Marboré. Undulating tracts of pasture-land furrowed by torrents, prodigious walls rising to 1,500 or even 2,000 or 3,000 feet in almost perpendicular height, gigantic steps on which whole nations might find room to sit, cascades which either spread out over the precipice and float away in a diaphanous veil of mist, or rush down into the valley like an avalanche; the high summits, glittering with unstained snow, which rear their heads high above the wall of cliffs, as if to look over the inclosure—all these features we find combined far in the recesses of these solitary mountains, so as to render the Pyrenean amphitheatre one of the grandest *tableaux* in Europe." In the third division, on the circulation of water, the author discusses at considerable length the phenomenon of snowfall on mountain heights, the successive stages through which the snow-field passes into the glacier form, the structure and phenomena of glaciers, subjects towards the elucidation of which Prof. Tyndall has made such valuable contributions. The cause of the intersection of crevasses in glaciers is fully explained. A marginal crevasse, as is well known, first appears in a direction tending up the stream of the glacier; it is then carried round by the current until it inclines in a downstream direction, and is then intersected by another crevasse opening like the first in an up-stream direction. The process is repeated until the numerous intersecting crevasses form a complete labyrinth.

After several very interesting chapters upon the subject

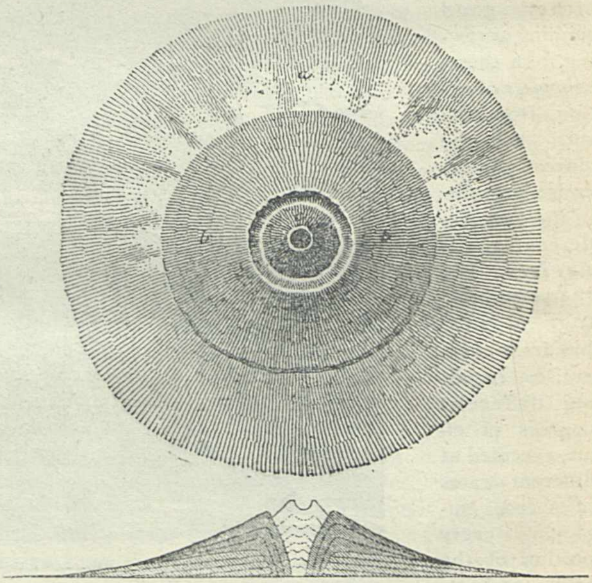

FIG. 2.—Plan and section of the volcano of Rangitoto.—*a* Declivities of tuff; *b* Cone of lava; *c* Pyramid of Scoriæ.

of springs in their different varieties, the remainder of this division is devoted to the discussion of lakes and rivers, and here we find the fact carefully explained and illustrated that the hydrographical systems in different parts of the world exhibit the same relative harmony and order as the forms of the continents. The chapters explaining the process of the formation of deltas, by what are aptly termed "working rivers" (*fleuves travailleurs*), are especially worthy of attention, and will be found to contain a collection of maps and diagrams in illustration of this branch of the subject.

The last division, on subterranean forces, contains some of the most interesting chapters of the whole work, being devoted to the consideration of the most mysterious and appalling of terrestrial phenomena, namely, volcanic eruptions and earthquakes. Science has not yet succeeded in establishing any definite theory respecting the origin of volcanic eruptions, although most valuable contributions have been made to this branch of scientific study by Prof. Palmieri, who so courageously stuck to his observatory on Mount Vesuvius throughout the whole of the tremendous eruption of 1872. The symmetrical form of the craters of many volcanoes is very remarkable, in some instances the outline of the cone and crater being absolutely perfect in its symmetry, as in the case of the volcano of Rangitoto, of which a plan and section here reproduced is given in the work.

Our space forbids our entering more fully at present into the merits of these interesting volumes. G. I. F. C.

## LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

### Dana on Corals

#### A Reply to the Criticism of Mr. Duncan

In a criticism of Prof. Dana's work on Corals and Coral Islands, printed in a recent number of NATURE (vol. vii. p. 119), Mr. Duncan has seen fit to mention my name and certain of my views adopted by Dana in a somewhat discourteous manner. I therefore beg leave to reply, as briefly as possible, to some of his strictures, which are both erroneous and unjust.

Concerning the general character and plan of Dana's book it is not my intention to say anything, for those are matters which chiefly concern the author and publisher. It is to be presumed that they know, quite as well as any critic, the kind of book demanded by the public—at least by the American public—and experience every day shows the errors of critics in this respect. Certainly few authors have had more extensive and successful experience in writing strictly scientific books for the public than Prof. Dana.

Mr. Duncan criticises the introduction of brief notices and descriptions of "animals which are not corals, and which in no way affect or produce coral reefs or islands," evidently alluding to the Actiniæ, Hydroids, and Bryozoa; for he says, "all the notices and descriptions of the Actiniæ and Hydroidea might have been omitted, as they only confuse the subject." Surely Mr. Duncan ought to know, and if he does, should not ignore the fact, that Millepora, and the allied genera, are true Hydroids, and at the same time form large and abundant corals, which contribute very largely to the formation of coral reefs and islands both in the Atlantic and Pacific Oceans. Moreover, this important fact is stated by Dana on page 104 of his book, and its discovery is correctly attributed to Agassiz, while the animals are illustrated by a cut copied from his figures. It should be added that this discovery, made twenty-five years ago, has recently been confirmed by Pourtales ("Deep Sea Corals," p. 56, 1871). That many of the ancient fossil corals were of the same nature scarcely admits of doubt, although the writer has elsewhere shown that this was not the case with all the so-called "Tubulata." Why, then, should this important class of corals be omitted from such a work? As for the Actiniæ, their relationship to the ordinary stony corals is so close, both in external appearance and internal anatomy, that no general work on corals could be considered at all complete without an account of them. Their physiology is also much better known than that of the coral animals. Moreover, they are the only near relatives of the true corals that the majority of the readers of the book will ever see alive.

The Bryozoa are also quite entitled to the page and a half allowed them in this book, for that they do contribute something to the existing coral-reefs can be easily demonstrated. One species of *escharella*, abundant on the eastern coast of the United States, forms solid coral-like masses often two or three inches in diameter, which accumulate in large quantities over wide areas, and, under favourable circumstances, would form limestones of considerable thickness. Some of the coral-reef species grow still larger and occur in profusion. In the Palæozoic coral-seas and reefs the Bryozoa were of still greater importance, and some of the so-called "true corals" of those times evidently belonged to this group in addition to those usually referred to it. The stony Algæ also, are by no means to be ignored in treating of coral reefs, and the half page devoted to them might well have been extended rather than omitted. Darwin, Agassiz, Major Hunt, and others besides Dana, have recognised their agency in furnishing calcareous matter to the reef limestones. Fine specimens of such limestones, composed almost entirely of their remains, may be seen in many American museums.

Mr. Duncan, in criticising Dana for adopting the classification which he believes most natural, makes this remark: "The introduction of American novelties to the exclusion of well-recognised European classifications, is neither right nor scientifically correct." Are we to infer from this that "American novelties" are less valuable than French or English ones, providing they be equally true to nature? Or does our critic prefer European error to American truth? Certainly no one has contributed more, in the way of original investigations and discoveries, to a true classification of the corals than Dana himself, in his great work on the Zoöphytes of the U.S. Exploring Expedition, which was far in advance of any work on this subject that had been written in Europe up to that time (1846). In some respects his classification was far more natural than that proposed afterwards by Edwards and Haime. Unfortunately at that period most of the corals and polyps in European museums had not been described or figured by European writers in a manner accurate enough to make their identification possible, or even, in many cases, to show their generic and family characters. That Edwards and Haime, having access to those collections, and having the benefit of Dana's great work, should have been able to make corrections and improvements was natural. Nor was it less natural that, after the publication of the more accurate descriptions and figures in their works, an American, having these and all the other works at hand, with constant access to the original types of Dana, to the unrivalled collections of corals brought together by Agassiz, and to all the other collections in the United States (by no means few or small) should, after devoting a large part of his time for twelve years to the special study of corals, have been able to make still other corrections and improvements, even in opposition to the views of certain European writers. But several European authors have also made numerous changes in the system of Edwards and Haime, and are likely to make many more. Certainly the time has not yet come when we can consider the classification of corals permanently fixed.

Whether the "novelties" to which he refers be "scientifically correct" is quite another question, and one that must be settled in the scientific way, by the evidence of facts observed, and not by denunciations, nor by dogmatic assertions. In selecting examples of the supposed inaccuracies of my views, as adopted by Dana, Mr. Duncan cites the "Oculina tribe," which the writer has established to include not only the Oculinidæ, but several other families, referred by Edwards and Haime to the Astræidæ and elsewhere. He says—"The admission of Orbicella, which is really the old Astræ of Lamarck (not of 1801), and of Caryophyllia into this well-differentiated tribe, is simply absurd, for they possess structural characters sufficiently diverse as to place them in different families." As a matter of fact, the writer has placed these same corals in different *families* in several papers published during the past five years, and this is the view adopted by Dana; so the argument quoted becomes "simply absurd." Again, he says that "Astrangia was well differentiated long before Prof. Verrill was heard of," and adds that Conrad Lonsdale and "the distinguished French Zoöphytologists consolidated the genus, which has nothing in common with the Oculinidæ." What he means by "consolidated" in this connection, it is difficult to tell, for all that Conrad and Lonsdale did was to describe very poorly, under the name of "Astræ," two or three fossil species, which Edwards and Haime afterwards referred doubtfully to Astrangia. The genus itself was first pointed out by Dana in 1846, and named Pleiadia, as stated in his book, page 68; but it was not at that time strictly defined, for there were no species in the collections of the Exploring Expedition; consequently the name Astrangia, proposed two years later, has been universally adopted. Dana's original specimens, with the MS. names placed upon them in 1845, still exist in our collections. But what my own age or reputation in the year 1848 has to do with the matter is not obvious. I trust that even then I was old enough to have seen the absurdities of such a criticism as that under discussion. That I have, since that time, carefully studied sixteen species of that genus and described a large number of new ones, while only three were known to Edwards and Haime, is true. That I have shown the close relationship between this genus and Cladocora and Oculina is equally true, and I presume that had Mr. Duncan enjoyed as good opportunities as I have had for studying this and all the related genera he would long ago have arrived at the same conclusions. It is certain that the soft parts of Astrangia, Cladocora, Oculina, and Orbicella are almost identical in all essential points of structure and form, as anyone may see by examining the published figures of the animals of these genera, though the living animals resemble one another much more closely than do the figures. Moreover there are species of Astrangia that bud laterally and grow up into branched forms not unlike Oculina, while the species of the latter are always encrusting while young, and have marginal buds, like the typical Astrangiæ, and some Oculinæ remain permanently nearly in this condition.

Nor do the internal structure of the corals afford any marked and constant characters for their separation. The Cœnenchyma is often nearly wanting in Oculinidæ, though usually characteristic, and it is sometimes present in Astrangiæ, even presenting the radiating surface lines so characteristic of Oculina. In fact it often requires very careful study to determine whether certain specimens belong to Oculina and Astrangia. Such are the genera that have "nothing in common." The relations between Caryophyllia and Astrangia, through Paracyathus, Phyllangia, &c., are sufficiently obvious, and as I have fully discussed all these relations elsewhere (Trans. Conn. Acad. I. pp. 512 to 540, 1869), it is unnecessary to say more upon this point.

