NATURAL SCIENCE:

A Monthly Review of Scientific Progress.

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NOTES AND COMMENTS.

Progress.

WITH this Number, NATURAL SCIENCE enters on its fourth volume. Two years of experiment, and of those difficulties incidental to all new publications, are now happily ended. Without deviating from the path originally marked out for it, this venture has secured for itself a basis of which the firmness may be measured by its wide extension. For this result, far more fortunate than they anticipated, the promoters are indebted less to their own labours than to the kindly aid so constantly offered them by an ever-swelling stream of contributors, and to the warm welcome extended by an ever-widening circle of readers. To all of these, whether at home in England or far off in her scattered colonies, whether fellow-workers of our own race in America or workers joined with us in the pursuit of a common aim in all foreign lands from Germany to Japan—to one and all this Number will bear our cordial thanks for the past, and will express that gratitude which is a lively sense of favours to come.

To those of our readers and helpers who have not been with us from the beginning, and who have found difficulty in obtaining our earlier numbers, we should like to take this opportunity of restating our aims. We have been from the beginning, and we still hope to be, as our sub-title indicates, a review of Scientific Progress. Month by month we bring to the specialist a critical account of what is being done in other lines than his own; while, for the general reader, the specialist himself is constantly invited to render more accessible his stores of knowledge. As examples of such work, we may refer to the articles in this number on Cell-Division and on the Fucaceæ. We endeavour also to search out items of interest that are hidden away in unlikely volumes or in publications not easily obtained. Chiefly, in this respect, do we attempt to give the news of our own local scientific societies and of similar bodies scattered throughout the British Dominions. And here it is that we need most of that friendly aid of which we have already spoken. It is obviously impossible for a scientific monthly to emulate the daily newspaper, to retain paid correspondents in every city of the globe, or to send a special commissioner on a roving tour. But with the goodwill of our colleagues Natural Science may easily be made a bond of union, and a means of communication between naturalists of our own race in all parts of the world. Not that we would in any way pass over foreign labourers in the same field; but if we can make our summary of British Scientific Progress fairly complete, then our Journal will be of all the greater use to those who have not had the rare good-fortune to be born Britons.

But it is not our only object to retail the results of investigation, and to summarise the news of the world of Natural Science. We do not merely wish to review scientific progress; but we hope to assist it. And in this hope we have polished our shield bright, and set our lance in rest. May all shams and bugbears, when they see themselves mirrored as they truly are, sink to the nothingness of which they are made; and may the more enduring obstacles to progress be, if not shivered, at least a little shocked by our onset! Of course this will gain us enemies as well as friends; but that is the more evidence of success, and, after all, we hope our enemies will not be very bitter, since we attack principles not persons, measures not men. It is in pursuit of this aim that we open our columns to those whom authority seems to treat too hardly, even if we do not always agree with them ourselves. It is not always the popular view that is the right one, and the history of Science shows too many instances of folly becoming wisdom, for even an editor to feel his judgment infallible.

F.R.S.—F.L.S.—F.G.S.—F.Z.S.

The Royal Society is again under fire. At the Anniversary Dinner the President himself deplored internal but obvious evidences of its decay, and a correspondent of *The Times* was not slow to take up the tale. His article, which appeared on December 2, emphasises Lord Kelvin's words and adds some exceedingly outspoken criticisms. The Society is falling, he says, more and more into the hands of biologists, while workers in other branches of science no longer lay their papers before it but before those societies specially interested in their subjects. The cause of this lies, he maintains, "in the excessive influence of a small body of permanent officials, in the practical effacement of the non-official council, and in the consequent government of the Society by cliques instead of by the common-sense of the scientific community at large." As the autocrats in question he denounces the Dons of Cambridge (Trinity College) and the Professors of South Kensington. The "undue preference" shown in the disposal of the Government grant next receives his censure. Especially does he blame the Solar Physics Committee for drawing money from this grant, despite the fact that they have since 1879 received an independent annual subsidy from the Government of no less than £500. It is, however, a little rash of the critic to wish that the distribution of this grant should be taken out of the hands of the Council; for if it were, as he suggests, divided among the various seats of learning about the country, the same difficulty of cliquism would, we fear, occur. No administrative body can wholly escape this charge.

There is another matter that might well have been touched on by *The Times* denunciator. The methods of election pursued, not only by the Royal but by many of our other learned societies, are exceedingly open to criticism. The mystic letters placed at the head of this article have too long imposed on the credulity of the public. It is too commonly supposed that they are symbols of vast erudition on the part of their happy possessors. Yet, with the exception of "F.R.S.," all these titles are obtainable by little more than simple purchase. The fellowship of the Royal Society comes, it is true, partly as the reward of original work, but mainly by the backing of influential friends. A glance at the list of that Society might possibly dispel the illusion that all its fellows were men of great learning. As for those who are really worthy of election, we do not deny that the majority of them get into the Society in course of time; but there are many others whose social position or personal peculiarities are, unjust as it may seem, allowed to tell against them. Indeed the whole system of election into the Royal Society seems to be in need of improvement. It may be legitimate, but it is hardly self-respecting for a man to suggest his own name as a candidate and then to tout round for support. So derogatory a proceeding should be impossible. Why should not the Society, without regard for personal feeling, select the twelve best men of the year, and let the election come as a surprise to the candidate? The distinction would at least be more honourable.

But it is possible that mere honour is not the only inducement to candidates for the fellowship of the Royal Society. Not this alone would cause a man to get his name put up year after year by some obliging friend, until common-sense or pique urged him to withdraw from the unsuccessful attempt. May not a deeper reason be sometimes found in the commercial value of the Fellowship, not only of the Royal but of the other Societies? We all know that F.R.S. means "Fees Raised Since," while not a few professional men could tell us, if they chose, what pecuniary profit accrued to them from the possession of any of the other magic letters. This is not just, either to the Societies or the public. Election does not and should not imply any professional ability on the part of the candidate. The tailor's cutter, when asked for a reference, replied, "Bring me some cloth and a pair of shears, and you'll want no reference." Such should be the attitude of self-respecting professional men; such is the attitude of the single-hearted devotee of science. Fellowships may have a value in commercial circles; but no number of them can raise the reputation of a master among his colleagues, either in his own country or abroad.

FONA OR FUDDLEITE. A NEW MINERAL.

IN Mrs. French-Sheldon's entertaining volume, "Sultan to Sultan," in which she records her expedition to Kilima-njaro, there are given (p. 324) two analyses, which we have in vain endeavoured to understand. They are the work of the Royal College of Science, where they were made "through the joint courtesy of Professor Judd and Professor T. E. Thorpe, February 22, 1892." The signature of "T. E. Thorpe" is placed beneath each of them. We beg to quote the formula for the former, which is called "salt stone," as a New Year's puzzle to our readers:—

$$2\ Na_2O\ 3\ W_2 4\tfrac{1}{2}\ O.$$

The mineral, on the strength of this formula, is said to be "*simply* a hydrated sesquicarbonate of soda." Simply that! Where has the tungsten come from, and whither has the carbon gone? How does Professor Thorpe square $4\frac{1}{2}$ O with the atomic theory? And what is the meaning of Nag°, which figures in both analyses?

The second analysis is of a substance called "Tobacco stone," and this seems to be a more complex material, as it is called by Professor Thorpe "fona, mixed with the carbonate of lime and magnesia, a trace of common salt and clay." There is 29·92 per cent. of nagging soda and only 30·48 of carbon dioxide; so, apparently, this up-to-date alkali is satisfied with such a remarkably small proportion of acid that even out of this 30 per cent. it can spare some for the magnesia and lime. If this had been an ordinary compound there must have been a fine scramble for the carbon dioxide between the soda, lime, and magnesia.

Professor Thorpe very justly gives a new name to the material which has yielded these quaint analyses, for we cannot find "fona" in any mineralogical index. As the word is twice repeated, it can hardly be a misprint, though it has a certain resemblance to trona. Fuddleite would, perhaps, have been a more appropriate name. Would some chemist kindly let us know whether the analysis appears clear to him, though we hardly like to invite anyone to a task which has given us cause to doubt our own sanity? Perhaps some interpreter of dreams and expounder of oracles will tell us that in place of "Signed, T. E. Thorpe," there ought to be substituted "Signed, T. E. Thorpe, revised and emended by M. French-Sheldon."

THE VIVISECTION PROBLEM: SELF-HELP OR LAISSEZ-FAIRE?

THE Anti-vivisectionists have been bestirring themselves of late. They have had a meeting and made many speeches. They have petitioned against the establishment of a Pasteur Institute in India. And that go-ahead Ladies' Club, or club of go-ahead ladies, *The Pioneer*, among its numerous subjects for discussion has lately included vivisection, and after an exciting debate declared it to be unjustifiable.

The justifiability of this practice depends on questions that have been questions since the beginning of civilisation, and that are likely to remain without their answer for many centuries to come. We at least do not presume to give an opinion. The above circumstances have, however, suggested one or two reflections that may be of service to both parties.

Everyone that knows anything of the progress of science, in whatever department it may be, is aware that it is effected by circuitous and often retrogressive paths. Many are the blind alleys up which we wander, many the pits into which we fall. What scientific man dares to say that he has never made a mistake? If such there be, we have small regard for him: be sure that he has never made a discovery. It is a cheap jibe to say that Science contradicts herself. That is nothing to be ashamed of. Oliver Wendell Holmes was wiser when he wrote:—

"Don't be consistent, but be simply true!"

What argument is it, then, to say that experiments on living animals have in some cases led to wrong conclusions, or that those who practised them have occasionally conducted unsuccessful operations? Prove that the whole method is unscientific, and that will be a valid argument. But who will be so rash as to maintain this, so long as in all other sciences there are not one but two factors of progress; not only observation, but also experiment?

We should hardly imagine that, at the present day, there could be found anyone who, having a knowledge of the subject, would deny that, however numerous the failures, experiments on living animals have been productive of great benefit to other animals. In both cases Man is naturally included under the term Animal. It is this benefit that is brought forward by the advocates of such experiments in excuse of any pain that may be inflicted by their performance. Benefit is, perhaps, not always derived; on the other hand, pain is by no means always inflicted. Let us assume that the exceptions balance one another. We shall then have left in one scale some amount of pain, some amount of benefit in the other. Now the benefit consists in the alleviation or the removal of pain. But it must be clearly borne in mind that, whereas the pain inflicted is on a finite number of individuals during a certain comparatively short space of time, the pain removed, on the other hand, is on an infinite number of individuals for all the unknown future. Which then is the heavier scale? Surely none will deny that the pain destroyed far outbalances the pain inflicted. Only on the assumption of an immediate millennium, can any other answer be given to the question.

The problem, though still perhaps insoluble, has become a little clearer. Pain and misery are inevitable in this world. For countless ages Nature has worked by woe. But out of anguish there rises advance, and pain is the parent of pleasure. It is thus that the mills of God are grinding, and man cannot stop their mighty wheels. But, may he hasten them? That is the question. A question which involves issues far larger than the justifiability of vivisection, issues such as the right of one individual over another, be the individuals animals or men. A question to which mere expedience has in all ages forced from the vast majority of mankind an affirmative answer. But, a question which, viewed from the peaks of philosophy or the precipices of morality, must still remain without reply.

THE NORTHERN DISTRIBUTION OF *Oxalis cernua.*

IN the recently-issued number of the *Proceedings of the Linnean Society* (Oct., 1893, p. 31), Professor G. Henslow discusses the northern distribution of *Oxalis cernua*, Thunb. This plant is a native of the Cape of Good Hope, but has become distributed, not only on the islands of the Atlantic, as the Bermudas, Canaries, and Madeira, but along both the north and south coasts of the Mediterranean. The first to allude to its occurrence in the northern hemisphere was Father Giacinto, who mentions the plant as being cultivated in the Botanic Garden at Valetta, Malta, in 1806. Professor Viviani records it for North Africa in 1824, naming it *Oxalis libyca*, while A. de Candolle refers (Fl. Calp., 1846) to its introduction into Gibraltar in 1826. About that time it probably arrived in Egypt with the mandarine orange, introduced from Malta by Youssouf Effendy; at the present time it occurs there only in the orange-gardens of Cairo and Esneh. The author suggests that the plant mentioned as cultivated in Malta in 1806—which Zerapha states that his contemporary, Dr. Giacinto, brought from the Cape, for the information of his pupils—was the source of the diffusion of the species in the Mediterranean region. The floral structure of the northern specimens affords an argument in favour of such an origin. While the species is naturally trimorphic (having long-, mid-, and short-styled forms) at the Cape, and also fruits there, it has never been known to bear fruit in the northern hemisphere, and the short-styled form is the only one described as occurring anywhere around the Mediterranean. Mr. Henslow examined numerous plants in the Maltese Islands and Egypt, and found, with but two exceptions, only the short-styled form. A single plant introduced with some palms observed at Cannes was also short-styled. The exceptions were two long-styled plants in the botanic garden of the School of Medicine at Cairo, one cultivated in a pot, and a stray one in the garden; and these, it is suggested, were a recent introduction from the Cape.

The intercourse in trade which has long existed between Malta and the African coast, is sufficient explanation of its early introduction into the latter region.

Mr. Henslow goes on to describe the method of multiplication in the northern hemisphere. In Malta the plant is ubiquitous, carpeting the roadsides as well as all the exposed open ground around Valetta, and insinuating itself between the loose stones of the walls, appearing at the surface like a green fringe around each. It covers the tops of the walls in many places, and the lofty fortifications; it forms luxuriant borders to the fields, and also invades cultivated soil, so that, where weeds are not uprooted, a field will look as yellow as an English meadow with buttercups. It is propagated entirely by bulbs. A large plant growing among loose, stony *débris*, if dug up in January, will be found to possess a long tapering stem, throwing off thread-like lateral roots, and bearing minute leaf-scales with small white bulbils at intervals, as well as several larger ones at the crown, below the cluster of leaves. The fine thread-like rhizome extends downwards, sometimes for more than a foot, and grows from a bulb of last season. In many cases when the plant grows as above, the stem proceeds further downwards like a thread; but after a certain distance suddenly increases in diameter, forming a short rod-like structure about 1½ to 2 inches long, with a bulb at the end. This explains how it can reach great depths from which new plants arise in a subsequent season. On plants growing luxuriantly, runners above ground may be formed, which also produce bulbs at the nodes, so that a number of young plants arise at a short distance from the site of the parent.

The author remarks that the extensive vegetative reproduction of *Oxalis cernua* in the Mediterranean, like that of *Elodea Canadensis* in this country, is a strong argument against the assumption of the necessity of cross-fertilisation to ensure a vigorous offspring. Change of hemisphere has also resulted in a changed flowering period, as, in the north *Oxalis cernua* is in full blossom all the winter from November to April, while it is described as flowering at the Cape in June and July. The lengthening of the period is doubtless due, in part, to the fact that no fruit being produced, the plant goes on flowering, as it were, in hope, using up the energy which would otherwise be expended in the formation of fruit and seed.

The Structure of Diatoms.

A recent number of the *Verhandlungen des Naturhist. Med. Vereins zu Heidelberg* (vol. v., part ii.), contains an interesting paper on the structure and nuclear division of Diatoms, by Dr. Lauterborn. Readers of Natural Science (*see* Sept., 1892) will remember the author's name in connection with some researches upon the movement of these organisms which were carried on by him and Professor Bütschli. The present paper is a preliminary communication (with one plate) of a more extensive work which Dr. Lauterborn promises to bring forward shortly. Besides many interesting details concerning the structure of the protoplasm and shell of Diatoms, and some valuable methods of staining the tissue while living, important and striking results were obtained with regard to the nuclear division, which in these forms always takes place by karyokinesis. The centrosome is always present close beside the nucleus, and visible even during life in the resting cell, but there are no striations round it until the commencement of division. At an early stage in the division there appears, between the centrosome and nucleus, a third body, which is the rudiment (Anlage) of the central spindle—though never spindle-shaped itself. It is probably derived from the centrosome, perhaps by division, but its origin has not been clearly made out. Appearing originally as a rounded body, then becoming rod-shaped, it expands and grows in a peculiar manner, which may best be illustrated by comparing its shape first to a coin, then, by increase of depth, to a piece used in the game of draughts, then to a drum, and, finally, to an elongated cylinder, which is longitudinally striated. Hence, in the rod-like stage its long axis does not correspond to the long axis of the future spindle, but to its transverse axis. When full-grown, it sinks into the nucleus, which, in the meanwhile, has passed through the stages with the dense and loose skein, and has now lost its membrane, and contains V-shaped chromosomes. At this period the centrosome, with its system of rays, becomes indistinct and disappears, and the cell protoplasm shows radiate striations round each of the poles of the central spindle. The chromosomes form an equatorial ring round the central spindle (*Monaster* stage). The ring splits into two rings which travel apart (*Dyaster* stage). The two rings become narrowed and constrict off the two ends of the central spindle, the two pieces so cut off becoming the centrosomes of the daughter cells. The cleavage of the cell passes through the middle of the central spindle, halving it accurately. The two halves of the central spindle perhaps become absorbed into the pieces which were cut off to form the daughter centrosomes. The daughter nuclei reconstitute themselves. The author concludes his paper with some interesting comparisons between this peculiar mode of formation of the nuclear spindle in Diatoms and in other cells. He considers that his observations support Bütschli's view of the homology between the centrosome and the micro-nucleus of Infusoria. It is interesting to note that all the stages of karyokinesis described —and observed chiefly in *Surviella calcarata*, Pfitzer, but confirmed in other species—were seen and drawn in the living state as well as in preparations; also that the protoplasm of these forms shows, both when living and after fixation, a distinct reticulate alveolar meshwork. The striations round the centrosome are seen to be formed by arrangement of the meshes or alveoli in rows, as formerly described by Bütschli. Dr. Lauterborn's complete work will be awaited with considerable interest.