What Mr. Duncan means by saying that *Caryophyllia Smithii* was first discovered by the *Porcupine* Expedition in the European seas, is not evident, if he means the well-known species which has passed under that name in all English works, and which Dana illustrates by a figure copied from Gosse's "Actinologia Britannica" (which is the only figure that Mr. Duncan specially criticises). He also finds fault with Dana for saying that *Caryophyllia cyathus* is "widely distributed over the bottom of the Atlantic, even as far north as the British isles," and tells us that "those unrecognised workers have shown that it is not *Caryophyllia cyathus* but *C. clavus* which has the great horizontal range," referring of course to the "workers" who had described the corals of the *Porcupine* expedition. But in Mr. Duncan's paper on those corals (Proc. Royal Soc., 1870, p. 289) he united both those species, together with *C. Smithii* and *C. borealis*, as mere varieties of one species, and makes a long argument to sustain that view, and concludes thus: "I have placed the species borealis in the first place, and regard the old species *C. clavus*, *C. Smithii*, and *C. cyathus* as varieties of it." Dana's statement was doubtless based on Mr. Duncan's assertions, in the paper quoted, that *C. cyathus* and *C. clavus* are identical, and the subsequent discovery of *C. clavus* in the Straits of Florida by Pourtales. The error, therefore, if such it be, belongs wholly to Mr. Duncan, and his remark that "had Dana waited a little longer he would have had the opportunity of quoting correctly," was, to say the least, quite uncalled for, and unbecoming to him. But the peculiar injustice of the critic is, perhaps, best seen in his studied omission of any credit to Dana for his extensive original observations and investigations upon the structure and formation of coral reefs and islands, and his intimations that the facts and theories are mostly borrowed. Thus he says, "The chapters on the structure of coral reefs and islands add little to the knowledge which Darwin and Jukes and Hochsteth have given us; but Dana's great powers of illustration enable him to reproduce the details with which we are so familiar—thanks to these authors—in very engaging forms." Dana has given Darwin full credit and well-merited praise, both in the preface and in many places in the body of the work, for his accurate observations of facts and discovery of the true mode of formation of coral islands; but he also states the well-known fact that his own observations had been made and his report written, in 1842, before the publication of Mr. Darwin's work. The report of Mr. Jukes was published still later (1847). Dana's observations were, therefore, wholly original, and relate mostly to regions not visited either by Darwin or Jukes. The chapters upon this subject are, as they purport to be, mainly a reprint of Dana's original report, with such additions from other and later sources as seemed necessary to make the work complete, all of which are credited to their original authors. In the preface the author says, "The observations forming the basis of the work were made in the course of the Wilkes Exploring Expedition around the world, during the four years from 1838 to 1842." Had Mr. Duncan taken the trouble to examine the original report, he would have found there the true source of most of the facts narrated. The figures of corals were also mostly copied from those in the atlas of his report on zoophytes, which were originally drawn by Dana himself from Nature, so that it is not strange that "some of them are very correct representations of Nature." When the figures are not original, their source has invariably been given. The charge that Dana does not give due credit to others is simply ridiculous, and in no case more so than when he is accused of treating the works of Edwards and Haime with "supreme contempt, inasmuch as he rarely gives them credit for their good work," for in the list (p. 379) of the species of corals described in his great work on Zoophytes, prepared at his urgent request by the writer, he has adopted, without hesitation, all the numerous rectifications made by them, as well as those made by the writer and others. A considerable number of corrections also appear in that list for the first time, and it must, therefore, be quoted as the original authority for such changes. Nothing less than the complete absence of personal vanity and pride, and entire devotion to the advancement of scientific truth, for which Prof. Dana is so justly distinguished, could have induced him to have published such a list in this book. No doubt instances may have occurred in which he has unintentionally overlooked writings of more or less importance. If so, he will doubtless make amends in the next edition. The authority for well-known facts is not always given, because such references would uselessly encumber the book. In other cases, where to mention would be only to condemn, such references have been intentionally omitted when they would have served no useful purpose. Such was the case in respect to the various erroneous European classifications, which were not adopted. Such was also the case when, in describing the extensive coral reefs of Brazil, so well explored by Prof. Hartt, and which were shown by the writer to consist of corals related to and partly identical with those of the West Indies, he does not refer to Mr. Duncan's assertion (Quar. Jour. Geol. Soc. xxiv. p. 30) that "the Orinoco drains a vast tertiary region, and shuts in the coral-life of the Caribbean on the south;" and that "the Florida reefs consist of few species," when more than forty-five species had even then been recorded from them, or more than he admits for any existing reefs. Other statements and theories concerning the recent and fossil corals of the West Indies, in the same paper, have become equally absurd, in consequence of the recent discoveries of Pourtales, and needed no exposure. His assertion that the isthmus of Panama was deeply submerged during the Miocene, and again forcibly urged in his criticism of Dana, may rest on no better foundation than the other assertions just quoted from the same paper, notwithstanding the careless way in which he misquotes, as to place of publication, and misrepresents, as to the contents, a brief article in opposition to that view by the writer. We still look in vain for such proofs as would be afforded by elevated coral reefs having relations to those of the West Indies, but situated on the Pacific side, or even upon the higher parts of the isthmus. The well-known existence of elevated coral reefs in the East Indies and Polynesia, and their presence in the West Indies, known long before Mr. Duncan began to write his valuable papers, proves nothing of the sort. Whatever relations do exist between the fossil corals of the East and West Indies can be easily explained in other ways. We think it singular that while certain geologists find it necessary to force the Gulf-stream across the isthmus during the warm Miocene, others find it quite as important to turn it out of the Atlantic, across the isthmus, during the glacial period. Both assumptions seem equally gratuitous, and may be opposed by numerous facts.

A. E. VERRILL

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### Animal Instincts

ALLOW me to add two or three facts to the interesting store supplied by your correspondents.

Some years ago a dog was sent to me at Taunton from Honiton, distant seventeen miles. It was conveyed in a closed hamper and in a covered cart. It escaped from my stable on the evening of its arrival, and at 11 o'clock on the following morning it was at its home again. The route lay over a ridge of steep hills.

Mr. Robert Fox, of Falmouth, so well known to the scientific world, is my authority for the following:—The fishermen of Falmouth catch their crabs off the Lizard rocks, and they are brought into the harbour at Falmouth alive and impounded in a box for sale, and the shells are branded with marks by which every man knows his own fish. The place where the box is sunk is four miles from the entrance to the harbour, and that is above seven miles from the place where they are caught. One of these boxes was broken; the branded crabs escaped, and two or three days afterwards they were again caught by the fishermen at the

Lizard rocks. They had been carried to Falmouth in a boat. To regain their home they had first to find their way to the mouth of the harbour, and when there, how did they know whether to steer to the right or to the left, and to travel seven miles to their native rocks?

Another, of which the drover is my informant. Large flocks of sheep are driven weekly from the Welsh hills to the London market. Some time since two escaped in the dark and were supposed to have been stolen. About a fortnight afterwards the two stray sheep reappeared on the Welsh mountains, whence they had been brought. They had found their way through a journey of at least 100 miles. My informant learned from some of the turnpike-gate keepers on the road that, when opening the gate at night to a traveller, two sheep had been seen to rush through.

The nightingale returns from Greece, not merely to the same country, but to the same field and the self-same bush. The swallow takes possession of the same nest.

EDWARD W. COX, Serjeant-at-law

Carlton Club, March 31

### The Sociability of Cats

IT may prove of interest to naturalists to record the following curious instance of the social habits of cats :—

I once had two she cats that were upon very intimate terms with each other, always together, and never appeared to have quarrelled. At one time, one of them being about to add an increase to their number, the other very kindly nursed it, and even performed the function of a midwife, and actually attended to the necesary offices that are in ordinary cases attended to by the parent of the progeny. Feeling some interest in curiosities of natural history, I carefully watched my pets, and can therefore vouch for the truthfulness of this extraordinary manifestation of feline sociability.

I may here mention that, as regards the teachableness of cats, I once saw at the house of an intimate friend a fine, large tabby tom-cat put through a drill which would perhaps outvie similar exhibitions of the genus *homo.* He was told to "stand up," "shoulder arms," "present arms," and "stand at ease," which, by observing the hands of the master, he would most obediently do, and with a promptness that was astounding. Another cat was told "to beg," which it at once did by jumping on to a Windsor chair, and performed some curious twistings and rollings that were continued until the morsel of meat was awarded. I have recently introduced a fine kitten to the company of two cats I have had for years. For a long time a deadly feeling of enmity was maintained against the stranger; but now, after a period of three months, the two older cats will not lap their morning's milk until the kitten is in their company; if absent, they actually retire, and refuse to take their meal.

Red Lion Street, March 26 J. JEREMIAH

### Manitoba Observatory

HAVING seen in vol. vii. p. 289 of NATURE a statement to the effect that the American Government had established an observatory at Fort Garry, Manitoba, I have to inform you that the so-called observatory is a telegraph reporting station maintained by the Dominion of Canada. Its tri-daily reports, however, in common with those from several other Canadian telegraph stations in correspondence with Toronto, are always placed at the disposal of the Washington weather office.

G. T. KINGSTON

Magnetic Observatory, Toronto, Canada, March 11

## *ST. THOMAS CHARTERHOUSE TEACHERS' SCIENCE CLASSES*

PRIOR to the introduction of Mr. Lowe's revised code, elementary science teaching was always to be found in the curriculum of our best primary schools. The properties of water, the constituents of some of the chemical elements, the first principles of mechanics and the like, were taught with much pleasure by the masters of the schools above alluded to. "Payment by results" on the three R's threw cold water upon this class of intellectual teaching, and it has only been revived recently through agitation emanating from enlightened educators. Teachers of late years too have had their studies very much limited by the low requirements of the Education department, and hence many young teachers were launched out into the teacher's profession unable themselves to impart instruction formerly given in our schools. Teachers have long been clamorous for having the standard of education raised in their schools, and have therefore hailed with great satisfaction the act of the Science and Art Department whereby additional grants are given to any pupils or adults or juveniles who could, after receiving a certain number of lessons from a qualified teacher, pass an examination on the subject-matter of these lectures. Teachers, however, before they are permitted to give these lectures to pupils, are required to pass an advanced examination on the subjects they propose to teach. To enable teachers to pass these tests, the St. Thomas Charterhouse Teachers' Classes were inaugurated in October last. The idea was organised by Mr. C. Smith, one of the teachers and organising secretaries, and was carried out under the auspices of the Rev. J. Rodgers, M.A. To the credit of our primary teachers it ought to be added that they have since the promulgation of the idea worked most heartily to bring it to this desired consummation. Profs. Huxley, Ansted, Carruthers, Sir John Bennett, and several other scientific men joined the committee for carrying out the classes. From every part of London masters and mistresses of our elementary schools gladly joined the Science School. Over 230 teachers were initiated, and it is hoped that most of the teachers will qualify themselves in the coming May examination to be able to teach the science subjects they have studied in these classes. Thus from this nucleus it is thought that next year we shall have science classes in connection with nearly every school (elementary) in the metropolis; and undoubtedly in a year or two more the inculcation of elementary general science knowledge will be almost universal.

Science teaching in the hands of a skilful instructor is always popular with young people, and as elementary teachers are eminently successful as collective teachers of the young, who could be better entrusted with imparting instruction which so brightens the intellect as these educators? The chief subjects taken this year at this science school are chemistry, mathematics, acoustics, light and heat, magnetism and electricity, botany (systematic and economic), geology, physiology, plane and solid geometry; but next year the promoters of the scheme hope to have classes in all the twenty-five subjects recognised by the Science Department of the Government. Most of the present students of the classes go in vigorously for physiology, physical geography, and acoustics, light and heat, a great many for chemistry. The teacher of chemistry, Mr. Spratling, has got up a first-rate laboratory for chemical experiments. Mr. Payne, teacher of magnetism and electricity, has all the approved auxiliaries for performing experiments connected with this subject. Next year the biology students will have every facility afforded them for microscopical practice. Mr. Simpson, who has done at least as much as any other person in London to train science teachers, is engaged as the special lecturer on Biology.

During the present session several of our leading scientific men have given a professional lecture to stimulate the teachers in their studies. Dr. Gladstone, Dr. Jarvis, Prof. Ansted, Prof. Carruthers, Mr. Tylor, Rev. W. Panckridge, Prof. Skertchley amongst the number. All the ordinary lectures are given by elementary teachers who have qualified themselves to teach. Two of the students, Mr. Bird and Mr. Powell, who have spent some of their leisure moments in making observations in botanical science, render much valuable aid to their fellow students in furnishing examples to illustrate the lessons given in botany. The students generally are pursuing their studies with great avidity, and as was observed at the Devon Social Society Gathering, by Mr. C. Clarke the importance of these classes cannot be over-estimated

## TROGLODYTES OF THE VEZERE*

IV.

IV.—*Arts among the Troglodytes*

THE men of the reindeer age cultivated drawing, chiselling, and even sculpture. We must admit that they had, like ourselves, many inferior artists; but among a large number of coarse attempts, such as our "street

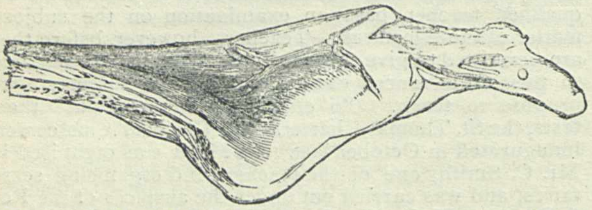

FIG. 23.—Sculptured pointed handle, representing an elongated reindeer.

arabs" chalk on the walls, there are some really remarkable ones, which denote at the same time a clever hand and an eye practised in the observation of nature.

Drawing, with this people, evidently preceded sculpture. The figures in relief are much more rare among them than those that are carved, and likewise much less perfect. The latter are common at the Eyzies and Lower Laugerie, but they abound more especially at the Madelaine, where they are also much more correct. These drawings are all carved. Most of them ornament the

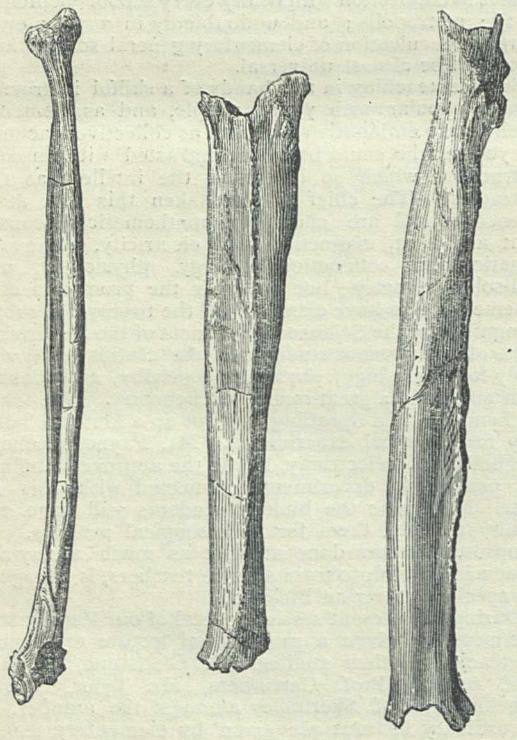

FIG 24. FIG. 25. FIG. 26

Bones of the old man of Cromagnon. Fig. 24—Shin-bone. Fig. 25.—Flattened tibia. Fig. 26.—Femur: profile view.

surface of different objects in deer horn, such as batons of command, handles of poignards; but some are engraved on pieces of stone, ivory, or deer horn, which were not intended for any other use, and which were prepared purposely to receive the work of the artist. (See Figs. 12 and 22.)

Nearly all these drawings represent natural objects. Some, however, are merely simple ornate lines, forming zigzag festoons, and more or less elegant curves.

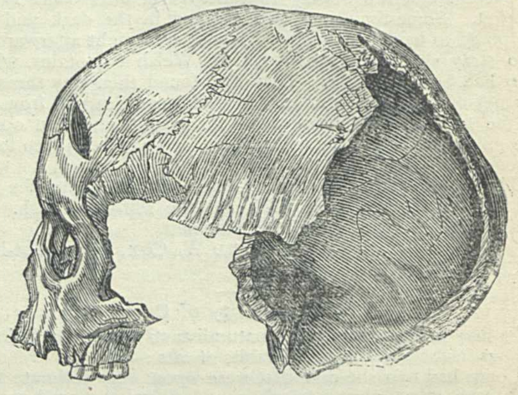

FIG. 27.—Skull of the woman of Cromagnon: profile. The wound in the frontal bone is shown.

Three little roses carved on a handle in deer-horn, seem to represent a polypetalous flower. All the other drawings are representations of animals.

The most numerous are those of the reindeer, then those of the horse: the ox and the aurochs are less common. These different animals are easily distinguished; their ways, their movements are sometimes reproduced with much elegance and accuracy; often they are isolated, dispersed in apparent disorder and in numbers over the whole surface of an object; then again they form groups, they are seen fighting together (see Fig. 22), or fleeing from man.

Of all these drawings, the most important and also the most rare, for it is at present unique, is that which repre-sents the mammoth, and of which I have already spoken.

Drawings of fish are pretty common. With one excep-

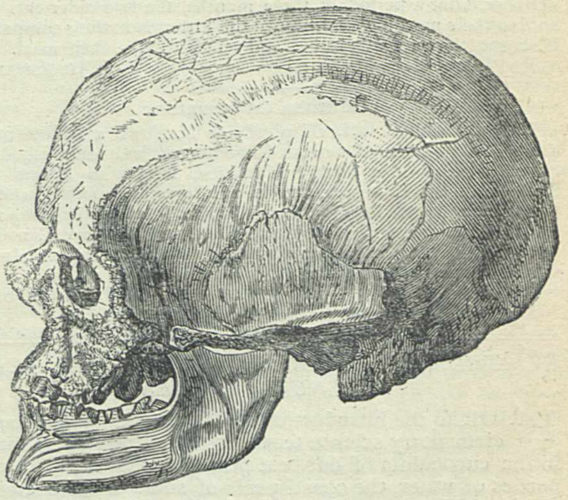

FIG. 29.—Skull of the old man of Cromagnon: profile.

tion, which represents an eel or a lamprey (if it is not a serpent), they have a shape which, though not very characteristic, may be intended for a salmon.

The Troglodytes, sometimes so clever in delineating animals, were very inferior artists of the "human form

* Continued from p 369

divine ;" they very rarely studied it. Only one study of a head has been found ; it is a very small drawing, representing a grotesque profile. Two other drawings, pretty much alike, represent the forearm terminating in a hand with four fingers, the thumb being hidden. I have already told you that the pieces of sculpture are much more rare than the drawings. There are not more than half a dozen, and they all come from Lower Laugerie. One of them, belonging to the Marquis de Vibrâye, represents a woman, another represents a reindeer (see Fig. 23).

V.—*Race*

To complete the study of this interesting people, I should now like to be able to characterise the race to which they belonged. The human bones that have been collected up to the present time are not, unfortunately, sufficiently numerous to satisfy our curiosity. However they suffice to prove that this race was very different from the succeeding ones, and to prove above all how much the learned anthropologist Retzius and his disciples were deceived, in stating that all the population of Western Europe, before the comparatively recent epoch of the Indo-European emigrations, belonged to the type of *short heads* or *brachycephals.*

M. Elie Massenat discovered, some months ago, at Lower Laugerie, the skeleton of a man who appears to have been buried in a landslip. But the anatomical description of this precious skeleton has not yet been published ; and I regret it the more, that it is the only discovered remains of the Troglodytes of the latest epoch.

The skulls and bones, of which I show you the models, belong to a much earlier date. They were found in the ancient burying ground of the station of Cromagnon, of which the geological, palæontological, and archæological characters have been ascertained with the greatest nicety by M. Louis Lartet. This sepulchre, henceforth celebrated, contained the remains of at least five people. But only three skulls, two male and one female, were sufficiently well preserved to make useful studies. One of the men had attained a great age ; the other man and the woman were adults ; near them lay a young child. Their stature was very lofty, and far superior to our own. The length of the femur of the old man indicated a height of more than 1·80m. The volume of the bones, the extent and roughness of the surfaces of muscular insertion, the extraordinary development of the branch of the jawbone, where the masticatory muscles are inserted, prove an athletic constitution.

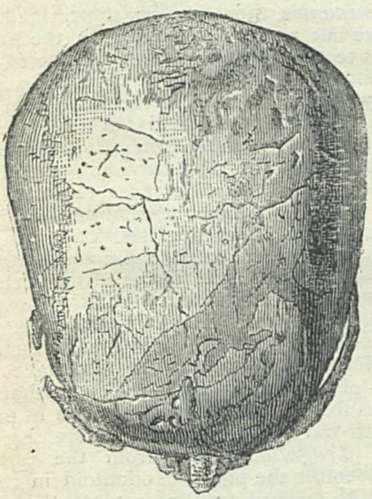
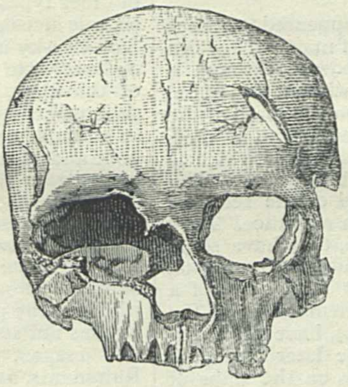
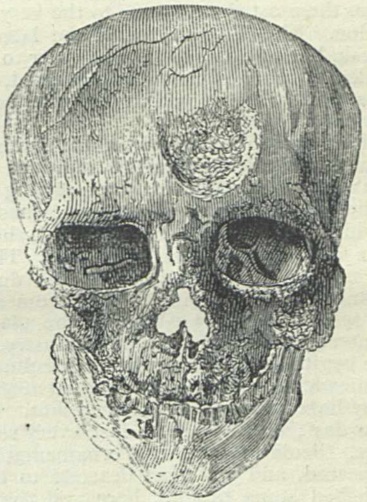

FIG. 31. FIG. 28. FIG. 30.

Fig. 28.—Skull of the woman of Cromagnon : front view. Fig. 30.—Skull of the old man of Cromagnon : front view. Fig. 31.—Skull of the old man of Cromagnon, *Norma verticalis*

The tibias, instead of being triangular and prismatic like our own, are flattened like those of the gorilla (see Fig. 24. The upper part of the cubitus, very powerful and arched, supports a very small sigmoidal cavity, and its characteristics again recall the shape of the gorilla. But the conformation of the femur differs radically from that of the monkey tribe. The femur of anthropomorphal monkeys is flattened from front to back—that is to say, much wider than it is thick, and it does not present, on its posterior surface, that longitudinal elevation which in man is called the *rough line.* In the existing human races, the thickness of the femur is in general rather greater than its width, but the difference is inconsiderable. At Cromagnon this bone is much thicker than it is wide (see Fig. 25). The rough line, enormously developed, is no longer a simple elevation ; it is a regular bony column, thick and projecting, which considerably augments the solidity of the bone and the extent of the muscular insertions. In this respect, therefore, the Cromagnon race differs much more from the Simian type than do the existing races. The skeletons of these robust Troglodytes bear the traces of their deeds of violence. One of the femurs of the old man presents, towards the lower extremity, a cavity such as is sometimes produced by our musket balls. It is evidently the result of an old wound. It was evidently a human hand, armed with a flint weapon, which produced a long penetrating wound on the skull of the woman. The width of the opening shows that the weapon must have reached the brain. This inglorious murder of a woman does not shed lustre on the people of Cromagnon. The study of their industry has already proved that their social status was not above that of other savage nations. An examination of their skulls confirms this notion,

With them, the sutures of the anterior region of the cranium are very simple, while those of the posterior region are rather complicated ; besides which the former have a manifest tendency to close long before the latter. These two characteristics are observable in people and in individuals who live principally an animal life. The Cromagnon Troglodytes were then savages. But these savages were intelligent, and open to improvement ; side by side with the proofs of inferiority I have just given, we find among them sure signs of a powerful cerebral organisation. The skulls are large. Their diameters, their curves, their capacity, attain, and even surpass, our medium skulls of the present day. Their form is very elongated. The alveolar process of the old man is oblique, but the upper part of the face is vertical, and the facial angle is very open. The forehead is wide, by no means receding, but describing a fine curve; the amplitude of the frontal tuberosities denotes a large development of the anterior cerebral lobes, which are the seat of the most noble intellectual faculties. If the Cromagnon Troglodytes are still savages, it is because their surrounding conditions have not permitted them to emerge from barbarism; but they are not doomed to a perpetual savage state. The development and conformation of their brain testify to their capability for improvement. When the favourable opportunity arrives, they will be able to progress towards civilisation. These rough hunters of the mammoth, the lion, and the bear, are just what ought to be the ancestors of the artists of the Madelaine.