The principles of geological correlation to which we drew attention in our last number (vol. iii., pp. 404–7), do not seem to find favour with many prominent Fellows of the Geological Society. At the meeting on December 6, one speaker considered that "unless there was a physical change accompanying a faunal one, the latter was of secondary importance. Palæontology must be the servant and not the master of Geology." Another well-known stratigrapher "had no faith in fixing a plane of demarcation between Purbeck and Wealden Beds by means of Ostracoda." Are not these gentlemen somewhat insular in their point of view? They do not seem to distinguish between local and world geology. Lithological differences and other evidences of physical change are, of course, all-important for the local geologist and for mapping, but when it is a question of separating the Jurassic period from the Cretaceous, then some principle is demanded that shall be of rather wider application than the bursting of a river bar, or the closure of a lagoon in our own little corner of Europe. In short, the rock scale is parochial, but the time scale universal.

The *Fortnightly Review* for December contains the second part of an article by Dr. A. R. Wallace on the "Ice Age and Its Work," dealing with the erosion of lake basins. It is well worth reading as a clear and concise statement of the arguments in favour of the power of ice to cut the basins. One of the points raised seems to be quite new. Dr. Wallace contrasts the well-known indented outlines of submerged valleys, such as now form harbours in the south of England, with the simple outlines of a lake in a glaciated region. In the latter the tributaries fall directly into the lake, instead of flowing into lateral arms formed by the partial submergence of the surrounding country, as would be the case if the main lake originated through subsidence.

We are glad to hear from letters from Mombasa that Mr. G. F. Scott Elliott left that town for the interior early in November. He has been delayed on the coast in the organisation of his caravan, which numbers 73 porters. The abandonment of the Ruwenzori and Toru Stations will add greatly to his difficulties; but he has left fully resolved to reach his goal of Ruwenzori. We are also glad to hear that Lieutenant von Höhnel has safely arrived at Mombasa. He was seriously injured by a wounded rhinoceros some distance to the north of Kenia, and great anxiety was felt as to whether he would survive the long journey to the coast. He returned *via* Kibwezi, where from Dr. Charters his wounds received proper medical attention. His companion, Mr. Astor Chanler, will continue his journey to the north as soon as the men whom he sent back with von Höhnel have returned to him.

I.

Tyndall.

WITH the death of Professor Tyndall has passed away the second of the men whose names are associated as the three English men of science of the Victorian era. His claim to be included in this trio does not rest on his being the deepest thinker, the most accurate and ingenious experimentalist, or the most original investigator in the branch of science upon which he was engaged. If it did so, he might have to yield his place to another, for Lord Kelvin is probably as much his superior as a physicist, as Browning is thought by many to have surpassed Tennyson as a poet. Nevertheless, in both cases, the lesser man may be the more typical of and more influential on the age in which he lived. Though Tyndall's work must be ranked far below that of Darwin, he was far more the representative man of the two, owing to his brilliant versatility, restless energy, his combination of the culture of the literary student with the insight of the scientist and the power of the man of action, his breadth of sympathy and the apostolic zeal with which he fought for a sounder and more scientific system of education.

Professor Tyndall was born in the village of Leighlin Bridge, in Carlow, in 1820, but he came of a Gloucestershire family which is said to have been connected with William Tyndale, the famous Protestant martyr. His parents occupied but a humble position in his native village; his father had been a private in the Royal Irish Constabulary, and after his retirement from this force, he was in business as a small country shopkeeper. Tyndall, however, had the advantage of a fairly good education in one of the small schools which used to be the pride of many an Irish village; here he was well grounded in mathematics and grammar, and acquired from the one subject a habit of scientific method, and from the other an interest in literature. He has himself told us[1] how much he owes to the study of the latter at this school, though he entertained less affection for the discussions on the comparative merits of Popery and Protestantism which occupied a large proportion of his time. In spite of his father's poverty, Tyndall was kept at school till he was nineteen, but this was by no means unusual in Ireland before the days when attendance till thirteen was compulsory. On leaving school he obtained an appoint-

[1] An Address to Students: University College, 1868.

ment as one of the Civil Assistants in the Ordnance Survey, and was at first quartered at Carlow. He was, however, soon moved to Lancashire, and then continued his studies at the evening classes of the Mechanics' Institute at Preston; he at this time intended to become a civil engineer, and contemplated emigrating to America. Some experiments, however, which he saw one evening during a lecture at Preston, roused in him a keen interest in pure science apart from its practical applications.

He remained on the Ordnance Survey for five years and, as he had had experience of most branches of the work, became a well-trained surveyor. When the railway mania burst upon the country, this meant money, and Tyndall in 1844 entered the employment of a Manchester firm; for three years he was kept very hard at work on various surveys, but the excitement and strain and wild unrest of this life were too much for him. He had saved about three hundred pounds, so he threw up his appointment and in 1847 joined the staff of Queenswood College in Hampshire.

This step was probably induced not so much by the fact that the toil of the railway survey was too severe: he had no interest in the work: he was never avaricious and he had already come to feel an enthusiasm for science and had fallen under the influence of Carlyle. He had intended to devote his leisure here to research, but he felt the need of further scientific education before he could seriously commence this. In company, therefore, with his friend and colleague, Dr. Edward Frankland, he left England in 1848.

It was probably due to the teaching of Carlyle that they decided to study in Germany, and there the fame of Bunsen drew them both to Marburg. There they studied chemistry under the great master, and worked at physics under Gerling and Knoblauch. With the latter he wrote one of his earliest papers, "On the Deportment of Crystalline Bodies between the Poles of a Magnet," which was published in the *Philosophical Magazine* for 1850, and was republished in the *Annales de Chemie*, the Archives of the *Bibliothèque Universelle*, and Poggendorf's *Annalen*. At the same time he was a constant reader of Carlyle; and Tyndall has himself told us that it was thus he derived the inspiration which kept him hard at work, and made him face his early morning tub through the cold of a German winter.

From Hesse-Cassell Tyndall moved to Berlin, where he worked at diamagnetism in the laboratory of Professor Magnus, and gained the friendship of Helmholtz and others of the ablest of the younger school of German physicists. He came to London in 1850, and there made the acquaintance of Faraday. Of his first meeting with the man of whom he has often spoken as "my master" he has given us a charming account in his life of Faraday. Immediately on his return to England he received an appointment at the Royal School of Mines, where he found among his colleagues his life-long friend, Professor Huxley. In 1852 he was appointed Professor of Physics at this school, then in Jermyn Street. The year 1853 was an important one in Tyndall's life. He was elected a Fellow of the Royal Society; and at the instance of Dr. Bence Jones he gave the first of his long series of lectures at the Royal Institution; and shortly afterwards Faraday gained for him the appointment of Professor of Natural Philosophy at the Royal Institution, with which Society he remained connected till his retirement in 1887. For the last 20 years of this period he was, in addition, Superintendent of the Laboratory there, to which office he succeeded on the death of Faraday in 1867.

During his student days in Germany Tyndall made a visit to the Alps, and the impression they made upon him was ineffaceable. He went back, in company with Professor Huxley, in 1856, in order to study some glacial problems, and from that year onwards rarely missed a visit to Switzerland. To his scientific work there reference will be made later on; but no sketch of his life would be complete which did not consider the Alpine feats of which he was so justly proud. He was one of the early group of mountain climbers, and one of the most successful of the band of Englishmen who led the attack on the more dangerous of the giants of the Alps. He must have been a man of splendid physique and sound judgment, or he must inevitably have come to grief during some of his reckless feats. No doubt most of Tyndall's early ascents and glacier expeditions had a scientific purpose; but they were carried out with reckless disregard for life and limb, and he did many things for which he would nowadays get his knuckles rapped pretty briskly in the pages of the *Alpine Journal*. Such, for example, are his ascent of the Jungfrau alone, without a greatcoat, and with only a light alpenstock, which he lost on the top. A still more daring deed was his first ascent of the west point of the Dufour-Spitz—the highest peak of Mte. Rosa—from the Riffel; in the only previous ascent of this point the party consisted of five first-class English climbers, Ulrich Lauener, and three other guides, and they went up, moreover, by the west arête. Tyndall did it absolutely alone.

His greatest Alpine achievement was the first ascent of the Weisshorn from Bies in 1861, in which he was accompanied by Wenger and the old guide who still lives at Zermatt, and has ever since been known as "Weisshorn Bennen." In his attacks on the Matterhorn he was less successful; but for long he held the highest record before the summit was actually reached. He was the third to gain the top, and the first who crossed the mountain from Breil to Zermatt; it was in a ten minutes' rest on the arète during this traverse that he thought out the exquisite little prose poem, "Musings upon the Matterhorn." Three years later he made the third modern traverse of the very difficult glacier pass known as the "Old Weissthor," by a variation on the previous routes, and crossing above the Filar glacier. The last and most difficult of his first ascents was in 1862, when he climbed from Breil with the guides, Bennen, Carrel, and Walthers, the peak that will long keep alive the memory of his Alpine feats with the name of the "Pic Tyndall."

Most of these ascents, and his other climbing adventures, and he had not a few, were recorded in his charming work, "Hours of Exercise in the Alps" (1871).

Another athletic feat was his expedition at Niagara, when he worked, by the south side of the gorge of the Horseshoe Fall, round the promontory upon which there stood the Terrapin Tower, and under the foot of the Fall.

In addition to his Royal Institution Professorship he held numerous other appointments at different times. In 1855 he was made one of the Examiners under the Council for Military Education. In 1864 he was given the post of Scientific Adviser to the Board of Trade, an office which he resigned in 1883, because he denounced as dishonest the action of the authorities in regard to some new patents. With characteristic generosity he had offered, when he accepted the office, to serve without pay, if his salary could be devoted to the benefit of the sailors. It is needless to say that he received numerous honours from the leading scientific societies at home and abroad; he was awarded the Rumford Medal of the Royal Society in 1864, while he was a doctor of four universities. Halle made him Ph.D., Oxford D.C.L., and both Cambridge and Edinburgh LL.D. In connection with the last it may be remembered that he received the diploma from the hands of Thomas Carlyle, who that year held the office of Rector. With Carlyle Tyndall was very intimate, and he reverenced him as a father. After Mrs. Carlyle's sudden death he carried off the broken-hearted old philosopher to the south of France, and when Froude's publication of her letters had thrown a shadow on the fame of Carlyle, no one stood up more manfully than Tyndall in the defence of his old teacher and friend. The bust of Carlyle on the Chelsea embankment was unveiled by Tyndall about this period, and the prophecy at the close of his speech was one of those that greatly help their own fulfilment. He compared Carlyle in nobility of form and ruggedness of strength to the Bel Alp that rises at the back of his châlet on the Eggishorn, and the shadow that overhung the memory of Carlyle to the bucket of water whipped up into a cloud that could temporarily obscure the mountain outline; but he predicted that the mist would soon be swept away, and the character of Carlyle stand out as clear and spotless as before.

Tyndall's connection with the British Association is mainly recollected owing to his famous Belfast address in 1874, in which he discussed the relations of contemporary scientific thought and revealed religion; the orthodox party took alarm at the views therein expressed being proclaimed so publicly before the world; and Tyndall was pelted with pamphlets, scolded in sermons, and denounced in the press. The address was unquestionably a materialistic manifesto, and it is a remarkable sign of the progress of the last twenty years, that those who, like *The Times*, denounced it at the time, accept it to-day. Tyndall first went to the meetings of the Association at Ipswich in 1851, and for some years was a regular attendant; in 1867 he delivered the "Working Men's Lecture," taking as his subject, "Matter and Force"; he was President of the Mathematical and Physical Section in 1868, when his address dealt with "Scientific Materialism." In 1870 he was the lecturer for the year, and read his famous essay on the "Scientific use of the Imagination."

In later years Tyndall was not so prominently before the public, especially after his marriage, in 1876, to the Hon. Louisa Hamilton, the eldest daughter of the late Lord Claud Hamilton. He spent most of his time at his house at Haslemere, and went every summer to his chalet, the Villa Lusgen, in Switzerland. In 1877, however, he accepted the Presidency of the Birmingham and Midland Institute, and gave as his inaugural address a lecture on "Science and Man," by which he again roused the wrath of his theological opponents. In 1887, he resigned his position at the Royal Institution, and was entertained at a farewell dinner by what was described by *Nature* at the time as the most representative gathering of English Science that had ever been held. Since then he had written or lectured but little, though the Orange blood that was in him led him to enter into political warfare in opposition to the different Home Rule schemes. Two years ago he was taken dangerously ill, but he recovered, and he visited Switzerland this summer as was his wont. He returned in October, and, in consequence of a tragic accident, peacefully passed away on the 5th December.

It is difficult for one who is not a physicist to give any sketch of Tyndall's work in science, as his main work lay in this department of research; but this I may be allowed to attempt, as physics do not come within the domain of NATURAL SCIENCE. The first research was upon "The Phenomena of a Water Jet," which was not, however, published till 1851. The subject which he made especially his own was diamagnetism, upon which he wrote about twenty papers, commencing with a short note "On Diamagnetic and Magnecrystallic Action," published in 1850 in the second volume of the *Chemist*, and in the Reports of the British Association in the following year a more detailed memoir on the same subject, entitled "Diamagnetism, the polarity of the diamagnetic force, the magneto-optical properties of crystals, and the relations of magnetism and diamagnetism to molecular arrangement"; this gained for him admission to the Royal Society. Radiation was another question on which he did much work. He took it as the subject of his "Bakerian" and "Rede" Lectures in 1864 and 1865, when he announced his discovery of "calorescence," in which, by altering the refrangibility of the ultra-red rays of the spectrum, they can be rendered visible. This is simply the converse of Stokes's well-known experiments on "fluorescence," by which the ultra-violet rays, after analogous treatment, can be seen. Some of his most interesting results with radiation were in connection with its meteorological influence. Thus he showed that the effects ascribed by de Saussure, Hopkins, and others to the atmosphere, really result from the aqueous vapour in it, which forms the blanket protecting the earth from excessive cold at night. His study of the atmosphere in this connection subsequently came in usefully during his elaborate experiments on fog-signals. In relation to the same subject, he was led to study the effects of the floating particles in the air, and he showed that the blue of the sky, of the Alpine lakes, and of the sea is due to the polarisation caused by these particles. He manufactured artificial sky by some new chemical reactions produced by light, in order to demonstrate the truth of these conclusions. Another outcome from his interest in this line of inquiry was his work on the putrefactive influence of the floating particles of the air. This he summarised in two lectures; one on "Fermentation, and its bearings on Surgery and Medicine," delivered before the "Glasgow Science Lectures Association" in 1876, and one on "Dust and Disease," in the course of which he described a fireman's respirator made from cotton wool and glycerine which he had invented.

More important scientifically was his valuable investigation into Dr. Bastian's claims to the discovery of the spontaneous generation of bacteria in vegetable infusions. As Tyndall has told us, as a believer in the nebular hypothesis, he is logically bound to believe that spontaneous generation did come about some time; but with true scientific candour he clearly showed that Dr. Bastian's experiments had not been performed with sufficient care, and that when full precautions are taken, the bacteria do not appear in the infusions.

His geological work is far more important than his biological. His first contribution to this subject was a lecture "On some of the Eruptive Phenomena of Iceland," delivered before the Royal Institution in 1853, in which he illustrated by experiments the causes of Geysirs. His remaining geological papers may be divided into two groups, first, those bearing on slaty cleavage; and second, on glaciers and glaciation. His main contribution to the former was published in three papers in 1856; one was "Observations on the Theory of the Origin of Slaty Cleavage of H. C. Sorby" (*Phil. Mag.*, vol. xii., pp. 161-164), the second was a lecture on "Crystalline and Slaty Cleavage," finally published in his "Fragments of Science," and the third was a "Comparative View of the Cleavage of Crystalline and Slaty Rocks" (*Proc. R. Inst.*, vol. ii., pp. 295-308). In these three papers he agreed with Sorby as to the fundamental difference between the mechanical and crystalline cleavage, and annihilated Professor Sedgwick's view that slaty cleavage is identical with crystalline, and that therefore mountains composed of slate are really often one huge crystal.

But Tyndall went further than Sorby and showed that slaty cleavage can be induced by pressure in an apparently homogeneous body, whereas in the experiments of the latter some flaky particles such as mica were always mixed with the substance used. Later on, however, Tyndall recognised that the lateral yielding of the clay under pressure, and the consequent tangential sliding of one particle over another, contributed very largely to the result.

Tyndall's glacier work was more extensive and important. His main contribution was the discovery of regelation, by which the *method* of glacier motion is easily intelligible. He next showed, by some difficult work on the Mer de Glace in mid-winter, that the glaciers move in the winter as well as in the summer, and determined the rate. He subsequently showed how the well-known "veined structure" of glaciers is a result of the flow of the ice. His principal paper upon the subject was one contributed to the *Philosophical Transactions* in conjunction with Professor Huxley in 1857.

His studies upon this subject were collected and summarised in his books on the "Glaciers of the Alps," and in "The Forms of Water," which were published in 1860 and 1872 respectively. In addition to his work on the properties of glacier ice, he closely watched the action of the glaciers and held somewhat extreme views as to the extent of their erosive power. Thus he assigned a far larger influence to glacial erosion in the configuration of the Alps, in his lecture in 1864, than is fashionable at the present day. He joined in the controversy on the origin of the Parallel Roads of Glen Roy, and advocated and restated with great clearness Jamieson's theory of their formation by the action of a glacier dam.

It is, however, less on his work as an original discoverer than in his brilliant powers of lucid exposition that Tyndall's influence has depended. It is generally argued that lecturing was his forte, and in this he was unusually successful. Most of his text-books were based on his lectures, such as his "Lessons in Electricity," which were given as a course of lectures to children at the Royal Institution, and show his capacity for using the simplest of apparatus. His books on "Sound," "Light," and "Heat, considered as a mode of Motion" were also compiled from lectures. The two first were given in a tour in the United States in 1872, the profits of which, amounting to 13,000 dols., he presented to the Universities of Harvard, Columbia, and Pennsylvania, for the endowment of research scholarships.

The department of this work for which, perhaps, the younger generation owes Tyndall the deepest debt of gratitude, is that, in conjunction with his two friends, Herbert Spencer and Huxley, he fought the fight which gained for Natural Science a free hand in the investigation of the whole range of natural phenomena. This now sounds like a truism; but it was not when he wrote that "the impregnable position of science may be described in a few words. We claim, and we shall wrest from theology, the entire domain of cosmological theory. All schemes and systems which thus infringe upon the domain of Science, must, in so far as they do this, submit to its control, and relinquish all thought of controlling it." If a distinguished prelate were to stand up before the British Association to-day, and say that recent theories on the sequence of Plutonic rocks did not agree with the order of the strata assigned to the Holy City in Revelations, and were therefore unorthodox, and therefore necessarily wrong, he would be laughed at. But when Bishop Wilberforce denounced Darwinism in 1857 this sort of argument was valid, and had to be replied to. The fact that the same is not the case now, is no doubt largely due to the Agnostic crusade of Professor Tyndall. It is now universally recognised that in all matters of natural phenomena and physical energy, Science is the final court of appeal, and that if religion teaches differently so much the worse for religion : the very reference to prayer as a form of physical energy, which was accepted 40 years back, now sounds irreverent, so great has been the progress.

During the course of this fight Tyndall made for himself many foes, in addition to those such as Forbes, Tait, and Ericson, whose enmity he had aroused during the course of his scientific work. Thus his series of papers on prayer and miracles, and his proposal to test the former by a series of laboratory experiments on a large scale, roused the fighting section of the Church. When Oxford gave him the degree of D.C.L., it was in face of the protest of some of the "old school." It was doubtless to the same cause that he owed the caricature of him that appeared in "The New Paul and Virginia," where as "The Professor" he appears as the vulgarest and coarsest of the creations of Mr. Mallock's usually subtle spite.

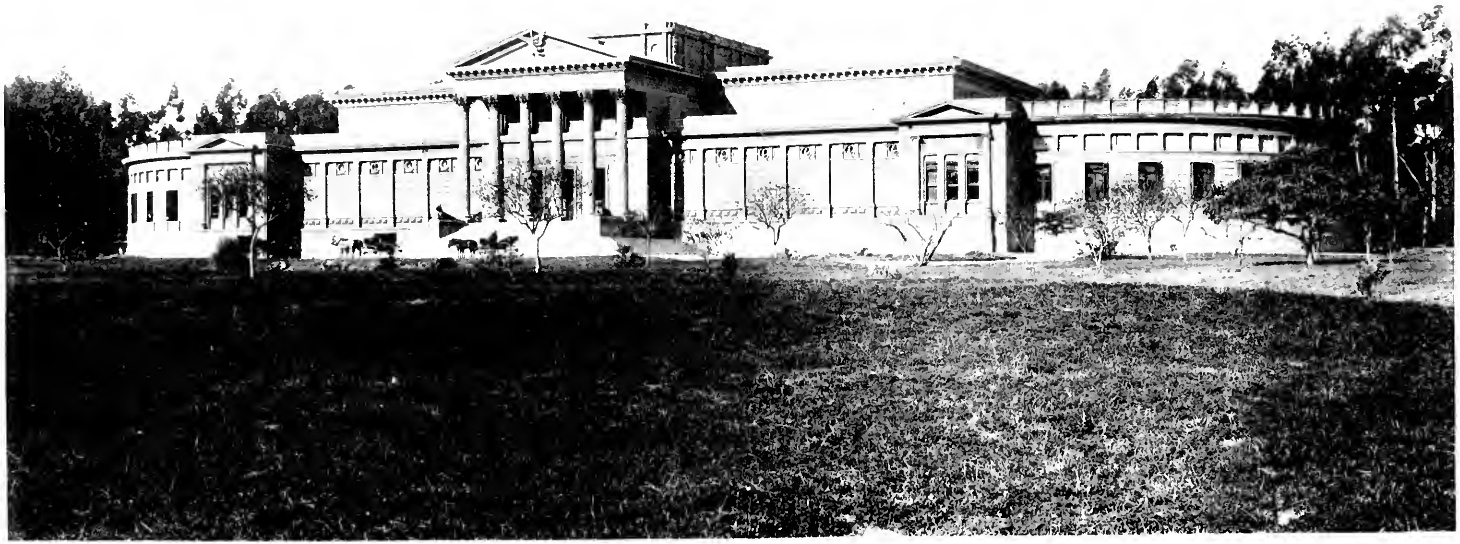
A second belief which Tyndall has largely helped to impress upon the public mind, is that the value of scientific education is not the dissemination of a mere catalogue of facts, but of more precise methods of thought. As he put it, "science should be studied not as a branch of education, but as a *means* of education ;" we are therefore bound to carry the scientific method into every department of thought, and work, and life, and to carry every argument to its logical conclusion, let them clash with whatever cherished beliefs they may. When Tyndall returned to England from Germany this was not the current method of thought. Men worked at science, but feared its conclusions; it was the date when, as Tyndall has put it, there were "Tories even in science who regard Imagination as a faculty to be feared and avoided, rather than employed." There were men like Faraday who seemed to belong to a kind of "Manchester School" in science, who worked at science all the week, and preached Sandemanianism on Sundays : they divided their brains into two watertight compartments, and put their reason in one, and their religion in another, and trusted to habit, fashion, and indolence to keep the bulkhead impervious. But Tyndall had no sympathy with this school of thought : he believed that, on the other hand, "science has of late years assumed a momentous position in the world. Both in a material, and in an intellectual point of view, it has produced, and it is destined to produce, immense changes—vast social ameliorations, and vast alterations in the popular conception of the origin, rule, and government of natural things." He therefore strove with a missionary zeal to shatter this dividing wall between science and general thought; and he did it. It was perhaps his recognition of a certain analogy between this bisected brain and the political brain of a later date, which often appears to be divided by a double bulkhead into three separate compartments for politics, morality, and reason, that led to the vigour of his anti-Gladstonian utterances. He recognised an old foe, and promptly beat his pen into a tomahawk, and dashed into the fray yelling the fiery warwhoops of his race.

There was no doctrine, he thought, savoured more of the evil one than this system of purchasing intellectual peace at the price of intellectual death; and throughout the whole of his career, in spite of all opposition and abuse, he hurled against it his most powerful ridicule and invective, and gave expression to the most passionate appeals that he could utter. The world has many such refuges, he said, and they will be used by all "to whom repose is sweeter than the truth. But I would exhort you to refuse the offered shelter, and to scorn the base repose; to accept if the choice be forced upon you, commotion before stagnation, the breezy leap of the torrent before the fœtid stillness of the swamp."

Thanks to his lucidity of exposition and the fascinating charm of his clear and nervous English, his efforts have exercised a deep influence, and before his death he had the pleasure of seeing the gospel he had preached from presidential chairs, in lectures, essays, and the Press accepted by the majority of his fellow countrymen. So much so has this been the case that even in reference to the Belfast address itself *The Times* could say on his death, "we all stand to-day where Tyndall stood 20 years ago."

It was, perhaps, an even greater satisfaction to him that he could watch the improvement in scientific education, for which he had so long contended, and the wider interest in which he did so much to foster. When we recollect how he was ever ready to leave the quiet of his study to help on the spread of scientific thought among his countrymen, one can but think that he had taken as his life motto the words of the old Israelitish leader that we may now adopt as his epitaph :—" Speak to the people, that they go forward."

J. W. Gregory.



LA PLATA MUSEUM.

II.

Natural Science in Japan.

I.—Past.

FEW people in this world have the love of Nature so strongly inborn in them as have the Japanese. It pervades all their life. Religion, art, poetry, daily pursuits and holiday recreations: all are imbued with this nature-spirit, that seems to belong to this nation like it has to no other with which the western world has been acquainted since the days of ancient Greece.

Pardon me, severely scientific readers, while I illustrate these bold remarks more fully.

Shinto, "the way of the Gods," which, before the introduction of Buddhism from China, served the Japanese as a religion, and which the restored Mikado has of late endeavoured to re-instate in its former pre-eminence, is a religion, not so much in our modern moral acceptation of the term, as in the primitive meaning that it had for the Romans of old. A veneration of ancestors; a worship of all the powers of nature, of wind and ocean, sun and fire, food and pestilence; a worship mingled with love that has personified the rivers, the mountains, and the trees of their beautiful native land; a religion of artless forms and homely prayers, that eschews both the maxims of the "ower guid" and the sermons of the "ower lang," and that is almost pathetic in its natural simplicity: such is Shinto.

Art, not the conventions of the schools and the copies of Chinese masters, but the living naturalism started by Okyo and perfected by Hokusai—how it sports with and idealises the minutest facts of this natural world! Natural this art is in its irregularity, even in its impossibility, and above all in the life with which it is instinct. It is not the remote or the grand that inspires these artists, but the near, the quaint, and the beautiful. "The Japanese," one must admit with Basil Hall Chamberlain, "are undoubtedly Raphaels of fishes, and insects, and flowers, and bamboo-stems swaying in the breeze." Not merely the painters, but the carvers in wood and in ivory, the workers in clay and in metal, all are caught in the embrace of an ardent naturalism chastened by a pure simplicity. With what loving diligence the craftsman toils over his golden representation of a beetle, with wings, elytra, and mouth-parts all complete, while the patience of the sculptor who gave five years to making the feathered eagle of steel, lately shown at Chicago, is hardly to be conceived by us hurried Europeans.

Poetry, with all its conventions, and they are neither few nor easy, is for the Japanese almost entirely an impressionist rendering of nature. Sometimes a mere sketch, that appeals to one solely by its beauty; sometimes a piece of such sympathy with the soul of things that its subtlety and delicacy perpetually charm while they perpetually elude us. But this is a subject on which my pen is apt to run away with me, so in this place I must content myself with translating, however imperfectly, a poem of either kind. First, then, read this description of—

AN AUTUMN EVE.

Passed the shower; but yet
On dark fir-leaf its memory lies
In pearls of glistening wet,
Wherefrom silver mists arise
Veiling in night the autumn skies.

And now hear this, remembering that it is centuries older than the song of Keats:—

MORNING-GLORIES.

Shame! that one should call
Morning-glories' dew-sprent gleam
A thing ephemeral.
Flowers, on that wise, might deem
Man an evanescent dream.

Thus we pass to the pleasures and pursuits of the people, of which this last poem inevitably reminds us. For if there is one thing characteristic of the Japanese, it is their love of flowers. When I was in Tokyo it was late summer, and early every day the florists' gardens at Irya were thronged by those who came to see the morning-glories bloom, while towards evening worshippers visited the island shrines of Benten to delight in the sacred lotos that flowered around them. Everyone has heard of the numbers that crowd that wonderful avenue at Ueno Park when its double cherry-blossoms float like pink clouds in the air, while the world itself has yielded to the chrysanthemum, the royal symbol of Japan. Nor is this merely fashion, of the same sort that takes some of us to private views and musical "at homes." No house in Japan so small but has its little landscape garden, if only in the back-yard; and no inn so humble but can find a flower to brighten the room of every guest.

The love of animals, though not perhaps quite so conspicuous, is nevertheless sufficiently obvious. Some of this may be due to the influence of the Buddhist religion with its principle of incarnation. This at least places a great check on the taking of animal life, so long, that is, as the animals are warm-blooded. This too, together with various mythological traditions, may account for the prevalent practice of keeping sacred animals attached to the various temples. These animals are generally albinos, but also include herds of deer, tortoises, and carp. In a few cases the number and different kinds of animals give the temple-yard almost the aspect of a zoological garden, and the resemblance is by no means diminished by the light-hearted crowds that pass from cage to cage, feeding the inmates with biscuits and beans. Whatever may be the theological explanation of this, the mere fact argues an initial sympathy with the brute creation, of that peculiar but common kind that manifests affection by imprisoning its object. Primitive and child-like this spirit may be; but we know it well enough ourselves, and so we have a fellow-feeling for these bright-eyed, brightly-clad little damsels that fly their butterflies fastened to a long black hair, and these laughing troops of boys that chase the cockchafers with long bamboo poles sticky at the tip.

More need not be said. The love that these children of nature have for their mother is now abundantly exemplified. But this feeling, as my friend O. H. Latter has recently reminded us (NATURAL SCIENCE, vol. iii., p. 41), is in no way connected with the scientific spirit. The demand for natural history objects supports more than one shop in Tokyo, itinerant vendors of the same ply a thriving trade, and the travelling raree-show reaps a harvest in every town. But the objects sold and exhibited are such as please children, not men; they excite curiosity and wonder without conveying knowledge.

At last, however, the scientific spirit, with other such modern improvements as quick-firing guns and labour disputes, has invaded the land of the rising sun; and it is the object of this paper partly to trace its gradual growth, partly to show how it flourishes to-day, now that the Japanese nation have cast off the leading-strings that they borrowed for a time from the Western world.

Just as, in ancient times, Japan received from China and Corea her religion, her literature, her art, and such science as there was to receive, so at the present day she has, for good or ill, adopted almost wholesale the methods and results of our own vaunted civilisation. The modernisation or Europeanisation of Japan has been a purely defensive measure, initiated and carried on by a certain section of the Japanese themselves, and notably by their great statesmen, the Counts Ito and Inouye. But the actual working out of the scheme has of necessity been placed till recently in the hands of foreigners employed by the Japanese Government. In this development two great races, the Anglo-Saxon and the Germanic, have played prominent parts, and in the particular parts they have played the respective genii of these two races have conspicuously asserted themselves. The English-speakers have, as usual, devoted themselves to the more practical and obviously utilitarian side of life, embellished, as usual, by the attempt to impose on an alien people their own particular religious opinions. To them are due the railways and the College of Engineering, the Navy and the Mint, the Press and the Prayer Book. The Germans, on the other hand, have exerted their influence chiefly in the direction of history, medicine, and the natural sciences. It is to the labours of such men as Engelbrecht Kaempfer, C. P. Thunberg, P. F. von Siebold, Edmund Naumann and Max Fesca that the present position of natural science in Japan is largely due. Of late, too, many Japanese students have been attracted to America rather than Europe, both by the improvement of scientific education there and by the greater nearness of that country. As a consequence of all this, English scientific men have less communication with their Japanese colleagues, and know less about their doings than it would be to their advantage to have and know. And this it was that suggested the present account.

The present state of Japanese science will be better appreciated if we compare it with what has preceded, and trace its gradual development.

It was originally through the commercial enterprise of the Dutch that scientific men were able to acquire for themselves some knowledge of this far country, and at the same time to introduce to its inhabitants some of their own more advanced methods and knowledge. The *materia medica* of snakes' skins, dragon's blood and more disgusting, if less rare, substances, and the oriental nostrums of massage, acupuncture and moxa were, if not superseded, at all events modified by the wider knowledge of drugs and the more rational acquaintance with human anatomy communicated by the physicians of the Dutch East India Company. Of these men the first of importance was Kaempfer, a Westphalian, who came to Nagasaki, then the only port of Japan with which the Dutch were permitted to trade, in 1651, being then 39 years of age. He stayed in Japan two years and two months, during which time he was, like other foreigners, practically confined to Deshima, an island district of Nagasaki, except on the two occasions when he attended the Dutch Embassy on its yearly visit of homage to the Shogun's Court at Yedo, now Tokio. In spite of the disadvantages under which he laboured, he collected a vast amount of information, subsequently given to the world in his *Amœnitatum Exoticarum Politico-physico-medicarum Fasciculus V.* (Lemgo, 1712), and in the *History of Japan*. Here we may venture to pride ourselves on the fact that at least the original publication of the latter work was due to an Englishman, Sir Hans Sloane, who purchased the manuscript, had it translated into English by Dr. J. G. Scheuchzer, and published the translation at London in 1727-8; and this English version was the basis of all subsequent foreign editions of the work.

In Kaempfer's time a knowledge of natural history seems to have been very sparingly diffused among the Japanese. Monsters, indeed, they were well acquainted with, such as the unicorn, by them called Kirin, the Hoo, which is generally translated Phœnix, and the sea-dragon or Ryo; but animals of a less exalted type appealed to them in a very small degree. Kaempfer regrets that the shells and other marine invertebrates, such beautiful material for a zoologist, are wasted on the sea-god, whom he calls Jebus. Pearls, indeed, they prized, having gained from the Chinese a knowledge of their value; but they knew so little of their nature as to imagine that some of them could grow of themselves and breed fresh pearls. Earthquakes, frequent though they were, they still ascribed to some large whale burrowing under the islands. We cannot, however, venture to laugh at the Japanese, for the works of Gesner and Aldrovandus, published not half a century before, contained monsters quite as terrible and myths no less absurd.

Over a century elapsed before another man of any scientific importance found his way to Japan. At last, in August, 1775, C. P. Thunberg, the Swedish entomologist, came as physician to the Dutch legation, and he stayed in Nagasaki till December, 1776. He was not idle during his visit, and the results are to be found in his *Flora Japonica*, published at Leipzig in 1784, in *Icones plantarum japonicarum*, five folios published at Upsala, 1794-1805, and in two volumes issued at Paris in 1796 and entitled *Voyages de C. P. Thunberg au Japon*. The natural history portion of the last work is comprised in chapters xviii., xix., xx., and xxiii., of volume ii. Besides making researches on his own account, Thunberg instructed some Japanese in various branches of natural history, especially botany.