I have just glanced over the principal facts in the history of the Troglodytes of the Vézère. For want of time, I have been obliged to shorten several and omit a number more. I hope, nevertheless, that you have been able to follow with me from Moustier to Cromagnon, from Cromagnon to Upper Laugerie and Gorge d'Enfer, and from thence finally to the three stations of the Eyzies, Lower Laugerie, and the Madelaine; the progressive evolution of an intelligent race, which advanced step by step, from the most savage state to the very threshold of civilisation. The Troglodytes of the latest epoch had, so to speak, but one step to take in order to found a real civilisation, for their society was organised, and they possessed arts and industry, which are the two great levers of progress.

This people have, nevertheless, disappeared, without leaving a single trace in the traditions of man. They did not die off by degrees, after having passed through a period of decadence. No, they perished without transition, rapidly, perhaps suddenly, and with them the torch of the arts was suddenly extinguished. Then began a dark period, a sort of middle ages, the duration of which is unknown. The chain of time becomes broken, and when we seize it again, we find, in the place of the reindeer hunters, a new society, a new industry, a new race. They are beginning to understand agriculture, they have some domestic animals, they are raising megalithic monuments, they have hatchets of polished flint. It is the dawn of a new day; but they have lost every remembrance of the arts. Sculpture, drawing, ornamentation, have alike disappeared, and we must descend to the later period of polished stone to find, here and there, on the slabs of some very rare monuments, a few ornamental lines which have absolutely nothing in common with the remarkable productions of art among the Troglodytes. The extinction of the Troglodytes was so complete and so sudden that it has given rise to the hypothesis of an inundation; but against this geology protests, and, to explain the phenomenon, we need only refer to the influence of man himself. Our peaceable reindeer-hunters, with their gentle manners, their light weapons, which were not adapted for fighting, were not calculated to resist the invasion of barbarians, and their growing civilisation succumbed at the first shock, when powerful conquerors, better armed for war, and already provided perhaps with the polished hatchet, came to invade their valleys. It was then seen, as it has often since been proved, that might conquers right.

## *PROF. FLOWER'S HUNTERIAN LECTURES*

### LECTURES XVI. XVII. XVIII.

*ARTIODACTYLATA.* The peculiarities of the skeleton in these animals have been already pointed out; it may be added as a constant special character, that the lower end of the fibula articulates with the calcaneum as well as with the astragalus; the premolars are also simpler than the molars, and there is an extra lobe to the last milk molar. The number of existing species is very great; they tend to divaricate in two directions, one culminating in the Pigs, and the other in the Cavicorn Ruminants. The Hippopotamus and Chevrotain at first sight do not look much alike, but the links between the two are very complete. The existing species are the most differentiated members of the order. Of the *Suina*, the Pigs are very exceptional among existing mammalia in retaining the typical number of forty-four teeth, Gymnura, an insectivorous animal, alone resembling them in this point; however there are spaces between some of them, so they do not form a regular series. The upper canines are very peculiar in being directed upwards instead of downwards, and in the Babirussa, where they pierce the upper lip, this is carried to an extreme. The molars are tuberculated, the tubercles being four in number in the Peccary, but much more numerous, especially in the last molars of *Sus*, where the extra ones represent the third lobe of the same teeth in the Ruminants. In a fossil pig from Pikermé the canines were similarly developed in both sexes, so the sexual differentiation must have been of later origin. In the Wart-hogs the incisors are rudimentary, and late in life the only molars persisting are the enormous columnar last molars; the great size of the canines is well known.

In the true *Ruminantia* there are no upper incisors, and the canines are but rarely developed. In the lower jaw there are eight teeth in a row along the front of the mouth, the two lateral can be proved to be canines, because in older types they are found of a different shape from the six true incisors. The anterior premolar is never developed. Kowalevsky has recently given the names *Bunodont* and *Selenodont* to the non-ruminating and ruminating members of this class, on account of the differences exhibited by their molar teeth, those in the latter presenting the ridges as a double crescent instead of in tubercles. The temporal bone and its surroundings give excellent characters whereby to separate these sub classes; the shape of the glenoid cavity and the direction of the external auditory meatus differing considerably in them. There is also no lateral notch in the palate of the pigs like those in the Ruminants. The Cervidæ and Cavicorn Ruminants also have the odontoid process of the axis peculiarly spout-shaped, whilst in the pigs it forms a simple peg, much as in man. It does not seem to have been remarked before that in this respect the *Tragulidæ* differ from the typical Ruminants, and resemble the pigs, the odontoid in them being a peg. With regard to the feet of *Sus*, Dr. Kowalevsky has made some important observations, having shown that the approximated sides of the two median metacarpals, which are the largest, send in towards one another processes which interlock, and that the shape of their distal articular surfaces causes them to be pressed together when the foot is to the ground. In the pigs the fibula is separate and complete, but in the Ruminants it is represented only by a small piece of bone outside the ankle; a rudiment is sometimes present above. That the deer approach the original type more than do the antelopes is evident from the facts that the upper canines are sometimes present, the crowns of the molars are shorter, and the lateral toes are present, being best developed on the fore-limb. The *Tragulidæ* are less differentiated in having the anterior metacarpals free and the fibula entire, though slender; the canines are well developed in the male at least, and the glenoid cavity is as like that of the pig as of the deer. *Dicotyles* approaches the ruminants from the other side, the metatarsals uniting to form a canon bone, and the foot altogether closely resembling that of Hyomoschus, though an outer toe is lost in the former. The camels are developed in a different direction, approaching the more generalised type.

Artiodactylates appear first in the middle Eocene, and therefore do not go so far back as the Perissodactylata.

*Anoplotherium* is from the upper Eocene of France and England only; there are two or three species. Though so early a form, it was much specialised, and its peculiarities have not been retained in more modern nor existing forms. It was about the size of the ass. The teeth formed an unbroken series, and, as in man, they were uniform in height. The upper molars were much as in Palæotherium, and the lower were a modification of the same type. Nineteen dorso-lumbar vertebræ were present; the tail was very long, with large chevron bones, which are not found in other Ungulata, and from which Cuvier somewhat rashly inferred that the animal was aquatic. The odontoid process of the axis was simple. In the feet there were only two toes before and behind; the metacarpals were quite separate. In one species there were four toes in front and three behind. *Elotherium* or *Entelodon* is another form from the lowest Miocene. It has been found in the middle of France and in the Mauvaises Terres of Dakotah. Its skull was elongated and somewhat pig-like, but the orbit was completed behind by bone. In size it approached the tapir. The teeth were somewhat carnivorous, the canines being long and bear-like, and the premolars trenchant; the forty-four teeth were present; the posterior molars were comparatively small, and the last one in the lower jaw had scarcely a rudiment of a third lobe. As in Anoplotherium there were only two toes on each foot, and the metacarpals and metatarsals were free.

Of the *Suidæ* many fossil species are known; the first appear in the upper Miocene of Eppelsheim and Pikermé, those in the latter locality much resembling the existing forms, the teeth only being less differentiated. There are no fossil true pigs in America. In the earlier and middle Miocene of Germany and France close allies are found in abundance, with the teeth simpler, only four tubercles being present, and the last molar not being excessively developed. One of these, *Amphichœrus*, had very long canines pointing downwards in the upper jaw. *Hyotherium* comprises *Palæochœrus* and *Chœrotherium*, the latter a small animal described by Leidy. There is a perfect transition between Palæochœrus and the fossil true pigs. Going further back it is doubtful how the line of descent continues. Acertherulum of Gervais may have had some relation to it. The American peccaries are peculiar in having only three premolars; in the fore-foot the outer toe is much reduced, and in the hind foot it is lost; a canon bone is formed by the metatarsals. Fossil peccaries have been found by Lund in Pleistocene caves of the United States, and in the American Miocene, scattered teeth of pig-like animals are not uncommonly met with.

Of recent hippopotamuses there are two species which have been further separated into different genera by Leidy, *Chœropsis* being the smaller and more pig-like; in it also the teeth are not so complicated, and it has two fewer lower incisors. In both genera the molars are very characteristic, being raised in four cusps, each of which in the little worn tooth is trefoiled on the surface; as the tooth gets more used these run together to form ultimately a single insula, undulated at the borders. In the Pleistocene caves and gravels of England, France, Germany, and elsewhere, remains of *Hippopotamus amphibius* are numerous, some are larger than existing individuals, but they do not otherwise differ. In Sicily a smaller species is found in enormous numbers. There are no hippopotamuses in the Miocene nor in the lower Pliocene. In Madagascar a smaller species used to abound. Dr. Falconer, in the Sevalik Hills, found remains of true hippopotamus with four incisors, but most from that region belonged to a distinct form in which all the six were present, and which has been named *Hexaprotodon*. There is no complete bridge between these animals and the pigs, and none have occurred in America.

Dr. W. Kowalevsky has drawn attention to an interesting point in the construction of the limbs of the different members of this class. He has shown that there are two methods by which the extremities may be supported on the carpus and tarsus respectively. In one, the *inadaptive*, the digits as they reduce in number, still are only supported by the carpals which originally articulated with them in the pendactylate foot. In the *adaptive* method, as the digits reduce, they enlarge their bases of attachment on the carpus, and so get a firmer support. This latter condition is found in all existing Artiodactylates except Hippopotamus.

Of the *Selenodonts* one of the earliest known is *Chœropotamus* from the upper Eocene of Montmartre; it was about the size of a pig, with the molars characteristic, presenting five tubercles, three in the anterior row, and two behind. *Anthracotherium* had similar molars, its limbs are unknown. *Hyopotamus* though but little known, was once very abundant; the species varied in size from that of a large rat to that of *Anthracotherium*: it is only found in the Eocene and early Miocene of Europe and North America. The molars were formed on the same principle as those in Chœropotamus, but they were more drawn out; the lower formed double crescents with an internal tubercle well developed; the typical forty-four teeth were present. Most had four toes, and feet very pig-like. Kowalevsky found some at Hordle with only two, and he has named these *Diplopus*. Between Hyopotamus and Anthracotherium there are many intermediate forms, *Xiphodon* with two toes, *Dichobune* and *Cainotherium*, this last had forty-four teeth, forming a continuous row, and three toes on the feet. *Dichodon* was a genus, named by Owen from some teeth, of which it possessed the full number, and the molars formed double crescents. From this we pass by easy transitions to the *Tragulidæ*, which have nothing to do with the Musk-deer, as is so frequently stated. They are at present confined to South Africa, South India, and the adjoining large islands. *Hyomoschus*, the African genus, has survived almost unchanged from the early Miocene period. *Tragulas* is not known fossil.

An American group here comes in to fill a gap. *Oreodon*, an animal about the size of a sheep, found in the early Miocene, is said by Leidy to be quite intermediate between the deer and the peccaries. It had forty-four teeth, its palate more closely resembled that of the deer, and the upper molars formed, as in them, double crescents. The canon bone was not consolidated, and there were apparently four toes They closely resemble Dichodon. Leidy divides them into three genera, *Agriochœrus*, *Merychyus*, and *Oreodon*. The first of these approaches Chœropotamus, and the crowns of the teeth were very short. *Gelocus*, described by Kowalevsky, is the earliest known form in which the metacarpals coalesced to form a canon bone; it occurs in the Eocene and the earlier Miocene. Those from the former have the metacarpals always free, but in the Miocene they anchylosed in the adult animal, and in higher strata they are fully coalesced. *Dremotherium* was a form which closely approached the deer. *Cervus* proper is first represented in the upper Miocene. In the earliest forms the antlers were very small and simple, closely resembling those of the Muntjac, and having long pedicles; the canines were also developed. All the Cervidæ adhere to the old type in having short crowns and well-marked necks to their molars. The Giraffes (*Camelopardidæ*) are first known from Pikermé and the Sevalik Hills; the molar teeth more closely approached those of the deer than any other animals. *Heladotherium* is not far removed from them; it was of large size and had no horns. *Sivatherium* was the largest of the extinct Artiodactylates. Its bones were bovine in character; the metacarpals and metatarsals coalesced to form a canon-bone, and there were only two toes on each foot; four horns were present, in pairs, apparently cavicorn and yet branched.