Again we pass over three-quarters of a century before the arrival of the greatest German of all who have visited Japan. Philipp Franz von Siebold was born at Würzburg in 1796. In 1822 he entered the service of the King of the Netherlands as physician to the East Indian army, and on his arrival at Batavia was appointed leader of a Dutch scientific mission then starting for Japan, in which position he landed at Nagasaki in August, 1823. Here, as Professor Chamberlain writes in his useful book *Things Japanese*,—"By force of character, by urbanity of manner, by skill as a physician, even by a system of bribery which fell in with the customs of the country, and which surely, under the circumstance, no sensible man of the world will condemn, he obtained an extraordinary hold over the Japanese, suspicious and intractable as they then were. Having, in 1826, accompanied the Dutch embassy to Yedo, Siebold obtained permission to remain behind—the sole European in that great Asiatic capital, then absolutely sealed against the outer world. The excuse pleaded and accepted was that he would instruct the Japanese physicians in the more recondite branches of their art. His leisure he utilised in multifarious scientific researches; and so well did he know how to ingratiate himself that some of the highest in the land willingly added to his store of knowledge. Suddenly a rumour got about that the chief Court spy had sold him a map of the country. This was treason according to the old Japanese law. The spy was ordered to commit *harakiri* [disembowelment], and Siebold was cast into a dungeon, from which he emerged only on the 18th January, 1830, with strict orders never to return to Japan." In 1859, however, after the American, Commodore Perry, had forced open the gates of Japan, Von Siebold returned as a semi-official ambassador, and, for a time, actually entered the Japanese service as a negotiator. In these troublous years he was not so successful, either in politics or science, and in 1862 he returned to his own country, where he died four years later.

The best known of Von Siebold's works is *Nippon: Archiv zur Beschreibung von Japan und dessen Neben- und Schutzländern*, a splendidly illustrated folio, published at Leyden and Leipzig, from 1834 to 1842, with the assistance of the King of the Netherlands. In conjunction with C. J. Temminck, H. Schlegel, and W. de Haan, he published a *Fauna Japonica*, which appeared at various dates between 1834 and 1851; while, with the assistance of J. G. Zuccarini, he presented to the Royal Bavarian Academy of Science a memoir entitled *Floræ Japonicæ familiæ naturales*. It is not, however, any of these elaborate works that now demands our attention, but, rather, a rare and little-known quarto pamphlet of 16 pages, originally published in 1824 at Leyden, and fortunately, since none of the London libraries seem to possess it, afterwards reprinted in Oken's *Isis*, Bd. xx., Heft 2, columns 135-143, 1827. Its title is *De historiæ naturalis in Japonia statu, nec non de augmento emolumentisque in decursu perscrutationum expectandis dissertatio, cui accedunt spicilegia faunæ Japonicæ*, and it contains so very curious and interesting an account of the state of natural science in Japan at the time of his visit that, considering its general inaccessibility, I think I cannot do better than quote from it somewhat extensively.

In this account of Von Siebold's, among other characteristics of the Japanese, some of which have already been alluded to, we shall notice especially these three: their love of the monstrous, the keen eye united with the cunning hand, and the practical bent of their minds. We shall further notice that the position of natural science had considerably improved since the days of Kaempfer, 175 years before. In fact Kaempfer's own labours, followed by the example of Thunberg, had aroused among the learned Japanese an almost incredible ardour and curiosity in natural history.

Botany, says Von Siebold, was especially cultivated by them, partly for its service in the pharmacopeia, since, like all oriental nations, they were much given to herbs, and had at least 500 in daily medical use, partly since they depended on the vegetable kingdom for almost all the necessaries of life, in the way both of food and clothing. But not entirely to these practical ends did they study the science, since our author adds, "for their own pleasure and for the ornament of their houses they cultivate the rarer plants, which they are at pains to procure not only from distant provinces of their own land, but even from China, and especially from Corea." Their

LA PLATA MUSEUM.

botanical knowledge came originally from China, and so they denoted not only these introduced plants, but also the common native ones, by Chinese characters. From Thunberg, however, they had also received the Linnean names, and remembered them with pleasure. In their rare intercourse with either botanists or their books, it was hardly to be expected that they should have made a systematic study of botany; "nevertheless," says Von Siebold, "I have often wondered at the exactness and dexterity with which they distinguish the slightly differing species of a complicated genus and define their varieties." And, again, he tells us how the Japanese paint flowers, both wild and cultivated, so accurately that one can easily distinguish genera and species. A beautiful example of a Japanese botanical work of this period is the *Honzo Zufu*, by Iwasaki Tsunemasa, Yedo, 1828, of which a copy, belonging to Mr. A. Bisset, is deposited in the library of the Botanical Department of the British Museum.

The study of Zoology had prospered less; for investigations into the qualities of animals seemed to this herbivorous nation less necessary and useful than into those of plants. "At the same time," says Von Siebold, "they have a very accurate knowledge of such animals as do happen to be of any use to them, especially of fish, crustaceans, shell-fish, and certain other molluscs. They often form collections of shells, and make various articles out of them. In all their collections they value a thing the more for its montrosity. They carefully preserve all deformities and oddities that Nature has chanced to issue from her mint, and what Nature is unable or unwilling to produce, they manufacture by art." The Mermaids and Dragons composed of parts of different animals joined by *papier maché*, such as are still to be seen in the museums attached to certain temples, are described by Von Siebold, who admits that they so rivalled nature as easily to deceive the eyes of a tyro. "They have even," he exclaims, "attempted to deceive me with a human fœtus made monstrous by their craft. Frogs and tortoises with supernumerary heads or limbs they esteem as rarities. The vogue of these artifices is shown by the fact that they are exposed for sale at exorbitant prices. The love of lucre invents fresh monsters from day to day, and is a strange stimulus to zoological labours. To this end they keep deer, bears and monkeys, also white rats, hares and rabbits, and they rear the rarer birds which they collect from remote provinces and even from China. Although the works of Linnæus may be found here and there, chiefly in the city of Yedo, and though his method of description may in some cases have been followed by the Japanese, nevertheless I have never found traces of any systematic zoology, while the pictures of many mammals, said to be native in the interior of Japan, display nothing characteristic, although at a first glance you would have called them well painted, since their colouring is true to life. These same drawings of the animal kingdom furnish another example of the peculiar mental attitude of the Japanese, since they fashion for themselves with their brush many birds and butterflies that are certainly not native nor have ever been seen. Still I admire their finer pictures of fish and butterflies drawn according to nature."

Geology is next treated of by Von Siebold. "I observed," he writes, "that the medical men whom I met daily could well distinguish the common minerals, such as Antimony and Zinc, and define them by their Dutch, Japanese, and even Chinese names. But in private collections of minerals, I have noticed, as above, that they chiefly esteem and preserve monstrosities. Hence fossil animals, fossil plants, with other stones curiously shaped by nature or chance, form the rarities of their collections." Obviously, though the Japanese collected fossils, they were not palæontologists; they even confused fragments of corals with simple stones. That they were excellent metallurgists, however, the fame of their copper, iron, brass, silver, gold, and gold alloy, is sufficient proof. They were also not ignorant of how to treat minerals by chemical operations, and made many preparations of mercury.

In conclusion, Von Siebold emphasises the desire of the Japanese for knowledge and their aptitude for investigation. He founded a medical college (which must have been in Nagasaki before he went to Tokio) and employed his students collecting specimens. Among interpreters and other natives he found "a liking and singular ability for natural history, excited partly by scientific, partly by pecuniary reasons." "In two weeks," he says, "I taught a Japanese youth the art of drying plants and all the methods of taxidermy, so that every day I more and more admired his manner of preparing specimens." Lastly, the more learned Japanese "lose no opportunity of gaining knowledge from European books."

My readers have by this time, if my attempt has been successful, gained some idea of the ground in which, when at last the fence was broken down, the seed of Western science was to be sown. And by this time they will be getting anxious to learn how the plant has flourished and what fruit it bears at the present day. This it will be the main object of the second portion of this paper to inform them.

F. A. BATHER.

(*To be continued.*)

III.

The La Plata Museum.

AS many of our readers are probably aware, when the city of Buenos Aires was made the capital of the Argentine Republic in the year 1880, it was at the same time considered advisable that the province of this name should have a capital of its own. Accordingly, two years later, the city of La Plata was founded on a site some thirty-five miles lower down the river than the metropolis, and inaugurated as the provincial capital of Buenos Aires. One of the reasons for selecting a site so near to the metropolis appears to have been the necessity of having a port where vessels of the largest tonnage could come alongside the wharves; and one of the first proceedings was to construct a magnificent ship-canal from the river, terminating at a spot known as the Ensenada, within easy distance of the centre of the new city, and provided with accommodation for ocean steamers of almost any dimensions. With characteristic Transatlantic energy, the planning and building of the future capital was pushed on apace; and there soon arose on the site of what had recently been a mere *estancia*, or cattle-farm, a city of lordly palaces and stately squares, which has been not inaptly designated the "enchanted city." While the "boom" which at that time was at its zenith in Argentina lasted, La Plata bid fair to become a rival of the metropolis, and population and building vied with each other in trying to get ahead. Unfortunately, these rosy prospects were but short-lived, and at the present time the princely palaces and broad boulevards of the "enchanted city" are, except during the sittings of the Provincial Parliament, well-nigh deserted; and instead of resounding with the rattle of carriages and the tramp of thronging multitudes, the paved streets are silent, deserted, and grass-grown.

Whether this state of comparative desertion and stagnation is likely to be permanent, or whether it is but the chrysalis-stage preparatory to the advent of a period of prosperity and progress, it behoves us not to enquire in these pages. There is, however, within the limits of La Plata, a noble building which must for ever render celebrated the name of that city throughout the length and breadth of the scientific world. This building, I need hardly say, is the Museum, which owes its foundation and present prosperity solely to the indomitable energy and perseverance of its able and accomplished Director, Dr. F. P. Moreno.

Recognising the importance of a proper appreciation of science in a country so richly endowed with palæontological treasures, Dr. Moreno lost no time in impressing on the Provincial Government the necessity of providing funds for the erection of a Museum which should be worthy of the palatial surroundings of the enchanted city; and, fortunately for science, his efforts were ere long crowned with the success they so well merited. Only two years after the inauguration of La Plata as a city—namely, in 1884—Government sanction was obtained for the erection of the Museum; and in 1889 the imposing edifice represented in our first illustration was practically complete. The building, we may state, is situated on the Ensenada, or river-side of the outskirts of the city, standing in a park, amid splendid avenues and groves of tall eucalyptus and other trees, which, in the course of a few years, will form a veritable forest. Since our excellent illustration (for which, like the others in this notice, we are indebted to Dr. Moreno) gives such a good general idea of the external appearance of the Museum, it will not be necessary to say much on this point; neither shall we spend much time on a description of the interior. We may mention, however, that after passing under the well-proportioned Grecian portico, the visitor, on entering the building, finds himself in a rotunda, with a gallery and roof supported by two tiers of iron columns, and lighted above by a large skylight; its walls being decorated with frescoes representing the scenery, native life, and some of the wonderful extinct mammals of Argentina. From this rotunda, which occupies the centre of the front of the building, there diverge, on the ground floor, two galleries on opposite sides, which, after running a straight course for some distance, curve round so as to form a pair of apses at the two extremities, which are again connected by a straight gallery running parallel to the one in front, both back and front galleries being connected by cross-galleries and chambers, so that the whole edifice forms a continuous block of building. The upper floor, which does not extend over the two terminal apses, contains the apartments of the Director and the Secretariat, together with the library, the art-gallery, and some portions of the ethnological section. On the ground-floor the central chambers are, in the main, devoted to anthropology and ethnology; while the galleries on the right of the entrance contain the geological and palæontological exhibits, and those on the opposite side the animals of the present epoch. The central hall, on the further side of the building opposite the rotunda, is, however, consecrated to the mastodons and sub-fossil cetaceans.

We might, of course, elaborate to any extent the description of the Museum itself, but since this is a matter of comparatively small interest, we proceed at once to the consideration of its contents. And here we may state at the outset that the most marvellous thing connected with this wonderful institution is the circumstance that nearly the whole of its unrivalled treasures have been collected within the last few years by the untiring energy of its Director. Probably many persons in England are under the impression that the La Plata Museum and the Buenos Aires Museum (of which the palæontological contents were so admirably described by its late Director, Dr. Hermann Burmeister) are one and the same thing. This, however, is far from being the case, the Buenos Aires Museum being the National institution, while the La Plata Museum pertains to the province only. Without entering into the question whether or no the establishment of two such institutions within forty miles of one another was strictly advisable in the interests of science, we may state that at the foundation of the La Plata Museum, the National Museum at Buenos Aires was left untouched, and the collection of the former started almost *de novo*. And we may add, in no disparagement to the elder institution—which must always claim the prestige of containing the whole of Burmeister's types—that the younger sister has shot far ahead, so far as palæontological treasures are concerned.

So far as we can gather from an account published by the Director in 1890, it would appear that the principal aim of the Museum is to illustrate the whole fauna—both recent and fossil—of the Argentine Republic. It has, however, been recognised that it would be impossible to study the unrivalled series of fossil mammals without the opportunity of comparison with the skeletons of the living members of the same class from all parts of the world; and the Director has accordingly paid special attention to the acquisition of a representative series of specimens of mammalian osteology; our second plate showing the gallery where the greater number of these skeletons are exhibited. Among those of more than ordinary interest are the fine series of skeletons of South American Cetaceans, most of which have been obtained from the estuary of the Rio de la Plata and the coast of Patagonia, where several of them have been found stranded. The series includes skeletons of *Balænoptera*, *Megaptera*, *Hyperoödon*, and *Orca*, most of which have been referred to species distinct from those of the northern hemisphere; and among these the splendid skeleton of a member of the first-named genus, seen suspended on the left side of our plate, is remarkable for its large size, the total length being upwards of 22½ metres. Of still wider interest is the skeleton of an individual of *Neobalæna marginata*—a cetacean which we believe to have been hitherto recorded only from the South Seas. With the bare mention that a large number of both native and foreign animals are represented by stuffed specimens, we must bring to a close these few remarks relating to the recent section of the Museum, and proceed to the palæontological department, which is the one from which the institution will derive a world-wide celebrity.

Before setting out on my recent visit to La Plata, I had been prepared by the glowing accounts sent to me by the Director, as well as from the published writings of other palæontologists, to find the

Museum exceedingly rich in the fossil Vertebrates of Argentina ; but on my arrival the reality far exceeded my most eager expectations, and during my first walk through the seemingly endless galleries of the Museum I was absolutely lost in astonishment and admiration at the number and beauty of its palæontological treasures. We find, for instance, in one of the galleries devoted to the display of the mammalian remains from the Pampean beds and the somewhat older formations of Monte Hermoso, near Bahia Blanca, two complete skeletons of *Toxodon*, while another of *Macrauchenia* lacks only a few of the hinder trunk-vertebræ. The latter genus is also represented by three complete mounted limbs; while around the walls are ranged, in almost endless number, skulls, jaws, teeth, and limb-bones of *Toxodon*, *Typotherium*, and *Macrauchenia*, belonging to individuals of all ages and sizes. Perhaps, however, the greatest treasures of this striking gallery are the skull of that remarkable Toxodont which has been described as *Trigodon*, but should properly be known as *Toxodontotherium*, and the skull and jaws of the allied *Zotodon*; the former being from the Monte Hermoso deposits, while the latter comes from distant Catamarca. It must be added that while one of the skeletons of *Toxodon* is formed from the bones of a single individual, the second has been completed from the remains of two animals. And here I may say a word in praise of the admirable manner in which all the skeletons have been mounted and the broken specimens restored by Señor Giacomo Pozzi, the Articulator of the Museum. At the present time the whole of the invaluable series of mounted fossil skeletons are arranged along the middle of the galleries without any kind of protection from injury. Since the palæontological section of the Museum is not yet thrown open to the general public, this unprotected state of the specimens does not lead to much harm, but I may venture to express the hope that when the whole Museum is opened the Government will be fully aware of the priceless value and world-wide interest of these unique specimens, and the necessary steps taken for providing suitable cases for their protection.

Leaving the Toxodont gallery (which is seen in the background on the right side of our third illustration) we pass on to a large hall containing the remains of *Megatherium*. Here we find one entire skeleton of this giant ground-sloth, while facing it is the trunk and pelvis of a second, with the greater part of the fore-limbs attached. Several mounted specimens of limbs and other portions of the skeleton occupy the centre of this chamber; and in the wall-cases are arranged numerous detached bones and some magnificent specimens of the skull, one of the latter being noteworthy on account of its enormous size. In the next gallery we come to a magnificent series of mounted skeletons of the Mylodons and their allies, the more or less nearly complete specimens being six in number (including one of *Scelidotherium*), while there is the greater part of the trunk of a seventh. These mounted specimens range in size from the gigantic *Mylodon* *armatus*, which approaches *Megatherium* in bulk, and is characterised by its enormously expanded muzzle and tusk-like anterior teeth, to the comparatively small *Scelidotherium leptocephalum*, which is not very much superior to a tapir in size. In the surrounding wall-cases are displayed an almost endless array of skulls, limb-bones, and vertebræ, many of which are associated. Although all the mounted specimens are from the Pampean formation, some of the wall-cases contain examples of the skulls and bones of *Scelidotherium* from the somewhat older deposits of Monte Hermoso, near Bahia Blanca. These remains indicate species of much smaller dimensions than those from the Pampean, and thus serve to illustrate the general decrease in the bodily size of the members of the various groups of mammals as we descend from the Pampean beds through the Monte Hermoso deposits to the Santa Cruz beds of Patagonia. This decrease is displayed not only among the Mylodonts, but likewise in the Glyptodonts, and the Macrauchenias, as well as in some other Ungulates. For instance, while the Pampean Mylodonts include species equal to the largest rhinoceros in size, the Monte Hermoso *Scelidotherium* was smaller then a tapir, while *Eucholæops* of the Santa Cruz beds was not more than a yard in length, although closely allied to *Mylodon*. Again, among the Glyptodonts, we notice that some at least of the representatives of the genera *Glyptodon* and *Dœdicurus* from Monte Hermoso were considerably inferior in size to their Pampean successors, while when we reach the Santa Cruz beds we meet with mere dwarfs, as exemplified by the genus *Propalæhoplophorus*, of which there is a beautifully-preserved skeleton and carapace in the Museum.

Reverting to the Pampean Mylodonts, I may mention that, although the time at my disposal did not admit of my undertaking a detailed survey of any of the Edentates, yet I have little doubt that, if this were done, the number of nominal species in this particular group might be considerably reduced. My opinion has already been expressed elsewhere as to the inadvisability of subdividing the true Mylodonts into separate genera, such as *Lestodon*, *Pseudolestodon*, and *Grypotherium*; while the proposal to split up the group of Ground-Sloths into several families, instead of including the whole in the Megatheriidæ, is not likely to commend itself to English zoologists.

Perhaps the most striking display in the whole Museum is the magnificent series of the remains of Glyptodonts, which are exhibited in one half of the gallery containing the Mylodonts. Here we see not only a fine array of specimens of the carapace and tail-shield, with or without the skull and limbs attached; but likewise a number of entire skeletons without the dermal ossifications. These specimens comprise examples of the genera *Glyptodon*, *Panochthus*, *Dœdicurus*, and the one generally denominated *Hoplophorus*; and serve to show conclusively that the original Owenian restoration of *Glyptodon* was incorrect, the terminal tube of the caudal sheath of an *Hoplophorus* having been attached to the carapace of a *Glyptodon*.

May we accordingly venture to suggest to the authorities of the Royal College of Surgeons that the specimen in their Museum thus anomalously restored might now be advantageously dismounted, since in its present state it merely tends to perpetuate an accidental error? Marvellous as are all the Glyptodonts, the most astounding monster in the whole series is undoubtedly the one denominated *Dœdicurus.* The total length of this monstrous skeleton, as it is now mounted, is upwards of 11 feet 8 inches measured in a straight line, while the carapace measures 10 feet 4 inches across the highest part of the back, and the length of the massive club-like terminal tube of the caudal sheath is upwards of 3 feet 11 inches. Since, so far as I am aware, there is nothing approaching to a complete skeleton of this strange creature in any European Museum, my readers will probably pardon me if I enter into a few details of its structure. It will be observed, in the first place, that the carapace is remarkable for its curiously hump-backed contour, in which respect it differs very markedly from the regularly egg-shaped shell of *Glyptodon*; while it is further distinguished by the absence of the bold conical bosses with which the periphery of the latter is ornamented. Then, again, there is a marked difference in regard to the structure of the individual plates of which the carapace is composed; for whereas in *Glyptodon* these are polygonal, with a rosette-shaped pattern formed by the impressions of the edges of the overlying horny shields, in the present form they are oblong plates of bone, with a smooth external surface, devoid of the impressions of horny shields, but severally perforated by from one to five large circular holes, through which quill-like bristles were doubtless protruded during life. The tail was protected for the first third of its length by eleven enormous bony hoops, each formed by a single ring of plates similar to those of the carapace, but two of which not unfrequently coalesce, the circumference of these hoops rapidly decreasing from the base of the tail towards its extremity. The terminal two-thirds of the tail are formed by the well-known club-like tube so frequently exhibited in European Museums. At its flattened and expanded extremity, this tremendous club bears a number of roughened, depressed, disc-like facets of an oval contour, which during life must evidently have given support to huge horny spines, probably not unlike the horns of a rhinoceros. The whole animal must accordingly have bristled with horns and quills, looking not unlike some giant porcupine. In the somewhat smaller species from Monte Hermoso, there are more of the disc-like surfaces on the tube of the tail, which also differs from that of the Pampean species by being less expanded at the end and by the presence of a number of flat oval plates on the upper surface. The two imperfect specimens of the carapace of the species of this genus from Monte Hermoso in the collection of the Museum are remarkable for having a crater-like elevation with a central perforation immediately over the point of attachment of the pelvis. The occurrence of this peculiarity in two examples shows that this feature cannot be an abnormality; but, unless (as Dr. Moreno thinks) it be glandular, I am quite at a loss to guess its rise or object. The skull in this genus has a straight profile from the occiput to the tip of the nasal bones, in consequence of which the oblong aperture of the nose is of great vertical height.

In marked contrast to *Dœdicurus* are the plates of the carapace in the allied genus *Panochthus*, which, although oblong in form, have a peculiarly roughened and particular external surface, without perforations for bristles. Occasionally, however, specimens are found showing the impress of horny shields arranged in a rosette-like pattern somewhat after the manner obtaining in *Glyptodon*. The tail of *Panochthus* differed from that of *Dœdicurus* in that the terminal tube was less flattened, and not expanded, while it was covered with granules interspersed with disk-like surfaces, which were prominent instead of depressed, and thus evidently bore a different type of spine. More striking is the remarkable difference in the form of the skull, which had a highly vaulted profile, narrow, oblique nostrils, and an enormous descending process to the zygomatic arch. One specimen of the skull has its dermal covering of bone still preserved; each plate consisting of a smooth central disc surrounded by granular bone. Of this gigantic creature, which rivalled *Dœdicurus* in bulk, although with a smaller tail, the Museum possesses in addition to several unmounted specimens, one entire carapace, three complete mounted skeletons, exclusive of the carapace, but with the terminal tail-tube, another lacking the tail, as well as a portion of a fifth.

In addition to the peculiarities in the structure of the component bony plates of the carapace already referred to, *Glyptodon* differs from both the genera above-mentioned by the form of the tail-sheath, which is composed of a number of rings, gradually decreasing in diameter, and ornamented with a series of conical knobs, the extremity consisting of a short cone similarly decorated; the similarity of this tail-sheath to that of the extinct Australian tortoise *Miolania* being not a little remarkable. The skull of this genus has neither the straight profile of *Dœdicurus* nor the convex one of *Panochthus*, but the frontal and parietal planes meet one another at an obtuse angle, thus causing the nasal aperture to be wider than long. One skull from the Pampean and a second from Monte Hermoso have the bony dermal shield preserved, and show that it was composed of small juxtaposed plates, which become larger and imbricating on the occiput. Of the Pampean forms, which apparently belong to two species, the mounted series in the Museum comprises two skeletons and nearly a score of more or less nearly complete carapaces. There is also a fine series of the remains of the smaller species from Monte Hermoso.

In the genus which we may provisionally allude to under the name of *Hoplophorus*, the skull, as is well shown in a beautiful example of the entire skeleton, is very different from that of all the allied genera, its chief peculiarity being the curiously-incurved form of the nasal bones, and the consequent involution of the nostrils. The head-shield was long, curved, and smooth, with the largest plates posteriorly. Three specimens of the carapace of this genus are mounted in the gallery; one of these being associated with the head-shield and tail-sheath. The species of this genus from the Monte Hermoso beds appear to have been fully as large as their Pampean representative.

Although I have at present had no opportunity of going into the question of the number of species of Glyptodonts represented in the Pampean formation, I have not the least hesitation in saying that a large proportion of those named on the evidence of specimens of the terminal tail-tube or fragments of the carapace will be found invalid. The same is doubtless true with regard to several of the so-called genera founded on remains from the older formations of southern Argentina. Although it is not my intention to enter here into the consideration of the Glyptodonts of the Santa Cruz beds of Patagonia, I may mention that one of the greatest treasures of the Museum is the entire skeleton and greater portion of the carapace of the dwarf *Propalæhoplophorus*, to which incidental allusion has already been made. As shown both by the conformation of the skull and tail-sheath, these dwarf Glyptodonts were much more nearly allied to *Glyptodon* than to either of the other Pampean genera, all the latter being probably, therefore, more specialised types of later origin.

Although in the Pampean formation the short-snouted Glyptodonts appear to have been the dominant types of the Loricate Edentates, it must not be inferred that the long-snouted Armadillos were absent. While some of these forms found in the deposits in question were more or less closely allied to, or even identical with, their living cousins, others, like *Eutatus*, were of much larger size, and differed by having the whole carapace formed of movable bands. Still larger was a recently-discovered armadillo, for which the name *Dasypotherium* has been proposed; the skull of this giant measuring upwards of 10½ inches in length. Remains of the existing genus *Dasypus* are not uncommon in the Pampean, and the Museum possesses some beautiful examples from Monte Hermoso, one of which shows both the skull and carapace. I may mention here that a species of *Dasypus* allied to the existing *D. minimus* (which it has been recently proposed to separate generically as *Zaëdius*) occur in the Santa Cruz beds; a fact which has an important bearing on the geological age of the latter.

Before leaving the mammals of the Pampean beds, I must not omit to mention the fine series of equine remains contained in the Museum; although in regard to one or two species, the La Plata collection is inferior to that of the Buenos Aires Museum. Among the more notable specimens, I may refer to a skeleton of an *Equus*, which has been assigned by Señor Ameghino to a so-called species which he terms *E. rectidens*, but which, like the other specimens so-named, I see no reason for separating from *E. curvidens* of Owen. Although possessing no complete skulls, like those in the Buenos Aires collection, the La Plata Museum also contains a fine series of the remains of those horses which have been generically separated under the name of *Hippidium*. Hitherto I have not considered this separation justifiable, but from the study of the actual specimens, I am now convinced that it will be convenient to regard the extreme backward elongation of the nasal slits characterising these extinct horses as a feature of generic value. And here I may mention an instance of that want of appreciation of differences due solely to individual peculiarities and variation in age which unfortunately characterises so much of the palæontological work of Ameghino. On the evidence of a single lower equine molar from the Parana, that gentleman proposed to establish a genus stated to differ from other Equidæ by the almost total absence of folds of enamel in the cheek-teeth, for which the name of *Hipphaplus* was suggested. As a matter of fact, this tooth is nothing more than an extremely worn molar of *Hippidium*, as is conclusively proved by a large series of Pampean specimens in the Museum, which exhibit a complete transition from the unused to the much-worn type. To make matters worse, when the error was pointed out by Burmeister, the founder of the so-called genus deliberately set to work to justify his own views, instead of frankly acknowledging his error. The existence of a genus closely allied to *Equus* in the Parana beds, which are set down as of Lower Oligocene age, would not, however, by any means have suited the views of the Argentine palæontologist, and hence *Hipphaplus* must be maintained at all hazards!

The third genus of South American equines is represented by a very remarkable skull recently discovered in the Pampean deposits on the coast of the province of Buenos Aires, and first described by Dr. Moreno under the name of *Onohippidium*. While agreeing with the skull of *Hippidium* in the extreme elongation of the nasal slits, this specimen is distinguished by the presence of an enormous lachrymal fossa of an oblong form and of great depth. Although it is certain this fossa must have contained a large lachrymal gland, its size is much greater than in any other mammal, either living or extinct, with which I am acquainted. The cheek-teeth were of the general type of those of *Hippidium*.

(*To be continued.*)

R. LYDEKKER.

IV.

Note on the Air-Sacs and Hollow-Bones of Birds.

MR. F. W. HEADLEY, in his interesting paper in the November number of NATURAL SCIENCE (vol. iii., pp. 346-356), calls attention to the fact that while the Gannet and the Cormorant belong to the same order, the one has large air-sacs and a remarkably pneumatic skeleton, while the other is devoid of air-sacs and has practically non-pneumatic bones. I have said practically non-pneumatic, because in *Graculus carbo* and related forms, the humerus and sternum have small pneumatic foramina, while in the extinct *Phalacrocorax perspicillatus* and other grooved-billed species these bones are quite non-pneumatic. Mr. Headley suggests that light bones would be out of place in, or unserviceable to, diving birds, and this is undeniably the case, since the problem with them is how to keep under water.

While the solid body and dense bones of the Cormorant are directly correlated with its mode of life, the air-sacs and pneumatic skeleton of the Gannet appear to be equally good adaptive characters. The Cormorant pursues its prey beneath the water, the Gannet plunges upon its victims from above, dropping upon them headlong from heights of one to two hundred feet. Now, as the cunning mechanic has devised an air-chamber to break the accidental fall of an elevator (American for lift), so nature has applied about the neck and breast of the Gannet a series of air cushions to break the shock which occurs when a bird weighing six or eight pounds strikes the water after a drop of a hundred feet or so.

In the Brown Pelican (*Pelecanus fuscus*) there are many air-cells present about the breast forming a thick mass of loose areolar tissue located exactly where they would do the most good as a buffer when this big bird plumps (dashes is hardly the word to use in connection with a pelican) down upon a shoal of fish. I have never dissected any of the white pelicans, and as these birds fish in quite a different manner from their darker relatives, it would be interesting to know if there is any corresponding difference in the arrangement or number of the air-sacs.

Another point possibly served by the air-sacs, as well as by the pneumaticity of the bones, is that of equalising the pressure of the air when a bird either dives from air into water, as does the Gannet, or rapidly descends from a great elevation in the air, as do some of the vultures. Soaring birds, such as the vultures, screamers, and some storks, certainly have very pneumatic bones; but I do not pretend that the above theory accounts for the fact, it is merely a suggestion as to one use of the character, and while the theory works very well when applied to such birds as the Gannet and Vulture, it fails in the case of the hornbills. Here, perhaps, we may fall back on the very convenient and much-abused theory of an inheritance from some active ancestor, but this again is merely a suggestion.

It is somewhat curious that of two nearly related birds one may have certain bones pneumatic, and the other non-pneumatic, a point well illustrated by the titmice. It is, too, a general rule that animals of rapid movements have light bones, and sluggish or aquatic animals non-pneumatic skeletons; and aside from the gain in size without increase of weight, which is rendered possible by a hollow bone, may there not be an actual oxygenation of the blood in the bones?

Frederic A. Lucas.

V.

Cell-division.

ALTHOUGH the main general features of cell-division are familiar to most readers of NATURAL SCIENCE, yet it is probable that not a few have been unable to find time to keep pace with even a part of the ever-increasing literature on the subject. So many varied, and in some cases contradicting, statements have been made recently, as to the real nature of the processes of cell-division, that any attempt to summarise them as probable truths is necessarily accompanied with considerable difficulty, and a likelihood to prove unintelligible or misleading. Nevertheless, it is hoped in this article to give some account of the chief features of ordinary cell-division looked at in the light of the latest researches. Ever since Strasburger, Bütschli, and Fol in 1870 drew attention to the extraordinary changes which generally take place in the nucleus of a dividing cell, a large army of investigators have given their almost undivided attention to increasing our knowledge of the subject, and it is a matter of no small regret that in such a wide field of research, which affords so many chances of gaining deeper insight into some of the most striking phenomena exhibited by living matter, few, if any, English names stand pre-eminent.

A cell may divide either (*a*) mitotically, that is to say, may pass through a process of change known as mitosis or karyokinesis, whereby a very perfect division of the chromatin, *i.e.*, the deeply-staining portion, in the nucleus, is brought about, or (*b*) amitotically, where a rough-and-ready splitting of the nucleus is substituted for the more elaborate mitotic division. The former is by far the more usual of the two, and although there are undoubted cases where amitotic division is the rule, it is probable that karyokinesis is even of wider occurrence than it is thought by many to be. It is with this form of nuclear division that the present contribution exclusively deals, and it will be found convenient to study the subject from the following points of view, viz.:—

(1.) The general features of karyokinesis.

(2.) The origin, nature, and function of the component parts of the nuclear figure.

(3.) The relation of karyokinesis to fertilisation and segmentation.

(4.) Theoretical considerations.[1]

The General Features of Karyokinesis.

In Figs. 1-8 (p. 43) the nucleus of a cell is represented in the various phases through which it passes during karyokinesis. In Fig. 1 the nucleus is in the resting condition, the chromatin being in the form of a much-coiled thread. The first preliminary stage towards division is marked by the thread acquiring a sharper contour, due to the withdrawal of numerous small branches and processes. It then proceeds to break up into a number (eight in this case) of pieces, Fig. 2. Each of these splits longitudinally into two exactly similar halves, forming in all sixteen daughter chromosomes (*Chr.*), as the masses of chromatin are now called, Fig. 3. The nuclear membrane at this period becomes indistinct and gradually disappears, and a new body comes into play, viz., the centrosome. Whatever may be its origin, the centrosome, owing to the active part it takes in the next stages, must be noticed at this point, though it will be dealt with in detail later on. A centrosome is thought by many to be an integral part of, and therefore present in, every cell during the resting as well as the active state. Since, however, it is unaffected by ordinary staining reagents, its presence is often difficult to demonstrate. At the moment when the nuclear membrane begins to disappear, the centrosome becomes surrounded by a number of radiating strands of protoplasm (Fig. 4, *c.*), which form the so-called "archoplasmic sphere." The centrosome then divides into two, each half remaining attached by means of numerous threads (*C. Sp.*). These threads are, in this case at any rate, the beginning of the future nuclear spindle, although in other cases a different origin has been assigned to it, as will be seen when the spindle is dealt with by itself. The next stage is represented in Fig. 5. The centrosomes have greatly increased their distance from one another, owing to the rapid enlargement of the spindle. The chromosomes (*x.*) have grouped themselves round the spindle in the median plane, to form the so-called equatorial plate. They have, furthermore, become doubled, each pair on itself, in such a way that the angle of the bend is directed towards the spindle, while the two ends point towards the surface of the cell. The next two stages are shown in Figs. 6 and 7. The two daughter chromosomes of each original chromosome gradually recede from one another and move along the spindle, until they come to lie, one set at one pole of the spindle and the other at the other. Nevertheless, they are not as yet entirely separated from one another, but still remain connected by delicate threads (Verbindungs Fasern, Hertwig) formed from the so-called "lâme intermédiaire" of Van Beneden. These must not be confounded with the threads comprising the spindle, from which they are quite distinct.

[1] It has been found possible in this article to treat of only the first two of these headings.