*Antelopes* and Deer coexisted in the Miocene era, but most of the former are Pleistocene in date. The crowns of the molars are prolonged in all the cavicornia. The *Camels* are not directly allied to the other forms; they retain an upper incisor; their molars are in double lunules, and of considerable length. Their geographical distribution is very peculiar, they being confined to North Africa, Arabia, and South America. Dr. Falconer has found their remains in the Sevalik Hills, and Leidy has done the same in North America, naming one of his genera *Procamelus*, and another earlier one Poëbrotherium.

This ends the description of the Artiodactylata, and terminates the course of lectures.

## AN ENGINEERING COLLEGE IN JAPAN

THE Japanese Government, as represented by the ambassadors who visited this country last summer and autumn, have resolved upon taking example by our western civilisation, and establishing a college in the city of Yeddo for affording instruction in civil and mechanical engineering to the youth of Japan, as a strong desire has arisen in that country to make an effort to develop the great natural resources which it is known to possess. Our advice and practical assistance in the establishment of the college have been called into requisition, owing to the ambassadors having observed during their sojourn amongst us, how intimately our eminent industrial status as a nation is dependent upon the attention which we devote to the cultivation of those sciences which are involved in the mining, metallurgical, engineering, and many manufacturing industries, and in bringing the forces of nature under the influence of man.

The general scheme of the instruction has been devised by one of our eminent engineers, a gentleman whose experience of Continental and British systems of instruction is very extensive and varied, and judging from the appointment already made, it is evident that the professorial equipment of the college will devolve upon this country. The principal of the college, who is also to be the professor of engineering and mechanics, is Mr. Henry Dyer, M.A. B.Sc., who studied at the University of Glasgow, under the late Prof. J. M. Rankine, Sir William Thomson, and their colleagues. Mr. Dyer was a Whitworth Scholar, and his career hitherto has been one of great and well deserved success. He is well qualified to act as principal of the Yeddo Engineering College.

Prof. Dyer is to be assisted in his duties in the Japanese College of Engineers by professors of mathematics, natural philosophy, chemistry, geology, and mineralogy, and by teachers of English, &c. At least two important appointments have been made, namely, to the professorship of mathematics and to the professorship of natural philosophy. The former has been conferred on Mr. D. H. Marshall, at present assistant to Prof. P. G. Tait in Edinburgh University; and the latter is to be filled by Mr. W. E. Ayrton, formerly of University College, London, and the University of Glasgow. The last-named gentleman has already been employed in the East Indian telegraphic service, and he is at present assistant-engineer in connection with the manufacture of the Great Western Telegraph Cable under Sir William Thomson and Prof. Fleeming Jenkin.

In connection with this Engineering College there are several other points of importance that may be stated. It is intended to institute a geological survey of Japan, and not improbably the active superintendence of that work will devolve upon the gentleman who may ultimately be appointed to the professorship of geology and mineralogy. As an important adjunct to the College, there will be erected a technical workshop, fitted with steam-engine, machine tools, and all the necessary appliances for familiarising the young Japanese engineers with the principles of construction, &c. There will also be a technological museum for the illustration of the progressive stages of various industrial processes from the raw materials to the finished products.

## NOTES

LETTERS, dated St. Thomas, appear in the *Times* and *Daily News* from correspondents on board the *Challenger*, where the vessel arrived on March 16. The voyage from Teneriffe had occupied 30 days. The usual programme was to furl sails early in the morning of every alternate day, put the ship under steam, obtain a sounding-haul of the dredge and serial temperatures at every 100 fathoms from the surface down to 1,500 fathoms, then at dusk sail was again made. The sounding line and dredge have been kept constantly going. The former showed that a pretty level bottom runs off from the African coast, deepening gradually to a depth of 3,125 fathoms at about one-third of the way across to the West Indies. If the Alps, Mont Blanc and all, were submerged at this spot, there would still be half a mile of water above them. Five hundred miles farther west there is a comparatively shallow part, a little less than two miles in depth. The water then deepens again to three miles, which continues close over to the West Indies. At the deepest spots both on the east and west side of the Atlantic, the dredge brought up a quantity of dark red clay, which contained just sufficient animal life to prove that life exists at all depths. No difficulty was experienced in obtaining these deep-sea dredgings, and it was merely a question of patience, each haul occupying twelve hours. In depths over two miles little has been found, but that little was totally new. One of the lions of the cruise is a new species of lobster perfectly transparent. Not content with obtaining animals with eyes so fully developed that the body may said to be an appendage, a new crustacean has now dredged up, in which the body has cut itself clear of the eyes altogether, and the animal is totally blind. It has no eyes, or even the trace of an eye. To make up for its deficiency nature has supplied it with the most beautifully developed, delicate lady-like claws, if one may use the term, it is possible to conceive. Nearer the West Indies, in a depth of only half a mile, some similar creatures were brought up, and here the claws, longer than the body, are armed throughout with a multitude of spike-like teeth, looking more like a crocodile's jaw than anything else. At a short distance from Teneriffe, in a depth of a mile and a half, a rich and extremely interesting haul of sponges and coral was obtained, but the latter was unfortuately dead. It is a white species, as large and heavy as the pink coral of the Mediterranean. There are great hopes of obtaining a specimen alive. The nature of the bottom brought up and the way the trawl and dredge frequently catch in being dragged along prove, undoubtedly, that the bottom of the sea, even at great depths, is not so smooth and free from rocks as has hitherto been supposed. A conclusion drawn from this fact is that a considerable movement of the water at the bottom must be going on. The *Challenger* will remain at New York until the 25th of April, and at Bermuda until the mail arriving on the 8th of May, after which she will sail for Madeira, carrying another section line across the Atlantic.

WE have learnt with pleasure that it is contemplated to present a testimonial to Dr. Murie, in recognition of his numerous additions to our knowledge in the field of Biology. From a list before us we learn that Dr. Murie is the author of seventy-five separate works, large and small, mostly connected with zoology. An opinion having been expressed that it might not be inappropriate to present Dr. Murie with a substantial recognition of the services which he has rendered to science by his numerous memoirs printed in the Proceedings and Transactions of the Zoological Society and other scientific journals, the following gentlemen have already acquiesced in that opinion, and state their belief that Dr. Murie's career has been a most meritorious one, very beneficial to science, and highly honourable to himself. The Viscount Walden, F.R.S., President of the Zoological Society of London, Sir Charles Lyell, Bart., Charles Darwin, F.R.S., Joseph D. Hooker, C.B., F.R.S., Allen Thomson, M.D., F.R.S., G. M. Humphry, M.D., F.R.S., James Glaisher, F.R.S., W. Sharpey, M.D., F.R.S., Wm. Turner, M.B., J. Lockhart Clarke, M.D., F.R.S., W. K., Parker, F.R.S., John Young, M.D., F.R.S.E., F.G.S., George Busk, F.R.S, St. George Mivart, F.R.S., Frank Buckland, F.Z.S., Inspector of Salmon Fisheries, William Aitken, M.D., J. Bell Pettigrew, M.D., F.R.S. Prof. Turner, of the University of Edinburgh, and Dr. Bell Pettigrew, of the Royal College of Surgeons of Edinburgh, have consented to receive subscriptions with a view to furthering the above object. Intending subscribers should communicate with either of these gentlemen.

AT the close of thee winter session of the Class of Physiology in Edinburgh University last Friday, Dr. J. G. McKendrick, F.R.C.P.E., was presented with an address signed by upwards of 400 present and former students of the class. Dr. McKendrick has for the last four years held the office of Demonstrator of Practical Physiology under Prof. J. Hughes Bennett, and during that period the classes in Practical Physiology have increased, from small beginnings, till more than 400 students have been enrolled in a single session. During the last two sessions Dr. McKendrick has conducted the entire work connected with the Chair, in the absence of Prof. Bennett from ill health.

THE government of New South Wales have generously granted 1,000*l*. for the purpose of observing the transit of Venus, and Mr. Russell is taking active measures to provide three stations in that colony with all the requisites for observing the transit, and obtaining at the same time photographs of the planet's position. The three stations will be at Sydney, at Eden, near the south-eastern point of N.S.W., and the third station on the Blue mountains, about fifty miles west from Sydney. Both stations are on telegraph lines, which will be used to determine their longitude. The mountain station has been chosen to avoid, if possible, any chance of cloudy weather, and in the hope that atmospheric difficulties generally will be less.

WE hear with great regret of the death of Dr. Torrey, which took place from pneumonia on March 10. Since the decease of Prof. Darlington he had been the Nestor of American botanists. Torreya, a genus of Taxacea of N. America and N.E. Asia, was named after him. He was a foreign member of the Linnean Society.

THE following has been sent us by a correspondent of M. Riedel:—"The Russian man-of-war *Tsanvina*, Commodore Michel Comancy, is steaming from Ternate to Papua the 28th of November past in search of the missed Russian naturalist, M. Micluha Maclay.—T. G. F. RIEDEL, C.M.Z.S.—Gorontalo, North Celebes, December 30, 187 2."

THE Royal Irish Academy has sanctioned the following grants out of the funds entrusted to it by Parliament for assisting scientific research:—50*l*. to W. H. Bailey for additional explorations at Kiltorcan for fossil plants; 40*l*. to G. H. Kinahan, to assist him in microscopical examinations into the structure of rocks; and 30*l*. to Prof. W. R. M'Nab, M.D., for researches in vegetable physiology.

WE are informed that the Hippopotamus, born a short time ago in the Zoological Gardens at Amsterdam, and which gave some promise of surviving, has, like most of its predecessors, died; so the young "Guy" in Regent's Park, which is doing as well as can be wished, is the only living specimen born and bred in Europe.

PROF. BRÜNNOW, the Astronomer Royal for Ireland, has just issued a second part of his astronomical observations and researches made at Dunsink, the observatory of Trinity College, Dublin. This part contains—New Determination of the Parallax of the Star Groombridge, 1830; Further Investigation of the Parallax of 615 Draconis; Determination of the Parallax of 85 Pegasi; Determination of the Parallax of the * Bradley, 3077; Further Investigations on the Parallax of $\alpha$ Lyræ; Observations of 1830 Groombridge and * (*a*); Observations of 1830 Groombridge, and * (*b*); Observations of 615 Draconis and * (9·5) preceding; Observations of 85 Pegasi; Observations of Bradley 3077 and * (10) following; and Observations of $\alpha$ Lyræ and * (10) following.

THE preliminary report of the U.S. explorations and surveys during the year 1871, in Nevada and Arizona, conducted by Lieut. George M. Wheeler, of the engineer corps, has lately been published in quarto form by the government printer. It contains an account of the plan of the survey, as initiated by Lieut. Wheeler in 1870, and which he has successively continued during the year 1872. The work accomplished during 1871 embraces, among other results, the mapping out of various mining districts, and the determination of the areas, direction, and condition of the lodes. The topographical features of the great Colorado plateau have been developed over the region extending from St. George, in Utah, to the White Mountains near the border line of Arizona and New Mexico, and much information has been gathered as to the geology of this plateau, and of numerous inclosed and interior basins in Nevada. The exploration of the Colorado has determined the absolute limit beyond which a party of examination will not be likely to ascend that river. It has been ascertained that a railroad can cross the Colorado and the mouth of the Virgin River, that it can be carried by easy grades, and that the Colorado can be crossed by a north and south line near the foot of the Grand Cañon.

THE Institution of Naval Architects commences its session for 1873 to-day. The meetings will be held as follows in the hall of the Society of Arts, John Street, Adelphi:—On Thursday, April 3, morning at 12, and evening at 7 o'clock; on Friday, April 4, morning at 12, and evening at 7 o'clock; and on Saturday, April 5, morning at 12 o'clock only. The Right Hon. Sir J. S. Pakington, Bart., M.P., G.C.B., D.C.L., president, will occupy the chair. Judging from the programme of proceedings, this year's meeting ought to be full of interest, and may be productive of important practical results.