The condition shown in Fig. 7 is called the dyaster. In Figs. 5–8 only half the number of original chromosomes have been drawn. The last phase (Fig. 9) is marked by the disappearance of spindle, centrosomes, archoplasmic spheres, etc., and a return to the resting condition, accompanied by division of the body of the cell. At the moment when, in the dyaster stage, the archoplasmic spheres have attained their maximum development, the division of the cell-body commences. This usually takes place by a nipping of the cell transversely to the axis of the spindle. The furrow grows deeper and deeper inwards, until it cuts the cell into two nearly equal halves. As soon as this is accomplished, the archoplasmic spheres begin to disappear, and the chromosomes rapidly pass into the resting condition, apparently by imbibition of fluid. This stage (Fig. 10) has been termed the dispirem The chromosomes eventually break up into small grains, and a vesicular nucleus is formed, with the chromatin substance distributed as a network or coiled thread. This passage of the chromosomes from an active to a passive condition has been followed out most carefully by Boveri, who has shown that they preserve their individuality throughout the whole of the resting stage. The nuclear membrane is apparently formed by a concrescence of some of the small grains of chromatin into which the chromosomes have broken down.

The above facts may be looked on as being typical of all forms of karyokinesis, as far as regards the behaviour of the chromosomes; in the cells of different animals, however, these may vary considerably in number and appearance, from a few large threads, as in the above instance, to a large number of more or less irregular granules. Furthermore, although an exact splitting of each chromosome of the nucleus of the parent cell has not been definitely observed in all cases, especially where the chromosomes are small and numerous, it may be almost certainly assumed that some sort of process of this kind invariably does take place, either during the resting stage or when the cell is undergoing karyokinetic change. Before going on, however, to more debatable ground, where not only the interpretation of the facts, but even information as to the facts themselves, varies as we study the works of one author or of another, certain abnormalities observed in karyokinesis deserve a passing mention. It has been found that cell-division can be influenced in a remarkable way by varying the external conditions under which it is placed. The brothers Hertwig have given an account of some experiments performed on the eggs of the sea-urchin, *Strongylocentrus*, of which the following are the most remarkable.

Intense cold, *e.g.*, 2° C., has been shown to destroy all parts of the nuclear figure excepting the chromosomes. Dilute quinine appears to have an extraordinary effect on the centrosome, as a result of which it divides into four or five, each surrounded by its archoplasmic sphere, and consequently the figure may have four or five polar stars instead of two. Perhaps, however, the most curious of all these pathological cases are those of ova which have been in some way enfeebled, and so are unable to prevent the entrance of more than one spermatozoon, a phenomenon which in these forms is abnormal. Many of these spermatozoa come into contact with the egg nucleus. There results a karyokinetic figure having three, four, or many spindles and consequently double as many polar stars as there were spermatozoa which reached the egg nucleus. Furthermore, those spermatozoa which have entered the ovum but not come into contact with the egg nucleus, may also divide karyokinetically, and combine together to form figures and patterns of most varied kinds.

The Component Parts of the Nuclear Figure.

It is now necessary to consider more in detail the various elements which go to make up the nuclear figure. From the foregoing account it will be seen that the parts of a karyokinetic figure can be tabulated in the following way :—

Nuclear figure	Achromatic elements.	Centrosomes.
		Archoplasmic spheres.
		Spindle.
		Lâme intermédiaire.
	Chromatic ,,	Chromosomes.

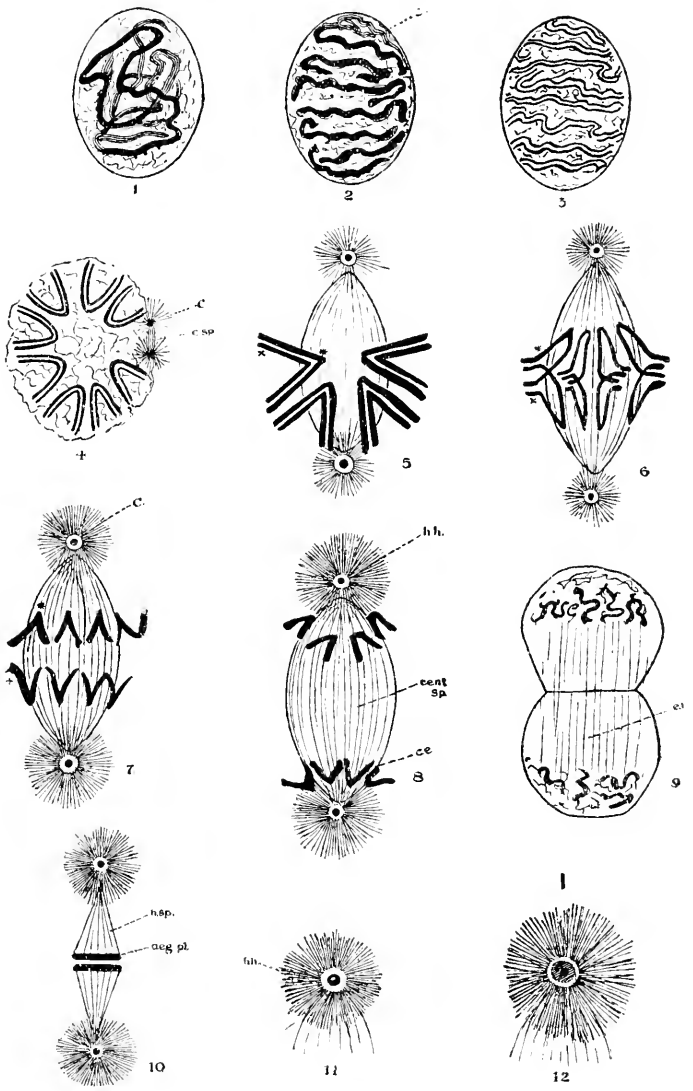
Centrosomes and Archoplasmic Spheres.—Although the so-called "Polkörperchen," or "centrosome," was discovered as early as 1870, by Fol and others, to exist in the centre of the archoplasmic spheres during the division of the nucleus, yet even at the present time opinions vary considerably as to its real origin. Van Beneden, Boveri, and indeed the majority of observers, look upon the centrosome as a permanent organ of the cell-body, present during the resting as well as active stage, and entirely external to the nucleus. Their views are to some extent borne out by the fact that in several instances, *e.g.*, epithelial cells of fishes and cœlomic corpuscles of Nemertines, an undoubted centrosome has been found during the resting stage in close proximity to, but perfectly distinct from, the nucleus. On the other hand, in few, if any cases, has the centrosome been actually traced through the stages of karyokinesis into the resting condition. O. Hertwig, on the other hand, is opposed to this view, and maintains that the centrosome is in every case essentially a nuclear structure, for the following reasons: (*a*) it has not been demonstrated, save in a few exceptional cases, as existing in the body of the cell during the resting stage; (*b*) its appearance is usually simultaneous with the breaking up of the nuclear membrane; (*c*) it has been observed to appear first at the edge of the nucleus, and then gradually wander into the body of the cell.

Although the opinion of Hertwig is contrary to that of most authorities, yet Brauer in Germany, and Moore in this country, have recently (September, 1893) published accounts of spermatogenesis, the former in *Ascaris megalocephala*, the latter in *Branchipus*, in which they have apparently conclusively demonstrated the nuclear origin of the centrosome.

Mr. Moore has been able to observe the actual formation of two distinct centrosomes, by fusion of bodies he calls dictyosomes, which apparently are parts of the achromatic reticular network. If Mr. Moore's conclusions can be applied to other cases, many previous existing ideas as to the nature of the centrosome will have necessarily to undergo considerable modification. Meanwhile, his results must be looked upon as forming an isolated exception. Brauer, on the other hand, considers the centrosome to be always present in the nucleus as a permanent body, which may or may not pass through the nuclear membrane preparatory to setting up karyokinetic division. As will be seen later on, in discussing the possible phylogenetic history of the centrosome, it is probable that the views of Hertwig on the one side, and Boveri on the other, may be equally true for different cases.

Peculiar interest was aroused when it was shown that the "Mittelstück," *i.e.*, that part which separates the head and tail of the spermatozoon, was really a centrosome, taken by the spermatozoon into the egg as an organ of division, a fact supported by all the more careful researches. Furthermore, Fol has shown in the case of the egg of an echinoderm, that the sperm-centrosome (*i.e.*, the "Mittelstück") and egg-centrosome take up their position one at either end of the first segmentation nucleus in the region of the future equatorial plane. Each then divides into two, and the halves travel in opposite directions, thus resulting in four centrosomes, one lying at each corner of the somewhat square-shaped nucleus. Each half of the original sperm-centrosome fuses with half of the original egg-centrosome, thus forming two centrosomes, both of which are partly paternal and partly maternal. This done, segmentation commences in the ordinary way. Although the above process takes place in one case at any rate, it is by no means so certain that it occurs in the large majority of instances which have been studied. On the contrary, it has been found that the centrosome of the egg almost invariably degenerates and disappears before the sperm-nucleus comes into contact with that of the ovum, and consequently every centrosome in every cell of the body of the resulting organism is derived from "Mittelstück" of the spermatozoon. The view that this egg-centrosome is typically a rudimentary organ was first proposed by Boveri, and his conclusions have been verified by Vejdowsky for *Rhyncelmis*, and Fick in his admirable paper on the maturation and fertilisation of the egg of *Axolotl* (*Ann. Mikr. Anat.*, Nov., 1893).

As to the explanation of these facts, it would seem probable that the degeneration of the egg-centrosome takes place in order to prevent parthenogenetic segmentation of the ovum. This supposition may appear absurd to those who look upon the egg nucleus after the giving



FIGURES OF THE CELL-NUCLEUS DURING KARYOKINESIS.

off of the polar bodies as thereby incapable of further division without additional chromatin elements derived from the spermatozoon. Boveri, however, has shown that, in certain cases, the spermatozoon may remain in the periphery of the ovum instead of travelling towards the egg nucleus. The sperm-centrosome, however, does not likewise remain inactive, but approaches the egg nucleus and divides into two. The egg nucleus then divides karyokinetically, and with it the whole body of the ovum. The spermatozoon only comes into activity when the 4- or 8-celled stage has been reached, when it fuses with the nucleus of that blastomere in which it happens to lie. In this case it is obvious that the egg nucleus, even after giving off the polar bodies, has sufficient chromatin left to enable it to divide and reproduce the organism, but at first lacks the organ whereby that division can be brought about. Many facts of this description could be adduced to prove that the presence of a centrosome is necessary for division to take place, and since it has been shown that a spermatozoon can "fertilise" a non-nucleate fragment of ova, and develop into larvæ of exactly the same species as the animal from which the spermatozoon was taken, the following important conclusion must be drawn as applicable to most cases:—A mature ovum and a mature spermatozoon have both sufficient nuclear matter for the production of a new individual, but cannot do so independently—the ovum because it lacks a centrosome, the spermatozoon because it has not the requisite quantity of protoplasm. The object of fertilisation is therefore that each may supply the wants of the other—the fertilised ovum possessing both a centrosome and a sufficient quantity of protoplasm. The advantage of additional chromatin elements derived from the spermatozoa will be dealt with later.

As to the nature of the archoplasmic sphere little need be said. It appears to be composed of radiating strands of protoplasm, which, however, do not arise from the centrosome. They do not probably come at all into contact with it, being separated from it by the so-called "heller hof." How they are formed and what is their meaning is at present very little understood.

Turning now to a consideration of the probable phylogenetic history of the centrosome, the presence of a macro- and micro-nucleus in many Ciliata at once suggests possible homologies. It is unnecessary to go into the details of the nuclear changes which take place in conjugating Infusoria, so admirably worked out by Maupas, for it will be remembered that the micro-nucleus only is the active and important structure corresponding to the nucleus in the cells of the metazoa, the macro-nucleus merely degenerating, to be formed afresh by division of the reconstructed micro-nucleus. Can the centrosome be homologised with either of these? This, of course, is very doubtful; but if any homology is to be drawn, it would appear probable that the centrosome is more nearly related to the macro-nucleus. This may seem improbable, since it is the view of most authorities that if any comparison can be made it is between the centrosome and the micro-nucleus. Some recent researches, however, on the ova of vertebrates and arthropods have revealed the fact that the centrosome of the ovum, although functionless, is relatively of enormous size, and remains for a considerable time, even until the embryo has reached an advanced stage in development. Later on it disappears. If the macro-nucleus of a ciliate protozoon be looked upon as a centrosome which, like the one just described, has lost its power of setting up nuclear division, and is merely a rudimentary organ, it can be homologised, or, at any rate, closely compared with the centrosome of an ordinary ovum, which, as a rule, degenerates and disappears. Hence, whether the centrosome be considered as a nuclear organ or as belonging solely to the cell-body, it matters little; for it is easy to imagine the former case to be the more primitive condition, and, from evidence gathered from different sources, we are almost compelled to allow that both conditions actually do occur. The following table may, therefore, be drawn up as representing the probable phylogenetic history of the centrosome.

(1.) A most primitive condition, where one nucleus only is present, which seems to possess not only the hereditary chromatin matter, but also power of spontaneous division. *e.g.*, *Amœba*.

(2.) A condition where the primitive nucleus becomes differentiated into two; one, the micro-nucleus, possessing the hereditary substance, the other, corresponding to the macro-nucleus, which functioned as an organ of division. Probably the two nuclei were of more equal size than are the macro- and micro-nuclei. Unrepresented as far as is yet known.

(3). The macro-nucleus has dwindled to become a centrosome. *E.g.*, Spermatozoa, tissue cells, and ova where the centrosome is practically active.

(4.) The centrosome is rudimentary and disappears, to be replaced by that brought in by the spermatozoon; thus the primitive condition of one nucleus is for a short time regained between the giving off of the polar bodies and fertilisation. This nucleus, however, has not the power of spontaneous condition. *E.g.*, inert ova.

If these are the probable stages in the phylogenetic history of the centrosome, it will be seen that the condition obtaining in such forms as *Paramœcium* is an offshoot of No. 2. The macro-nucleus, after losing its function as a centrosome, has probably increased largely in size and become a storage nucleus. The micro-nucleus has taken on double duty, so to speak, *i.e.*, it is not only the bearer of hereditary substance, but is also capable of spontaneous division.

It is by no means illegal to make this supposition of a change of function for the macro- and micro-nuclei respectively, since such a phenomenon is of constant occurrence in the animal kingdom. In the afore-mentioned cases of vertebrate and arthropod ova, a most primitive condition seems to exist. Although the macro-nucleus or centrosome has lost its function, it retains its original size and shape, and the fact that it surrounds itself with an archoplasmic sphere, points to some of its original power being still left. Furthermore, there can be little doubt that, whether we homologise the centrosome with the micro- or macro-nucleus, it was originally derived from the single primitive nucleus. Where it appears to come out of the nucleus before, and to go back again after, karyokinetic division, it is merely a recapitulation of its past history. A point in advance has been gained by those cells where the centrosome remains permanently outside the nucleus.

No mention has been hitherto made of the remarkable observations of Herr Lauterborn on living diatoms, an account of which appears elsewhere in this number of Natural Science (p. 7). His results are so at variance with all previous known facts of karyokinetic division, that at present it seems safer to draw no conclusions until more confirmatory evidence has been obtained. Besides, the mechanics of the processes which he describes are completely unintelligible.

The spindle.—What has been said with regard to the nuclear or non-nuclear nature of the centrosome applies equally well to the spindle. It appears to be formed by the activity of the centrosomes. Where the latter remain permanently in the cytoplasm, the spindle would appear to be made up of strands of protoplasm resembling those which make up the archoplasmic spheres appearing between the two daughter centrosomes. Where the centrosome has an intranuclear origin, the spindle is undoubtedly formed from the achromatic portion of the nucleus.

Furthermore, two kinds of spindle must be distinguished, viz.:—(1) The so-called "central" spindle; (2) the spindle which is made up of two "half-spindles." An instance where the former obtains is that taken as a typical case of karyokinesis. The second kind of spindle is shown in Fig. 9. It will be seen that it is discontinuous in the equatorial plane, the fibres merely extending from the archoplasmic rings to the chromosomes. The function also of the two seems to be different. The two half-spindles appear to exert a pulling on the chromosomes, whereas the central spindle is probably a groundwork in which the chromosomes move by their own activity. Van Beneden derives the spindle from both the cytoplasm and the achromatic network of the nucleus.

It would, however, seem probable that, where the spindle is derived from the protoplasm of the cell (as it appears to be so in those cases where the centrosomes are permanently extra-nuclear), it takes the form of two half-spindles; but where it is formed from the achromatic network in the nucleus, it is of the "central" type. This point has not yet received sufficient attention. It may, moreover, be urged against the assumption of two different kinds of spindle, that the supposed existence of the central spindle is due to a wrong conception of the "lâme intermédiaire" as being part of the spindle. On the other hand, it is possible that the two half-spindles are merely the rays of the archoplasmic spheres, and in no way to be compared to the central spindle. These points obviously still require considerably more light to be thrown upon them.

The lâme intermédiaire.—This name was given by Van Beneden to the layer of achromatic substance between the split halves of the chromosomes. It consists chiefly of delicate fibrils (Verbindungs Fasern) which lengthen out as the chromosomes increase the distance from one another. Brauer has attempted to distinguish between these fibres and those that form the central spindle, on the ground that the latter are actively contractile while the former are merely connecting threads, but whether this is so or not, there can be little doubt that these connecting threads are formed from some portion of the achromatic network of the nucleus, even in those cases where the spindle may have an extra-nuclear origin. In some cases they appear to persist longest of any of the elements of the karyokinetic figure, remaining visible even if the daughter cells have become completely cut off from one another. The chromatic elements of the nuclear figure will be dealt with in a future paper, but there are two points which should here be noticed, viz.: (*a*) The mechanics of karyokinesis. (*b*) The fate of the nucleolus.

(*a*) *Mechanics of karyokinesis.*—More, perhaps might be written on this part of the question than on any other, but it would be almost entirely of a speculative nature. Nothing is really known as to how the chromosomes move towards the poles, although it is the opinion of many that the threads of the spindle are contractile, and so pull the chromosomes apart. Exactly the contrary is the view of Strasburger for plants, and Watase for the cells of embryo Cephalopods. The former believes that the threads of the archoplasmic spheres penetrate through the porous nuclear membrane, forming two half-spindles. The movement of the chromosomes, he considers, are due partly to their own independent activity, and partly to the fact that they are pushed towards the poles by swelling up of the "lâme intermédiaire" due to the osmosis of nuclear fluid.