THE first report (for 1872) of Governor N. P. Langford, superintendent of the Yellowstone National Park, has just made its appearance, and contains an account of what has been done during the year to protect and preserve this interesting region for the benefit of future visitors. We are informed that new natural wonders are continually discovered, and that the number of geysers, hot springs, &c., is almost countless. The Park was visited during 1872, in connection with the expedition of Prof. Hayden, and new routes determined, by which access will be much easier than heretofore. At present the only mode of approach is by means of saddle and pack trains, and Governor Langford suggests the propriety of constructing several waggon-roads for the convenience of the public. When improvements are made it is thought that extensive settlements will spring up in that region, supported in part by the travel of tourists, and partly by the exportation of lumber made from valuable timber in the district. No mines appear to have been detected, nor is there any prospect of them.

WE have received from the U.S. Engineer Office a well-constructed skeleton map prepared by Lieut. Geo. M. Wheeler, Corps of Engineers, U.S. Army, covering that part of the United States west of the 100th meridian, and exhibiting the relations that exist between lines and areas of explorations and surveys conducted under the auspices of the War Department in that region. It is of interest as showing, in an approximately detailed manner, the routes of government surveys over the large area embraced.

AN excellent opportunity for obtaining a valuable collection of minerals and fossils is furnished by the offer for sale in the U.S. of the celebrated Troost Cabinet, which, indeed, almost belongs to a former generation, having been packed away since the death of its collector at Nashville, Tennessee, a period of over twenty years. It was brought together at a time when rare and choice minerals were more easily obtained than at pressent, by Dr. Troost, who was at the time state geologist of Tennessee, and succeeded in making up one of the finest series of minerals in this country. The collection is at present in charge of Professor J. B. Lindley, of Nashville, to whom communications on the subject are to be addressed.

THE Syndicate recently appointed by the University of Cambridge to inquire into the scheme for establishing a county college at Cambridge have issued their report. While favourable to the scheme generally, they are not prepared to recommend that any special title should at present be offered by the University to students in the manner proposed, or that the University should prescribe rules for the admission of students into the proposed college. They recommend that a general approval be given to the proposed scheme. His Grace the Duke of Devonshire has consented to name the trustees.

THE Marquis of Westminster, K G., presided at a meeting at Chester on Saturday, in furtherance of a scheme for uniting under one roof the City Library and Reading Room, the Society of Arts, the Architectural and Archæological Society, the Natural Science Society, and also for establishing a local museum, the nucleus of which is already secured to the city by a valuable and extensive collection of geological specimens presented by the Marquis.

THE foundation-stone of the new Presidency College, Calcutta, was laid on February 27 by his Excellency the Governor.

A NEW archæological society has been started at Rajkote, Kattywar, India, named the Sourashtra Society. Its object is the encouragement of antiquarian research, the recording of traditional and ethnological information, and generally to add to the knowledge of the physical, social, and philosophical condition of the Province of Kattywar.

PROBABLY the oldest collection of specimens of natural history now extant in the United States constitutes a portion of the present cabinet of Princeton College, New Jersey. It was first brought together by Monsieur Delacoste, a French collector and naturalist, who flourished in New York at the beginning of the present century, and who published in 1804 a catalogue of his curiosities (chiefly collected in Guiana), filling a pamphlet of about ninety pages. The collection embraces about 260 species of birds, 63 of quadrupeds (which included both mammals and turtles), over 50 of fishes, and other objects in proportion. This collection is still preserved, for the greater part in good condition, at Princeton. The establishment of the Delacoste collection does not antedate that of Peale in Philadelphia; but that long since disappeared, partly by the scattering of the material collected, and partly from its destruction by fire.

COMMANDER SELFRIDGE arrived at Panama on January 21 last, and sailed on the 25th, on board the steamer *Tuscarora*, for the coast of Darien, for the purpose of continuing the survey of the Darien Ship-Canal route. Work will be commenced about latitude 6° 32′ north and be carried across the "divide," following the valley of the river Bajaya, a tributary of the Atrato, to its junction with the latter river, at a distance of about 150 miles from the Caribbean Sea.

MESSRS. BLACKWOOD AND SONS have sent us a well-constructed North Polar Chart, by Mr. Keith Johnston. Besides showing the latest discoveries of voyagers within the Arctic circle, the chart indicates each of the farthest points which have as yet been attained on the margin of the unvisited area, the great glacier and snow fields, the average and extreme limits of the appearance of sea ice, the northmost limits of tree growth on the land, the depths of the Arctic waters, so far as these are known, and the elevation of the land which surrounds them. The political boundaries of the countries which come within the limits of the map are also indicated.

WE have received a copy of the correspondence between the Royal Geographical Society and the Government with reference to the new Arctic Expedition which Government was unsuccessfully petitioned to undertake. The pamphlet contains *in extenso* all the documents submitted to Messrs. Lowe and Goschen, containing information of great intrinsic value.

THE earthquakes in Samos continued in March. A report had been spread by the Smyrniotes that the statement of earthquakes had been invented in the island to draw the Bey back from Constantinople.

ON Feb 20 no less than 20 distinct shocks were felt at Afioom Kara Hissar in Asia Minor, causing great alarm, as there was also almost incessant moving of the earth's surface. On the next day the wind veered round to the north with sharp cold and frost.

ON March 7, at 6 A.M., a smart shock of earthquake was felt at Rhodes.

OUR neighbours on the other side of the Atlantic are continually sending us what they term "Preliminary Descriptions" of novel forms of existing or extinct animals. These consist of new names, followed by short and very imperfect accounts of any apparently peculiar specimens which the author has had the good fortune to hit upon, a note being generally appended to the effect that fuller descriptions will shortly appear in some work now in hand. Our friends seem to forget that the form of ability which gives rise to an illustrious name, is gained by the employment of original method, rather than by the simple recording of novel facts. We fear that the large amount of undigested matter thus brought forward may in the long run produce a condition of dyspepsia of the scientific mind, which will tell hard on the more modest and painstaking workers on the subject, by producing a generally diffused and excessive scepticism as to the value of new discoveries, however promising.

THE "Results of Meteorological and Magnetical Observations, 1872," taken at Stonyhurst College Observatory, show that the meteorological work there is done with great care and minuteness.

WE would recommend to all science teachers the lecture recently delivered by Mr. Joseph Payne at the College of Preceptors, on "The True Foundation of Science-Teaching," now published in a separate form.

THE additions to the Zoological Society's Gardens during the past week include two Barbary Turtle Doves (*Turtur risorius*) from Africa, presented by Mr. G. Hanney; a Yellow-footed Rock Kangaroo (*Petrogale xanthopus*), and a Prince Alfred's Deer (*Cervus alfredi*), born in the Gardens; also a White-thighed Colobus (*Colobus bicolor*) from West Africa, purchased.

## *THE THEORY OF EVOLUTION IN GERMANY**

II.

WE must now examine how the primitive organisms have originated, or rather the single primordial organism from which all others have issued. Lamarck has attempted to solve the problem by his hypothesis of *archigony* or primitive being. Darwin avoids touching this question, doubtless to leave a last refuge for the hypothesis of a creation, and to make a final concession to the spiritualist systems. Haeckel shows no such caution; he is willing neither to renounce the scientific explanation of the phenomenon, nor to abandon the ground of natural philosophy to go astray upon that of faith or poetry; before resigning himself to the incomprehensible, he proceeds to explain, by a mechanical hypothesis, the primordial production of life.

He admits first, as to the origin of the earth, the system of Laplace, of whom Kant, about 1755, was the precursor, in his "Theory of the Heavens." This system is in harmony with all the phenomena at present known, and has not been found to disagree in any single instance. Moreover, it has the advantage of being purely mechanical, and of not requiring a resort to any supernatural force. This theory, consequently, plays the same part in cosmogony, and especially in geology, that the theory of Lamarck does in biology, and especially in anthropology. Both are founded exclusively upon efficient, and not upon final and intelligent causes. Both fulfil the conditions of a scientific theory, and have the same title to universal adoption, until the time when even better hypotheses shall be discovered. Haeckel, however, acknowledges that the theory of Kant and Laplace has a feeble foundation upon two points which it cannot explain—the heat to which is due the gaseous mass which formed the primitive world, and the rotatory movement impressed upon that mass. But every attempt to explain these facts leads us inevitably to the untenable theory of an absolute beginning.

We can no more conceive an absolute beginning for the eternal phenomena of movement than we can imagine an absolute end. The universe is, in the order of space and time, immense and without limits. It is eternal and it is infinite. The great law of the conservation of energy, which has become the basis of all our views of nature, does not allow of any other conception. The world, so far as it is accessible to our knowing faculties, appears to us as an uninterrupted chain of movements which determine a continual change of forms; each form is only the transitory result of a sum of phenomena of motion; but under this change of forms, force remains eternally indestructible.

Life could not commence before the earth had cooled sufficiently to allow the water, which had hitherto been in a state of vapour, to become liquefied and to be deposited on the surface; for all animals and all plants, all organisms in short, consist for the most part only of water combined in a particular manner with other materials. But how is it possible to conceive the commencement of organic life? In answer to this question, Haeckel examines first the relations which exist between organisms and the inorganic kingdom, from the standpoint successively of chemistry, of form, and of motion.

Chemistry teaches us that there does not enter into the material composition of living beings, absolutely any substance, which is not found in inanimate nature. There does not exist any distinct organic matter. The differences which exist between organic beings and the inorganic world cannot then have their essential foundation in the different nature of the substances of which they are composed, but only in the processes by which these substances enter into combination. A greater or less density suffices to place a chasm between two groups of bodies; moreover, the degree of density does not depend upon the component elements, but solely upon the temperature: by heating sufficiently a solid body, we can make it pass first into the liquid, and then into the gaseous state. In contrast to these three degrees of density of inorganic bodies, the solid, the liquid, and the gaseous, Haeckel attributes to living beings a fourth state of aggregation which is proper to them, is neither solid like stone, nor liquid like water, but appears to be a mean between the two, and consists always in a characteristic combination of water with organic matter. This mixed state, which is of the highest importance in the mechanical explanation of the phenomena of life, is explained in its turn, according to Haeckel, by the physical and chemical properties of a simple substance, viz. carbon. This element has a peculiar tendency to form with other elements, in the most diverse proportions of number and weight, complicated and very various combinations. Above all it enters into combination with three other elements, oxygen, hydrogen, and nitrogen, in order to form the indispensable base of all vital phenomena, viz. albumen or protein. Certain very simple organisms, such as the monads, are only small masses of semi-liquid, semi-solid albumen; and it is the same for the most part with other organisms in the earliest stages of their development, when they are as yet only simple cells; albumen then takes the name of *plasma* or protoplasm, and this plasma is now considered as the starting-point of all vital phenomena. Thus it is not more difficult for us to give a general explanation of life than it is to explain the physical properties of inorganic bodies. It is true that ultimate causes are hidden from us; but it is the same in the inorganic world. If we are unable to say why such a combination engenders a cell, no more can we understand why gold crystallises into a tetrahedric or antimony into a hexagonal form. Thus, from a chemical point of view, it impossible to establish any difference between the organic and inorganic kingdoms.

Again, with respect to Form, the simple and homogeneous structure of crystals is opposed to the heterogeneous and complicated structure of living beings; but certain inferior organisms, such as the monads, are formed solely of a small albuminous mass of a structure as simple as that of a piece of silex. Animals and plants thus appear, at first sight, not to have any mathematically determined form like crystals; but Haeckel has pointed out among the *Radiolaria* and many other protozoa a great number of inferior organisms, which, like crystals, may be referred to regular geometrical forms. He has also, in his "General Morphology" (pp. 375—574), presented an ideal system of stereometric forms which explain both the actual forms of inorganic crystals, and those of organic individuals. There is finally a large number of living beings completely amorphous, such as the monads, the *amœbæ*, &c., whose shape is constantly changing, and in which it is as impossible to recognise a determinate form as it is in the case of amorphous inorganic beings, such as non-crystallised stones, precipitates, &c. In respect of form, then, there is no more essential difference between organic and inorganic beings.