Watase, on the contrary, although he believes with Strasburger that there is no central spindle, but only two half-spindles, considers that the threads are stiff, like bristles, and flatten out the nucleus into an equatorial plate. By this means they gradually push the chromosomes between one another, eventually carrying one set to one pole and one to another, the membrane of the nucleus being preserved during the whole process. This view, which Watase thinks to be of general application, seems somewhat fantastic; yet, at the same time, it must be allowed that his figures strongly suggest such a process. It has recently been suggested that the centrosome is by no means a definite structure, but is merely an expression of the peculiar substance in the archoplasm, and has attractive power on the chromosomes. Ed. van Beneden considered that the spindle threads were contractile, and fixed into the centrosome as a fulcrum. More careful examination has shown that the centrosome is invariably separated from the striated archoplasmic sphere by a light area ("heller Hof" of Boveri), in which there are no fibres or striations. It is, therefore, best to dismiss the idea of contractile threads, and to consider that the chromosomes move by virtue of their own activity along the threads of the spindle. That they do so under some sort of chemiotactic influence derived from the centrosome is also very probable, nay, almost certain. Fick has, in his paper on the fertilisation of the egg of the axolotl, shown that the spermatozoon, after entering the ovum, turns completely round, so as to bring the "Mittelstück" foremost in the direction of the centre of the ovum. The latter proceeds towards the egg nucleus, while the former follows a short distance behind by means of amœboid movements. If in this case a centrosome can apparently exercise such a strong attractive power on the sperm nucleus, which is nothing more than a mass of chromatin, why should it not have a similar influence on the chromosomes in a nuclear division?

As opposed to this view it may, however, be asked, What is the use of the spindle if the centrosome can act so powerfully on the chromosomes? In answer to this, it is possible to imagine that, owing to the necessity for perfect halving of the chromosomes, a definite path is necessary for each chromosome to move along in order to prevent confusion. Haecker believes that he has discovered the actual product which acts chemiotactically on the chromosomes. Figs. 11 and 12 show this. Fig. 11 represents a centrosome surrounded by its archoplasmic sphere at the time when the equatorial plate is just being formed. It will be noticed that the "heller Hof" (*hh.*) is large, and that the centrosome has somewhat of a vesicular appearance. Fig. 12 is drawn at the moment when the chromosomes have begun to migrate towards the poles. It will be seen that the centrosome now appears as a homogeneous granule, while between it and the "heller Hof" is a zone of a staining semi-fluid consistence. This Haecker believes to be the contents of the centrosome, which are thrown out, and exert the attracting influence on the chromosomes.

Haecker's work was chiefly carried out on Cladoceran eggs. His views must be considered as yet to be purely speculatory, especially as they do not appear able to fit in with facts described by other observers.

(*b*) *The fate of the Nucleolus.*—The word "nucleolus" has, unfortunately, to do duty for at least three distinct components of the nucleus, viz.:—(1.) The true nucleoli, which appear to be part of the achromatic network, and are unaffected by ordinary staining fluids.

It has been suggested that the centrosome is formed by a concurrence of two or more of these nucleoli. (2.) Lumps of chromatin which may be numerous, few, or even represented by a single mass. The fate of these structures is quite easy to follow out. They break down to form the chromosomes. (3). The so-called "germinal spots" which exist in the ova of many animals. They may be either masses of deeply-staining nuclear substance, with or without vacuoles; there may be one large germinal spot consisting of two distinct parts, a smaller deeply-staining moiety, and a large, more vesicular portion. The smaller of these nucleoli appear to run together to form one larger one, in which the vacuoles are rhythmically contracting. Thus, in some cases at least, the germinal spot probably acts as an excretory organ to get rid of the waste products of the actively-growing chromosomes. The vacuoles run together into one large one, which then bursts. The whole process has been watched in living eggs, and occupies from four to eight hours for each systole and diastole. What the actual fate of this kind of nucleolus is, is not yet certain, although it has been observed to maintain its individuality for some time after the dissolution of the nuclear membrane. It then suddenly disappears, and is, on this account, possibly to be looked upon as chromatin which has taken on a special function, and consequently become useless as hereditary substance. Hence its apparent dissolution when the nucleus passes into the active condition.

These, then, are the main facts of Karyokinesis. It is hoped, in a future article,[2] to discuss its important relations to those theories of Heredity which locate the hereditary tendencies in the chromosomes of the nucleus, and also to compare Mitosis with Amitosis, which latter, in all probability, was the most primitive form of cell-division.

M. D. Hill.

[2] With that article will be given references to the more important papers bearing on the whole subject.

VI.

Recent Researches on Olive-Brown Seaweeds.

ALTHOUGH the nature and functions of the contents of the conceptacles of the Fucaceæ were well-known previously, there was no definite account of the development of these bodies themselves until 1880, when the first thorough examination of the subject was made by Professor Bower (1). He gives the views of earlier writers, and tells us that Reinke looked on the bodies variously called Fasergrübchen, cryptostomata, vegetative and neutral conceptacles (simply conceptacles full of hairs but without antheridia or oogonia) as the "type of these structures" originating "by a separation of four or five neighbouring cells of the limiting tissue from one another. He compares this process with the formation of the resin-passages in the Coniferæ."

It is interesting to see that Luerssen published four years later a different view, and one nearer the truth, though he does not describe the development of the conceptacle in any detail.

Professor Bower next made an investigation of the subject, and described the whole development of the Fucaceous conceptacle in all its detail. He showed that "the division of the outer cell of the limiting tissue of the thallus by vertical walls into four, ceases in certain cases. The division by walls parallel to the surface, however, continues. A linear series of cells is thus formed which may be traced some distance into the tissues, but which is terminated by a single cell only. Later, the activity of division in the horizontal direction also ceases, and as the terminal cell of the series does not increase in size, the result is that it is surpassed by the tissues surrounding it. The terminal cell of this series we may call the 'initial' cell of the conceptacle, the cell immediately beneath it may be termed the 'basal' cell."

The development of both cryptostoma and conceptacle is shown by Professor Bower to be the same, and this fact has, of course, given rise to theories as to which was the earlier of the two in the history of the Fucaceæ. Professor Bower takes the view that the cryptostoma is an abortive conceptacle, and proposes the term "neutral" or "sterile" conceptacle. Oltmanns (2), on the other hand, takes the view that the cryptostomata are the older of the two, and have in course of time come to bear oogonia and antheridia; while I (3) have ventured, in describing the anatomy of the genus *Turbinaria*, to take a third view, viz., that both conceptacles and cryptostomata are of equal antiquity, and that neither is an outcome of the other.

For some reason that I hardly understand, all these views, and apparently mine in particular, have supplied a source of innocent merriment to Mr. George Murray, who, both in the *Journal of Botany* and his *Phycological Memoirs*, has treated the "ancestors of the Fucaceæ" as if they came from Wardour Street. As will be seen later on, fate has been so ironical that his researches have thrown fresh light on the whole dark subject and possibly a way out.

The matter was in this stage when, as Mr. Murray has since shown, an important side-light was thrown on the subject by the investigation of the development of the conceptacles of *Splachnidium*. This strange-looking plant had been often mentioned and described, but never properly investigated, till Mr. Murray, suspecting that it might prove interesting in connection with the question of cryptostomata, handed it over to Miss Mitchell and Miss Whitting for examination. The result (4) exceeded his anticipations. The first point of interest was the strange persistent apical cell which the authors describe in the following way:—

"The apical cell in *Splachnidium rugosum* differs entirely in appearance from the surrounding meristem; it has a pear-shaped body bounded by a thick transparent mucilaginous wall, and a filiform basal process stretches towards the interior of the thallus. This cell and the very active surrounding meristem are sunk in a slight depression; the two outer layers of the meristem by radial division form the epidermal cells, which continue to divide radially until the part of the thallus in which they lie has reached maturity."

. . . .

"The apical cell persists throughout the life of the plant, and not only does it appear at the apex of the main branch, but cells of the same kind are found at other points where growth is taking place, *e.g.*, in the young conceptacles and at the point of formation of lateral branches. It seems as if its appearance were the herald of every local development."

Except for a slight difference in the casting of external layers of the mucilaginous cell-wall, and in the junction of the process at its base with the filaments of the thallus, the initial cell of the conceptacle was found to resemble in every particular the apical cell described above. Former investigators had supposed these conceptacles to be cryptostomata, like those of Fucaceæ, to which this alga was supposed to belong, and in their earlier stages they are exactly similar, "the tufts of hairs extending," like those of *Cystoseira*, "a long distance beyond the ostioles." Mr. Murray (6), in comparing these points in *Splachnidium* and *Fucus*, says: "In *Fucus* it will be remembered that hairs are not produced until the formation of a young conceptacle with an ostiole, while the initial cell has decayed. The hairs in the conceptacle of *Splachnidium* are long, septate, and unbranched, increasing in length by successive divisions at the base, and giving the young conceptacle the appearance of the cryptostomata of the Fucaceæ. The sporangia are developed later. We have, in fact, in this type a sorus of sporangia and paraphyses comparable with those of *Laminaria*, rolled up and definitely limited in a conceptacular body, produced, not exactly in the same manner as the Fucaceous conceptacle, but after another manner directly comparable with it."

The occurrence of cryptostomata is by no means confined to the Fucaceæ; we find them in genera of Laminarieæ—*Alaria*, *Saccorhiza*, and *Adenocystis*. They also occur on other algæ, such as *Hydroclathrus* (Scytosiphonaceæ), described by Miss Mitchell (5), and on *Chnoospora* (Sporochnaceæ).

As regards the Laminarian cryptostomata, Mr. Murray, who has examined them himself, writes: "I have been so fortunate as to obtain good examples of their occurrence in *Saccorhiza bulbosa* and *Alaria esculenta*. *Alaria* has been frequently described as possessing cryptostomata. Greville definitely refers to them as "minute pores from which issue minute tufts of filaments"; and Professor Bower refers to them also in passing. I have not placed myself in antagonism to these authorities on this minute point, without arming myself with certainty . . . . No pits or conceptacles are formed, and in a very old *Alaria* frond which I have examined, there was at most a depression one cell deep. The *Alaria* cryptostomata, if I may call them so, are tufts of hairs of basal growth, the cell at the apex of the hair being first cut off from the epidermal layer. On Plate XVI., Fig. 7, I have illustrated the mature cryptostoma of *Saccorhiza bulbosa*. So far as I am aware, the mature stage of these bodies in *Saccorhiza* has not been figured before, and the reader who compares this figure with that of the young conceptacle of *Splachnidium*, while it yet bears hairs only, cannot fail to be struck by the resemblance in all respects except the persistent initial cell of *Splachnidium*. We have here, then, a body which has every claim to rank as a cryptostoma." Mr. Murray then alludes to Mr. Setchell's paper on *Saccorhiza dermatodea*, in which he has figured an early stage of the cryptostomata of this plant, which strongly resembles the early stage of *Alaria*. The development of the cryptostoma of *Alaria* is regarded by Mr. Murray as "arrested," and he accounts for this by the fact that the frond of *Alaria* is so thin as not to allow room for the formation of pits. He is confirmed in this view by Mr. Setchell's remark that "the cryptostomata are present on the one-layered portion of the blade (of *Saccorhiza dermatodea*) as clusters of hairs upon the flat surface."

Mr. Murray then goes on to consider *Adenocystis*, a hollow sac-like alga, in form quite unlike any of the other Laminarieæ. He says: "It bears a resemblance both to the cryptostoma of its ally *Saccorhiza* and to those of *Hydroclathrus*, illustrated by Miss Mitchell.

The reproduction of *Adenocystis* is by zoospores, borne in zoosporangia and the cryptostomata occur in the middle of sori of unilocular sporangia." The paraphyses and sporangia, which are truly Laminarian, grow on the very edge of the depression. "In the other Laminarieæ examined, the sorus occurs separately from the cryptostomata, but, in this form, in the middle of the sporangia and paraphyses, as if in a nascent effort (or a dying one, as the case may be), to form a conceptacle like that of *Splachnidium*. It will be remembered that a young conceptacle of *Splachnidium* bears hairs only at first and sporangia later on."

In *Hydroclathrus*, cryptostomata are described by Miss Mitchell as occurring among plurilocular sporangia.

Mr. Murray concludes his paper by alluding to Professor Bower's remark about the groups of hairs in the Dictyotaceæ, "which are the precursors of the reproductive cells." Professor Bower says: "How far these may be compared with the initial cell or hair of the Fucaceæ, it remains for closer observation to decide." Mr. Murray attaches a prophetic value to this utterance, and notes that Falkenberg has pointed out "that in *Scytosiphon* single epidermal cells within a sorus remain sterile and grow out in the form of club-shaped unicellular paraphyses." Hairs are also found in *Asperococcus* and other allied forms, arising in similar situations, "resembling the hairs in the conceptacles and cryptostomata of the Fucaceæ, *Splachnidium*, *Saccorhiza*, and *Adenocystis*, and those in the sorus of Cutleriaceæ and Dictyotaceæ."

In conclusion, I cannot do better than quote here the summing-up of Mr. Murray's interesting paper. "A comparison of the Fucaceous conceptacle and cryptostoma, the Splachnidian conceptacle, with its persistent initial cell and the formation of its hairs yielding place to sporangia, the development of the *Adenocystis* cryptostoma in the heart of its sorus, the other Laminarian cryptostomata (*Saccorhiza* and *Alaria*) apart from the sorus, the cryptostoma of *Hydroclathrus* among its plurilocular sporangia, and finally the cases of the hairs in *Asperococcus* and the Cutleriaceæ and Dictyotaceæ—a comparison of these cases and of the evidence plainly furnished by them points very significantly to a possible origin of cryptostomata." These are striking admissions by one who has heaped contempt on "the ancestors of the Fucaceæ."

Such is the present state of our knowledge of the history and development of cryptostomata. Links are still needed to complete the chain of evidence which is to connect the hairs growing out from the surface of the Dictyotaceæ with the well-developed conceptacles of the higher forms of the Fucaceæ. But there are types still to be examined, and much interesting work to be done. The foreign forms of the Laminarieæ may, and probably will, show variations and gradations in the scale of development hitherto unsuspected, and we may look forward to most interesting results when any worker examines and describes the sori of these forms in the light of what has been already done.

The questions to be answered, if possible, appear to me to be these :—

Are the Fucaceous conceptacles and cryptostomata the descendants of similar bodies evolved by ancestors approaching the Laminarian type, in which we see them now dying out? Is the Laminarian sorus a mere flattened-out conceptacle? or, have such shelters for spores, antheridia and oogonia, for they are merely that, been evolved independently of each other by these different types under a common necessity of protecting their spores, etc.? Do we now witness nascent or dying efforts to produce conceptacles in such forms as *Adenocystis* and *Hydroclathrus*? Are the barren cryptostomata of *Saccorhiza* prophetic or ancestral structures?

Their further examination, at all events, cannot fail to throw light where it is much needed—on the relationships of the Natural Orders of Phæophyceæ.

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E. S. BARTON.

The Exhibition of the Photographic Society of Great Britain, & Extracts from the Press.

The annual exhibition of the Photographic Society of Great Britain is one which is looked forward to year by year with increasing interest by a large number of persons. To this exhibition we are accustomed to turn for information regarding the most recent applications of the science. The Photographic Society is not an artistic but rather a scientific society. Its principal aims are evidently to foster the researches of science in the advancement of the optical and chemical investigations which result in the triumphant discoveries with which photography from time to time startles the world. . . . Two large frames, which have deservedly received the medal of the Photographic Society, are those by Mr. J. C. Burrow. They contain a series of views taken "'Mongst Mines and Miners." Both photographically considered and for their general interest they are distinctly remarkable.—*The Times.*

A very curious and interesting series of Photographs is Mr. J. C. Burrow's "'Mongst Mines and Miners," two sets of studies of Cornish miners at work in the mines, which were taken by magnesium lamps combined with lime-light, and printed by the gelatino-chloride process. —*Graphic.*

"'Mongst mines and miners" (3), by J. C. Burrow, is well deserving the medal awarded to it, for though, of course, the subjects are not pretty or artistic, nor entirely original, they illustrate a phase of life little known to the outer world. The work is praiseworthy, considering the adverse circumstances that hedged about the exposures, and the groups have little appearance of posing, even though some are 2,000 ft. below the surface. The technique is exceedingly good. The judges give a medal for this, and a similar set of pictures illustrating the same subject (72). —*Photography.*

John Taylor, Esq., M. Inst. C.E., F.G.S. at a meeting of Shareholders in the Ooregum Gold Mining Co. of India, Ltd., said :—

"Now, gentlemen, I always feel a considerable amount of doubt as to how far I make myself understood in describing these operations to those gentlemen who may never have gone down a mine perhaps in the course of their lives, and I will occupy only a moment of your time in saying that those who take a practical interest in the subject would do well to visit the Photographic Society's Exhibition, in Pall Mall, where they will see a number of photographs in two large frames taken by Mr Burrow, of Camborne, of the underground workings in Dolcoath and some of the large mines in Cornwall. They are admirable specimens of photographs taken under such circumstances, and give a capital idea of the manner in which workings are carried on in our large metalliferous mines." *The Mining World and Engineering Record, October 17th, page 529.*

"We believe it is somewhat novel for underground workings to be photographed in this Country. We are glad, however, to find that Mr. J. C. Burrow, of Camborne, photographed the underground workings at Dolcoath most successfully."—*Mining Journal.*

"A largely attended and very enjoyable conversazione was held at the Royal Institution of Cornwall, Truro, on Thursday evening, immediately after the associated meeting of the four county learned societies. In addition to the lime-light slides shewing micro-photographs of Scottish and Cornish cherts, and the deep sea deposits dredged by H.M.S. Challenger, and of the diatoms, sponges and radiolaria exhibited by Mr. Howard Fox, Mr. W. Thomas, Secretary of the Mining Association and Institute of Cornwall, exhibited a number of slides representing views photographed underground at East Pool, Dolcoath, Cook's Kitchen, and several other mines, by Mr. Burrow." *Western Morning News.*

"'Mongst Mines and Miners,"

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VII.