Let us now consider Movement. At the present day, as the hypothesis of a vital force is completely abandoned, it is necessary, according to Haeckel, to refer all manifestations of life, and particularly the phenomena of nutrition and reproduction, to the properties of carbon, or at least of hydrogen. With regard to growth, the only difference between living beings and inorganic bodies lies in this, that the former grow in size by intersusception, that is, by the introduction of new particles into their interior, while the latter are enlarged by opposition, by the external addition of new matter. The external conformation is determined, in crystals as well as in organisms, by the laws of adaptation; the form and the size of the crystal depends on the circumstances in which it is placed, on the vessel in which the process of crystallisation goes on, on temperature, on atmospheric pressure, on the presence or absence of foreign bodies. The form of every crystal, as well as the form of every organism, is thus the result of the struggle between two factors,—an internal plastic force proceeding from the chemical constitution of the body, and an external plastic force the result of the influence of the medium. Consequently, if growth and form are processes of life, there is no reason for refusing to attribute life to the inorganic world, as well as to organisms.

As soon as this unity of organic and inorganic nature is fairly established, the problem of primordial or spontaneous generation presents much fewer difficulties. If the attempts which up to the present time have been made to bring about experimentally spontaneous generation have not led to positive results, the only inference to be drawn is, that we are as yet ignorant of the conditions in which it takes place, conditions which, moreover, we may perhaps not now be able to reproduce. It is evident that all the matter which has become organic, would, at the time when the earth was not sufficiently cooled, be mixed in the atmosphere in a form of which we are ignorant. How are we able to reproduce completely in our laboratories all the chemical, electric, and other conditions of that primitive atmosphere? Meanwhile, the combinations of carbon which have already been obtained artificially, give ground for hoping that ere long we shall be able to reproduce the most important of all, the matter of the *plasma* or albumen.

* Continued from p. 352.

But the most powerful arguments in favour of spontaneous generation are furnished by the study of the monads, the simplest of all organisms, which Haeckel has made the subject of a special monograph. Seven species of these are known, some of which live in fresh water, and some in the sea, all of them consisting of small formless masses of albuminous combinations of carbon, and differing from each other only in their mode of reproduction, development, and nutrition. As these living beings do not present any complication of diverse parts, any division of functions or of organs, as all the phenomena of life with them proceed in a homogeneous manner, and without determinate form, it is very easy to conceive of their spontaneous generation. There is indeed one species which even at the present day appears to be born spontaneously, it is that which has been discovered by Huxley, and which has been described under the name of *Bathybius Haeckelii*. It inhabits the sea at depths of from 12,000 to 24,000 feet; it covers the ground sometimes as a network of strings of *plasma*, and sometimes in little heaps. The nucleus of it seems to be formed by a local condensation of albuminous matter, and the monad becomes a cell. As we have seen above that all animals and plants have their starting-point in a cell, it is allowable to suppose that all species are only monads gradually modified by natural selection.

It will be seen that all the views of Haeckel are founded upon the cellular theory as it has been formulated by Schleiden and Schwann. Haeckel always distinguishes two elements—*cytodes* and cells properly so called, reuniting these two elements under the generic name of *plastides*. Cytodes are parcels of plasma destitute of a nucleus, while cells are plastides endowed with a nucleus; each of these two species being subdivided in its turn into two groups, according as they are or are not enveloped by an exterior membrane. Hence there are four forms of *plastides*: (1) Naked or primitive cytodes, like the present existing monads, the only ones which can proceed directly from spontaneous generation; (2) Cytodes with membranes (*lepocytoda*), proceeding from naked cytodes by a coagulation of the exterior portion of the plasma; (3) Naked or primitive cellules by coagulation of an interior portion of the plasma; and (4), Membranous cells, proceeding either from membranous cytodes by interior condensation of the nucleus, or from naked cells by the external formation of a membrane.

There are two theories, one of which may be adopted. Either the monads at present known are descended by propagation from primitive monads and have preserved the same form for millions of years; or, even at this present time, as was the case in the earlier days of organisation, they owe their existence to repeated acts of spontaneous generation. The latter hypothesis is in no respect less probable than the former.

(*To be continued.*)

## SCIENTIFIC SERIALS

*Journal de Physique Théorique et Appliquée.* Par J-Ch. d'Almeida, Prof. de Physique au Lycée Corneille, Paris. We have before us the numbers of the "Journal de Physique théorique et appliquée" extending over the first year of its existence. The object of the journal, which consists of monthly parts of about forty pages each, is stated in the preface to the first number (January 1872) to be the giving of a new impulse to the study of physical science. This its authors aim at doing "by unfolding the more recent and less known theories, by describing the experiments upon which they rest, by indicating the most easy means of repeating them, and by narrating the progress which physical science makes day by day in France and other countries." By the execution of this project "they hope to interest everyone who is acquainted with the principles of science, to enliven teaching, to excite the spirit of research, and to stimulate discoveries." The journal, which is principally mathematical in its treatment of the subjects, differs considerably from such a journal as the "Philosophical Magazine." The original articles in it are few and unimportant. There are criticisms on and reprints of articles selected from other journals, and bearing on the subjects to which this is devoted; but the distinguishing feature of the journal consists in articles, continued generally through several successive numbers, reproducing and elucidating important theories and investigations, which are thus presented in an easily accessible form. Thus the first number starts off with an article on "Electrostatic measures." We also have a series of articles by M. Terquem on electricity and magnetism, beginning in No. 1 with a short article stating the experiments by which it is demonstrated that free electricity resides only in the surfaces of conductors, and then proceeding in No. 2, and subsequent numbers, to treat of the various units employed in measuring quantities of electricity and magnetism, and the relations which exist between them. The reader will gather the character of such articles as those to which we refer, from the following enumeration of the titles of a few others of those which are more important:—"On the action of a magnet on a magnetised molecule at a distance," "On the analogy between the propagation of heat and the distribution of electricity," "On the propagation of permanent electric currents," "On the employment of the wave theory in optical calculations," "On Electrodynamics and the theory of induction." These articles do not contain original matter, nor for the most part do they contain matter arranged in an original way, but they contain useful and concise expositions of the subjects, reproducing such points as the proof of Ampère's theory, Ohm's laws, the method of comparing electro-magnetic and electro-static units, and the like. Such articles will be principally useful to those who cannot obtain the original investigations, or who desire to avoid the labour of consulting those manuals in which these investigations may be included. The journal seems certainly well calculated to extend a knowledge of and interest in the subjects with which it deals, and thus to assist in achieving the end which it proposes to itself.

JAMES STUART

## SOCIETIES AND ACADEMIES

### LONDON

Royal Society, March 20.—"On the Temperature at which *Bacteria*, *Vibriones*, and their Supposed Germs are killed when immersed in Fluids or exposed to Heat in a Moist State." By H. Charlton Bastian, M.D., F.R.S., Professor of Pathological Anatomy in University College, London. (*Continued from p.* 413.)

The facts just cited concerning the behaviour of thin films of turbid infusions which had been heated to different temperatures gave me the clue as to the proper direction of future work. It would seem that when mounted in the manner described, such thin films of infusion continue capable of supporting and favouring the multiplication of any already existing *Bacteria* and *Vibriones*, although, under such conditions, no new birth of living particles appears to take place even in these fluids. The question then arose as to whether, by subjecting larger quantities of the same infusions to any particular sets of conditions, we could ensure that they also should continue to manifest the same properties. Because if so, it would be almost as easy to determine the death-point of *Bacteria* and *Vibriones* when exposed to heat in these infusions, as it had been to determine it for the saline solutions already mentioned.

It was pointed out by Gruithuisen early in the present century that many infusions, otherwise very productive, ceased to be so when they were poured into a glass vessel whilst boiling, and when this was filled, so that the tightly-fitting stopper touched the fluid. Having myself proved the truth of this assertion for hay-infusion, it seemed likely that, by having recourse to a method of this kind, I should be able to lower the virtues of boiled hay and turnip infusions to the level of those possessed by the boiled saline solution with which I had previously experimented—that is, to reduce them to a state in which, whilst they appear quite unable of themselves to engender *Bacteria* or *Vibriones*, they continue well capable of favouring the rapid multiplication of such organisms.

This was found to be the case, and I have accordingly performed upwards of one hundred experiments with inoculated portions of these two infusions raised to different temperatures. The mode in which the experiments were conducted was as follows:—

Infusions of hay and turnip of slightly different strengths were employed. These infusions having been first loosely strained through muslin, were boiled for about ten or fifteen minutes, and then whilst boiling strained through ordinary Swedish filtering-paper into a glass beaker which had previously been well rinsed with boiling water. A number of glass bottles or tubes were also prepared, which, together with their stoppers or corks, had been boiled in ordinary tap water for a few minutes.* They were taken out full of the boiling fluid; and

* The vessels employed have varied in capacity from two drachms to four ounces; some have been provided with glass stoppers and others with very

the stoppers or corks being at once inserted, the vessels and their contents were set aside to cool. When the filtered infusion of hay or turnip had been rapidly cooled down to about 110° F. (by letting the beaker containing it stand in a large basin of cold water), it was inoculated with some of a turbid infusion of hay swarming with active *Bacteria* and *Vibriones*—in the proportion of one drop of the turbid fluid to each fluid ounce of the now clear filtered infusion*. The beaker was then placed upon a sand-bath, and its contained fluid (in which a thermometer was immersed) gradually raised to the required temperature. The fluid was maintained at the same temperature for five minutes by alternately raising the beaker from and replacing it upon the sand-bath. The bottles to be used were then one by one uncorked, emptied, and refilled to the brim with the heated, inoculated fluid.† The corks or stoppers were at once very tightly pressed down so as to leave no air between them and the surface of the fluids. The beaker was then replaced upon the sand-bath and the gas turned on more fully, in order that the experimental fluid might be rapidly raised to a temperature 9° F. (5° C.) higher than it had been before. After five minutes' exposure to this temperature other bottles were filled in the same manner, and so on for the various temperatures the influence of which it was desired to test.

Thus prepared, the bottles and tubes have been exposed during the day to a temperature ranging from 65° to 75° F. And generally one had not to wait long in order to ascertain what the results were to be. In some cases, if the contents of the vessels were to become turbid, this was more or less manifest after an interval of forty-eight hours. In other cases, however, the turbidity manifested itself three or more days later, and the reason of this difference will be fully discussed in a subsequent communication.

For the sake of simplicity and brevity, the necessary particulars concerning the 102 experiments have been embodied in the table which will be found below.

The experimental results here tabulated seem naturally divisible into three groups. Thus, when heated only to 131° F., all the infusions became turbid within two days, just as the inoculated saline solutions had done.‡ Heated to 158° F. all the inoculated organic infusions remained clear, as had been the case with the saline solutions in my previous experiments, when heated to 140° F. There remains, therefore, an intermediate heat zone (ranging from a little below 140° to a little below 158° F.), after an exposure to which the inoculated organic infusions are apt to become more slowly turbid, although inoculated saline solutions raised to the same temperatures invariably remain unaltered. The full explanation of these apparent anomalies I propose to make the subject of a future communication to the Royal Society; meanwhile we may quite safely conclude that *Bacteria*, *Vibriones*, and their supposed germs are either actually killed or else completely deprived of their powers of multiplication after a brief exposure to the temperature of 158° F. (70° C.).

This evidence now in our possession as to the limits of "vital resistance" to heat displayed by *Bacteria*, *Vibriones*, and their supposed germs in neutral saline solutions, and in neutral or acid organic infusions, is most pertinent and valuable when considered in relation to that supplied by other sets of experiments bearing upon the all-important problem of the Origin of Life. These latter experiments alone may possibly leave doubt in many minds; but the more thoroughly they are considered in relation to the evidence brought forward in this communication, the more fully, I venture to think, will every lingering doubt as to the proper conclusion to be arrived at be dispelled.

Thus, we now know that boiled turnip- or hay-infusions exposed to ordinary air, exposed to filtered air, to calcined air, or shut off altogether from contact with air, are more or less prone to swarm with *Bacteria* and *Vibriones* in the course of from two to six days. But, placed under slightly different conditions such as were employed in the inoculation experiments above quoted, although infusions of the same nature do not undergo "spontaneous" putrefactive changes, yet when living *Bacteria* and *Vibriones* are added and not subsequently heated, putrefaction *invariably* takes place and the fluids thus situated rapidly become turbid. There is therefore nothing in the conditions themselves tending to hinder the process of putrefaction, so long as living units are there to initiate it. Our experiments now show that as long as the added *Bacteria*, *Vibriones*, and there supposed germs are subjected to a heat not exceeding 131° F. (55° C.), putrefaction invariably occurs within two days, whilst, on the contrary, whenever they are subjected to a temperature of 158° F. (70° C.) putrefaction does not occur. To what can this difference be due, except to the fact that the previously living organisms which, when living, always excite putrefaction, have been killed by the temperature of 158° F.? It would be of no avail to suppose that the absence of putrefaction in these latter cases is due to the fact that a heat of 158° F., instead of killing the organisms and their germs, merely annuls their powers of reproduction, because in the other series of experiments (with which these have to be compared) where similar fluids are exposed to ordinary or purified air, or are shut off from the influence of air altogether, the most active putrefaction and multiplication of organisms takes place in two, three, or four days, in spite of the much more potent heat of 212° F., to which any pre-existing germs or organisms must have been subjected. The supposition, therefore, that the *Bacteria*, *Vibriones*, and their germs were not killed in our inoculation experiments at the temperature of 158° F., but were merely deprived of their powers of reproduction, would be no gain to those who desire to stave off the admission that *Bacteria* and *Vibrones* can be proved to arise *de novo* in certain cases. Let us assume this—which is indisputably proved by these inoculation experiments—viz. that an exposure to a temperature of 158° F. (70° C.) for five minutes deprives *Bacteria*, *Vibriones*, and their germs of their usual powers of growth and reproduction—that is that it reduces them to a state of potential, if not necessarily to one of actual death. What end would be served by such a reservation? The impending conclusion would not be staved off by means of it. The explanation of what occurs in the other set of experiments, where the much more potent heat of 212° F. is employed, still would not be possible without having recourse to the supposition of a *de novo* origination of living units, so long as those which may have pre-existed in the flask could be proved to have been reduced to such a state of potential death. It would be preposterous, and contrary to the whole order of nature, to assume that the vastly increased destructive influence of a heat of 212° F. had restored vital properties which a lesser amount (158° F.) of the same influence had completely annulled.

The evidence supplied by these different series of experiments in whichever way it is regarded, as it seems to me, absolutely compels the logical reasoner to conclude that the swarms of living organisms which so often make their appearance in boiled infusions treated in one or other of the various modes already proved to be either destructive or exclusive of pre-existing living things, are the products of a new brood of "living particles," which, in the absence of any co-existing living organisms, must have taken origin in the fluid itself. For this mode of origin of living units, so long spoken of and repudiated as "spontaneous generation," I have proposed the new term Archebiosis.

*Inoculation Experiments made with the view of ascertaining the Temperatures at which* Bacteria, Vibriones, *and their Supposed Germs are killed in Organic Infusions.*

NEUTRAL HAY INFUSION.

| Temp. to which exposed. | Number of Experiments made. | Date of Turbidity, if any. | Results at Expiration of the 8th day. |
|---|---|---|---|
| 122° F. (50° C.) | 1 | 24 hours | Turbid. |
| 131° F. | 7 | 48 hours | All turbid. |
| 140° F. | 9 | 1 in 48 hours<br>6 in 60 hours<br>1 in 3 days<br>1 in 8 days | All turbid. |
| 149° F. | 4 | 2 in 5 days<br>1 in 8 days | Three turbid.<br>One clear. |
| 158° F. | 15 | ... ... | All clear. |
| 167° F. | 4 | ... ... | All clear. |
| 176° F. (80° C.) | 12 | ... ... | All clear. |

tightly fitting corks; and the latter I find have answered quite as well as the former. On the whole I have found tightly corked 1 oz. phials to be about the most convenient vessels to employ in these inoculation experiments.

* It was found desirable to filter the infusions after they had been boiled, because the boiling generally somewhat impaired their clearness.

† At this stage, of course, *very great care* is needed in order to avoid all chance of accidental contamination either with living organisms or with unheated fragments or particles of organic matter.

‡ In the experiments already referred to.

ACID TURNIP INFUSION.

| Temp. to which exposed. | Number of Experiments made. | Date of Turbidity, if any. | Results at Expiration of the 8th day. |
|---|---|---|---|
| 122° F. | ... | ... ... | ... ... |
| 131° F. | 7 | 5 in 24 hours<br>2 in 48 hours | All turbid. |
| 140° F. | 12 | 6 in 40 hours<br>4 in 3 days<br>2 in 4 days | All turbid. |
| 149° F. | 10 | 1 in 3 days<br>3 in 5 days<br>1 in 7 days<br>2 in 8 days | Seven turbid.<br>Three clear. |
| 158° F. | 17 | ... .. | All clear. |
| 167° F. | 4 | ... ... | All clear. |
| 176° F. | ... | ... ... | ... ... |

March 27.—"On the Radiation of Heat from the Moon, the Law of its Absorption by our Atmosphere, and its variation in amount with her Phases." By the Earl of Rosse, D.C.L., F.R.S.

In this paper is given an account of a series of observations made in the Observatory of Birr Castle, in further prosecution of a shorter and less carefully conducted investigation, as regards many details, which forms the subject of two former communications* to the Royal Society. The observations were first corrected for change of the moon's distance from the place of observation, and change of phase during the continuance of each night's work, and thus a curve, whose ordinates represented the scale-readings (corrected) and whose abscissæ represented the corresponding altitudes, was obtained for each night's work. By combining all these, a single curve and table for reducing all the observations to the same zenith-distance was obtained, which proved to be nearly, but not quite, the same as that found by Professor Seidel for the light of the stars. By employing the table thus deduced, and also reducing the heat-determinations obtained on the various nights for change of distance of the sun, a more accurate phase curve was deduced, indicating a more rapid increase of the radiant heat on approaching full moon than was given by the formula previously employed, but still not so much as Prof. Zöllner's gives for the moon's light.

By employing Laplace's formula for the extinction of light in our atmosphere, the heat-effect in terms of the scale-readings was deduced, and an approximation to the height of the atmosphere attempted.

From a series of simultaneous measurements of the moon's heat and light at intervals during the partial eclipse of November 14, 1872, when clouds did not interfere, it was found that the heat and light diminish nearly if not quite proportionally; the minimum for both occurring at or very near the middle of the eclipse, when they were reduced to about half their amounts before and after contact with the penumbra.

PARIS

Academy of Sciences, March 24.—M. de Quatrefages, president, in the chair. M. Faye read a long and exhaustive reply to M. Vicaire's criticisms on his solar theory and attempted revival of Wilson's hypothesis. He answered each objection in detail, and maintained that his position had not been affected by M. Vicaire's arguments.—M. Berthelot read a paper on the constitution of the solutions of the hydracids, and on their inverse reactions. He believes that the increase of heat evolved with increased dilution proves the existence of a number of hydrates, and that the quantity of hydrated acid required to precipitate certain chlorides from their solutions will throw more light on this point.—On certain propyl new derivatives, related to the metallic propyl compounds, by M. A. Cahours.—M. Th. Lestibondois read a note on certain anomalous lianas.—Papers were read on the conditions under which certain periods of the quadratics of a curve of *m* degrees disappear or become infinite, by M. Max Marie.—On a new double-image micrometer, by M. C. Noel.—On the measurement of the chemical effect of solar light, by M. E. Marchand.—On Phylloxera, &c., by M. L. Faucon.—On a new method of determining the position of the nodal surfaces in masses of vibrating gas, by M. D. Gernez.—On the volumetric estimation of carbonic anhydride, by M. Houzeau. The author has devised a method for the application of volumetric analysis to the determination of $CO_2$ in agricultural chemistry. The process consists in absorbing the gas in soda solution containing zincic oxide, precipitating the carbonate formed with neutral solution of baric chloride, and titrating the free soda left with standard sulphuric acid.—Researches on trichloracetic acid and the trichloracetates, by M. A. Clermont.—On the bursting of the skin of fruits exposed to persistent rain, &c., by M. Joseph Boussingault. The author finds that this is due to the diffusion of water into the fruit. Many kinds of fruit thus absorb large quantities of water, and ultimately burst. The author has also experimented on leaves and stalks. In every case sugar diffused out of the fruit and leaves.—On the snow-line, and its elevation in different parts of the world, by M. Ch. Grad.—On M. Pasteur's process for silk-worm preservation, by M. Guisquet, was an answer to M. Guerin-Méneville, who has denied M. Pasteur's statements.—On the phenomena of hibernation presented by flies exposed to successive changes of heat and cold in Russia, by M. Goubareff. Flies found perfectly torpid became lively at + 33° Réaumur, and became again torpid when the temperature was allowed to fall.—On an optical phenomenon produced by the condensation of dew on grass, by M. J. Leterme.

* Proceedings of the Royal Society, vol. xvii. p. 436; xix. p. ;

## DIARY

*THURSDAY*, APRIL 3.

ROYAL SOCIETY, at 8.30.—On the Structure of Striped Muscular Fibre: E. A. Schafer.—Note on the Synthesis of Marsh Gas, and the Electric Decomposition of Carbonic Oxide: Sir B. C. Brodie.—On an Air Battery: Dr. Gladstone and A. Tribe.

SOCIETY OF ANTIQUARIES, at 8.30.—Greek Liturgies and Byzantine Architecture: Edwin Freshfield.

CHEMICAL SOCIETY, at 8.—A way of exactly determining the specific gravity of Liquids: Dr. H. Sprengel.—On Cymene from various sources Dr. C. R. A. Wright.—Researches on the action of the Copper-zinc couple on organic bodies. II.—On the iodides of Amyl and Methyl: J. H. Gladstone and A. Tribe.—Contributions from the Laboratory of the London Institution, No. XI.—Action of the acid chlorides on Nitrates and Nitrites: Dr. H. G. Armstrong.

LINNEAN SOCIETY, at 8.—On new Indian Fishes: Surgeon-Major F Day.—On the Fungi of Ceylon: Rev. M. J. Berkeley and C. E. Broome.

ROYAL INSTITUTION, at 3.—Coal and its Products: A. V. Harcourt.

*FRIDAY*, APRIL 4.

ROYAL INSTITUTION, at 9.—Observations on Niagara: Prof. Tyndall.

GEOLOGISTS' ASSOCIATION, at 8.—The Diamond Fields of South Africa: G. C. Cooper.—On some Fossils from the Margate Chalk: J. W. Wetherell.

ARCHÆOLOGICAL INSTITUTION, at 4.

*SATURDAY*, APRIL 5.

ROYAL INSTITUTION, at 3.—Darwin's Philosophy of Language: Prof. Max Müller.

*SUNDAY*, APRIL 6.

SUNDAY LECTURE SOCIETY, at 4.—The Stereoscope, the Pseudoscope, and Binocular Vision: W. B. Carpenter.

*MONDAY*, APRIL 7.

ENTOMOLOGICAL SOCIETY, at 7.

LONDON INSTITUTION, at 4.—Elementary Botany: Prof. Bentley.

VICTORIA INSTITUTE, at 8.—Force: Prof. Kirk.

*WEDNESDAY*, APRIL 9.

PHOTOGRAPHIC SOCIETY, at 8.

GEOLOGICAL SOCIETY, at 8.—Lakes of the North-eastern Alps, and their bearing on the Glacier-erosion theory: Rev. T. G. Bonney.—Notes on Structure in the Chalk of the Yorkshire Wolds: J. R. Mortimer.

LONDON INSTITUTION, at 7.—Paper and Discussion.

ARCHÆOLOGICAL ASSOCIATION, at 8.

ASTRONOMICAL SOCIETY, at 8.

SOCIETY OF TELEGRAPH ENGINEERS, at 7.30.—On a Bell Alarm for Submarine Cables: Wm. F. King.—On the Measurement of Battery Resistance: Jas. Graves.—On the Mechanical Tests of Iron Wire: R. S. Culley.

*THURSDAY*, APRIL 10.

MATHEMATICAL SOCIETY, at 8.—On Systems of Porismatic Equations, Algebraical and Trigonometrical; Note on Epicycloids and Hypocycloids; Locus of point of concourse of perpendicular Tangents to a Cardioid; Elliptic motion under acceleration constant in direction: Prof Wolstenholme.—On the calculation of the Value of the theoretical unit-angle to a great number of decimal places: Mr. J. W. L. Glaisher.

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