Scientific Volapuk.

WE have more than once alluded in these pages to the misapplied ingenuity of certain scientific writers, who, being unable to use the language with which their natural heritage has supplied them, imagine that they can better convey their ideas to the world through the medium of words that are not merely new and strange, but often incorrectly constructed and far too vaguely defined (NATURAL SCIENCE, vol. ii., p. 6, and vol. iii., p. 242). Let it not for a moment be supposed that we deny the value and even the necessity of scientific terminology; on the contrary, for technical purposes, a distinct and well-defined term is, we consider, far superior to an ordinary word distorted from its ordinary meaning. At the same time, it is obviously desirable that these scientific and technical terms should be constructed according to etymological principles of a higher grade than those that govern the appellation of the latest patent medicine or the newest thing in window-blinds. And, apart from this, there are other cautions that might profitably be attended to by many of these word-mongers.

Chiefly should one hesitate before encumbering—we will not say the English language, but—the Volapuk of scientists, with any additions to its already overcrowded vocabulary. Reflect first if the idea cannot be as clearly expressed by words already in use. Brevity may brighten wit, but no less does it darken wisdom. Next consider whether the idea be actually new, or, if new, whether it be a reality. Does, for instance, Mr. Ryder or anyone else seriously suppose that there is an abstract formative force concerned in modifying the forms of bones? If not, where is the necessity for a name? As for those people who go out of their way to invent terms which neither they nor anyone else will probably ever use again in this world, what torture in the next world would be appropriate? Yet this is what Professor Hyatt does in his paper on Bioplastology, when he suddenly stops to tell us that if Hering were right in supposing heredity to be a form of memory, then *Mnemegenesis* would be a very good word for heredity. Shall we suggest that Professor Hyatt should be set first to suppose forms of punishment, and then to invent Greek names for them?

So many new terms have been proposed in the last few years, that we have determined to make some attempt to collect them year by year in a form available for the use of the scientific public, adding definitions, too often forgotten by the original authors, and derivations when we have been able to discover them. It is not likely that our list for this year is complete. We have purposely taken no notice of terms dealing only with limited groups of animals, and we have not thought it necessary to include every possible combination of terms with prefixes and suffixes suggested by authors. Thus in his paper on Bioplastology (3), Professor Hyatt also subdivides each of the stages of Ontogeny, from Nepionic (= Brephic, Buckman and Bather) to Gerontic, into three substages, which are distinguished, on Buckman's suggestion, by the prefixes *ana-* (up towards), *meta-* (in common with), *para-* (beyond). Thus the Gerontic stage, instead of having two substages, Clinologic and Nostologic (Hyatt), or Catabatic and Hypostrophic (Buckm. and Bath.), will have three, viz., *Anagerontic*, *Metagerontic*, and *Paragerontic*. Professor Hyatt also proposes to apply Haeckel's physiological terms, or his own modifications of them, to Phylogeny, by using the prefix *phyl-*; thus, *Phylanaplasis*, *Phylometaplasis*, and *Phyloparaplasis*.

Besides these, other terms have doubtless escaped our notice, and we shall be glad of any additions. Authors would also confer a favour by sending us, in future, a note of any new terms they may propose.

We cannot conclude without protesting against a tendency, far too prevalent, of introducing these and similar terms, originally invented for the benefit of specialists, into works of a more popular description. This is not the way to popularise science. Possibly the writers think that long words give an air of learning. We believe that they tend to mystify both writer and reader, substituting sound for sense, and, too often, fancy for fact. It was to politicians, not to scientists, that words were given for the purpose of concealing thought; yet we fear that some day the latter also may find that they have floated too far into the clouds of unintelligibility, and may be brought back to earth only to repeat, in the words of the man they shouted "Hi!" at, in the *Hunting of the Snark*—

"I said it in Hebrew—I said it in Dutch—
I said it in German and Greek:
But I wholly forgot (and it vexes me much)
That English is what you speak!"

LIST OF NEW TERMS PROPOSED IN THE NATURAL SCIENCES DURING 1893.

Aborad and *aboran*, converse of "orad" and "oran." (SCHULZE.)

Astrokinetic (ἄστρον, a star; κινητικός, setting in motion), applied to phenomena of motion of centrosomes of cells. (RYDER.)

Astrosphere (ἄστρον, star; σφαῖρα, sphere), improved term for "attraction sphere," a phenomenon of cell-division. (STRASBURGER.)

Astrostatic (ἄστρον, a star; στατικός, causing to stand still), applied to phenomena of rest of centrosomes of cells. (RYDER.)

Autotrophic (αὐτός, self; τροφικός, nourishing), existing without aid of commensals: applied to lichens. (MINKS.)

Axian, *axial*, *axiad*, adjectival forms of axis, *i.e.*, the longitudinal or main axis. Compare "Centrum" and derivatives. (SCHULZE.)

Bathmology (βαθμός, a step; λόγος, science), the science of growth. A term proposed as alternative to "Auxology" (Buckman and Bather), and correlative of "Bathmism" (Cope). (HYATT.)

Bilateralien. Organic bodies with three axes of symmetry, viz., *isopol*, which equals the perlateral; *heteropol*, or dorso-ventral; and heteropol or longitudinal, the main axis. (SCHULZE.)

Bioplasmology (βίος, life; πλάσμα, substance; λόγος, science), cellular biology; correlative of "Bioplasm, etc." (Beale.) (HYATT.)

Bioplastology (βίος, life; πλαστός, moulded; λόγος, science), the study of the correlations of ontogeny and phylogeny. An alternative to "Biogeny" (Fiske) and "Biogenesis" (Haeckel non Auctt.) (HYATT).

Blastokinesis (βλαστός, germ; κίνησις, movement), migrations of embryo through and over yolk, as in the Orthopterous insect *Xiphidium ensiferum.* (WHEELER.)

Centrad or *proximad*, directed towards the Centrum. (SCHULZE.)

Central or *proximal*, near but not in the Centrum. (SCHULZE.)

Centran, within the Centrum. (SCHULZE.) In the polar axis of a Synstigma. (HYATT, 4.)

Centren, equivalent to "centran" (Schulze) (HYATT, 4.)

Centrum, the imaginary geometrical centre of a Synstigma. (SCHULZE.)

Cephalan, *cephalal*, *cephalad*, adjectival forms from κεφαλή, head. Compare "Centrum" and derivatives. (EDITOR in HYATT, 4.)

Co-type (erroneously for "syntype," *cum*, with; τύπος, type); applied in zoology to one of two or more specimens together forming the basis for the original determination of a species. (THOMAS.)

Ctetic (erroneous application of κτητικός, acquisitive), a term for "acquired characters." (HYATT.)

Ctetology (erroneously for "ctematology," κτητός acquired; λόγος science), the study of the effects of environment on organisms, and of the inheritance of those effects. (HYATT.)

Cytokinetic (κύτος, a cell; κινητικός, setting in motion), phenomena of motion within plasma or cells. (RYDER.)

Cytostatic κύτος, a cell; στατικός, causing to stand still), statical conditions within plasma or cells. (RYDER.)

Dextran, *dextral*, *dextrad*, adjectival forms from *dexter*, right; referring to right half of perlateral axis of "Bilateralia." Compare "Centrum" and derivatives. (SCHULZE.)

Dictyosome (δίκτυον, net; σωμα, body), thread-like bodies appearing in cell-division, *e.g.*, spermatogenesis of *Branchipus.* (MOORE.)

Diplanetism (apparently an erroneous form of *diplanesis*, from δίς, twice, and πλάνησις, a dispersing), double swarming of zoospores (Humphrey.)

Distad, directed from the Centrum. (Schulze.)

Distan, on the periphery of a Synstigma. (Schulze.)

Dorsan, on the outer surface of the dorsum. (Schulze.)

Ectergogenesis (ἐκτός, without; ἔργον, work; γένεσις, birth), the passive reactions of an organism to environment. (Hyatt.)

Ectergogenic (erroneously for "ectergogenetic"), adjectival form of the above. (Hyatt.)

Entergogenesis (ἐντός, within; ἔργον, work; γένεσις, birth), the active reactions of an organism to environment. Equals "effort" of the Neo-Lamarckians. (Hyatt.)

Entergogenic (erroneously for "entergogenetic"), adjectival form of the above. (Hyatt.)

Entergogenism (an impossible word), the principle of the above. (Hyatt.)

Ergogeny (erroneously for "ergogenesis") (ἔργον, work; γένεσις, origin), general term for all forms of energy producing modifications of bone. (Ryder.)

Ergogenetically adverbial form of the above. (Ryder).

Genesiology (γένεσις, birth; λόγος, science), the study of the phenomena of heredity. (Hyatt.) This term has already been used in another sense, viz., "the science of generation," and should therefore be inadmissible.

Genetic force, the active force of heredity. (Hyatt.)

Genism (an impossible word), the principle of heredity. (Hyatt.)

Hemera (ἡμέρα, day), a chronological subdivision of the geological term "age," marking the acme of development of one or more species. (Buckman.)

Heteropol, see *Bilateralien*.

Heterotrophic (ἕτερος, other; τροφικός, nourishing), existing with aid of commensals; applied to lichens. (Minks.)

Isopol, see *Bilateralien*.

Karyokinetic (κάρυον, a kernel; κινητικός, setting in motion), applied to phenomena of active stages of cell-nuclei, an old term restricted. (Ryder.)

Karyostatic (κάρυον, a kernel; στατικός, causing to stand still), applied to phenomena of resting stages of cell-nuclei. (Ryder.)

Kinetogeny (erroneously for "kinematogenesis," or "kinesigenesis," κινεῖν, to move; γένεσις, origin), energy of motion, the agency producing modifications in the form and proportions of bones. (Ryder.)

Meta-type (μετά, after; τύπος, type), applied in zoology to a specimen collected at the exact locality whence was obtained the type of the species to which it belongs, and named by the author of that species. (Thomas.)

Mnemegenesis (μνήμη, memory; γένεσις, descent), Hering's explanation of heredity as a form of unconscious organic memory. (HYATT.) It will be observed that, in this compound, "genesis" is used in a different sense to that which it bears in the rest of Hyatt's coinage.

Monocyclon, or *Monocyclic*, is applied to a phylogeny in which only one cycle is observed. (HYATT.)

Morphic (μορφή, form), connected with structure. Instead of morphologic, when incorrectly used in this sense. (HYATT.)

Nepiastic, an emendation of the corrupt "nepionic," or "næpionic," of Hyatt; derived from νήπιος, infant, presumably by way of the rare form, νηπιάζω, I play like a child. It equals "Brephic" of Buckman and Bather. (SCHUCHERT.)

Nostic (erroneously formed from νοστός, a return home), the final stage of decline. Supplants "Nostologic" (Hyatt), and "Hypostrophic" (Buckman and Bather). (HYATT.)

Ontocycle or *Ontocyclon*, the cycle of individual development. (HYATT.)

Orad, towards the mouth opening, when mouth and anus are terminan and opposite. (SCHULZE.)

Oran, within the mouth opening, under the same conditions. (SCHULZE.)

Paraplasis, decline in Ontogeny, senescence. Supplants "Cataplasis" (Haeckel). (HYATT.)

Parameridian (a mongrel term from παρά and *meridianus*), applied to any plane parallel to the meridian or plane of the principal axis in a Syngramma. (SCHULZE.)

Paratangential (a mongrel of the same litter), within the body of a Synstigma and at right angles to its radii. (SCHULZE.)

Para-type (παρά, alongside of; τύπος, type), applied in zoology to a specimen of the original series forming the basis for the original determination of a species, but not the type, in cases where the author has himself selected a type. (THOMAS.)

Peripheran, on the periphery of a Syngramma. (HYATT, 4.)

Phylocycle or *Phylocyclon*, the cycle of development of the race. (HYATT.)

Polycyclon or *Polycyclic* is applied to a phylogeny in which many cycles are observed. Further, the number of cycles may be expressed: thus, the Arietidæ, having ten cycles, are *Decacyclic*. (HYATT.)

Pseudosomes (ψεῦδος, false; σῶμα, body), bodies corresponding with centrosomes in everything except number, which appear in spermatogenesis of *Branchipus*. (MOORE.)

Sinistran, *sinistral*, *sinistrad*, converse of *dextran*, etc. (*q.v.*). (SCHULZE.)

Statogeny (erroneously for "stasigenesis," στάσις, a standing; γένεσις, origin), antithesis of *kinetogeny*. (RYDER.)

Sympeden = *Bilateralien*. (SCHULZE.)

Syngramme (σύν, with; γράμμα, a drawing), organic bodies symmetrical about a main axis. This term supplants "Centraxonia" (Haeckel). (SCHULZE.)

Synstigmen (σύν, with; στίγμα, a mark), organic bodies with an imaginary geometrical centre. This term supplants "Centrosigmen" (Haeckel). (SCHULZE.)

Syntrophy (σύν, with; and τρέφω, I nourish) with erroneous variant *syntrophism*, and substantive *syntroph*. Apparently equals "commensalism" of former authors, but is specially applied to the endophytic elements of lichens. (MINKS.)

Tangential, at right angles to the radii of a Synstigma, and on the surface thereof. (SCHULZE.)

Termini, the ends of the main axis of a Syngramma, with adjectival forms *terminal*, *terminan*, *terminad* (compare "Centrum" and derivatives). (SCHULZE.)

Topo-type (τόπος, place; τύπος, type) applied in zoology to a specimen collected at the exact locality whence was obtained the type of the species to which it belongs. (THOMAS.)

Ventran, on the outer surface of the venter. (SCHULZE.)

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SOME NEW BOOKS.

ANNALS OF BRITISH GEOLOGY, 1892. A Digest of the Books and Papers published during the Year with Occasional Notes. By J. F. Blake, M.A., F.G.S. Pp. 310, 8 plates, and text illustrated. London: Dulau & Co., 1893. Price 10s.

THIS is the third volume of an extremely useful work, the previous volumes of which were noticed in NATURAL SCIENCE (vol. i., p. 69, and vol. ii., p. 234). The labour of preparing such a record is so enormous that we should under any circumstances have offered our thanks to Mr. Blake; but the present volume is so great an improvement on its predecessors that we must also tender him our congratulations. The work has passed through the fire of criticism and has emerged all the better for its ordeal. It has occasionally been thought that Mr. Blake was too unwilling to distinguish between the functions of annalist and analyst. The pungent notes that he used to interject in the middle of an abstract sometimes caused as much wrath as merriment. These are now absent, to the delight of authors if not of readers. Not but what our recorder still has his say, only his criticisms are now placed together in the form of an introductory review. This, he thinks, can scarcely be objected to if we admit the principle that "thou shalt not muzzle the ox that treadeth out the corn." To judge from this review the authors also seem to have improved, at least in Mr. Blake's opinion, and we do not think any of them are likely to reply, in the words of Agamemnon's watchman,—

> "For the rest I must be silent, a great ox hath trod upon my tongue."

The abstracts now seem still more carefully done, and if they do not satisfy authors, then the authors have only themselves to blame, since they are now afforded the opportunity of revising the manuscript itself, and this is a privilege of which we are glad to see the majority have availed themselves. The illustrations are also greatly improved, partly owing to original blocks having been lent by some societies and individuals, a mode of assistance which might very well be extended. It is, however, to be hoped that the wretched appearance of fig. 2 is not due to the fact of the author having changed his printer.

Except for the addition of the interesting introductory review, which the authors mentioned will save us the labour of criticising, the arrangement of the volume follows the old lines. One or two papers, however, seem to have gone astray. The Cave Men of Mentone, for instance, were hardly Britishers, while Mr. Teall's paper in NATURAL SCIENCE on the "Sequence of Plutonic Rocks" took its examples from foreign rather than home sources. The inclusion of a section dealing with papers on foreign geology published in England is probably intended as a bait for foreign purchasers;

personally we think that in abstracting these papers, the compiler gives himself unnecessary trouble.

We have now done our duty by this book. It only remains for our readers to order copies, and so to give Mr. Blake that pecuniary support without which work of this kind cannot be carried on. If this support is not given, "the only remaining hope," says Mr. Blake, "would be that the Geological Society should undertake a record at their own expense, by the aid of paid recorders." A society so poor that it cannot subscribe £100 *per annum* for the recording of palæontological literature, is hardly likely to jump at this suggestion. On the other hand if support is forthcoming, then, says Mr. Blake, the "Annals" might very well be expanded to the "Annals of British and *Foreign* Geology."

It may be pointed out that records of geological literature are now published in most European countries and to some extent in America. Why, in the name of common sense, cannot the societies and individuals engaged in carrying on this most valuable work combine their scattered and often wasted energies, and issue a series of annual bibliographies for each country of the world? Each such bibliography might contain either the papers published *in* its own country or those *about* its own country. The former plan would be cheaper, easier, more likely to be complete, and in the end more useful. The labourers are there; they only want a leader. *Verb. sap. sat.*

F. A. BATHER.

THE STORY OF OUR PLANET. By T. G. Bonney, D.Sc., LL.D., F.R.S. Medium 8vo. Pp. xv., 592, with six plates and 170 illustrations. London: Cassell & Co., 1893. Price 31s. 6d.

THIS work forms a companion volume to Sir Robert Ball's "Story of the Sun." It is planned, as the author himself states, somewhat on the lines of Lyell's "Principles of Geology," and it seems a pity that so excellent a model is not more closely followed. Professor Bonney divides the book into five sections, entitled: "The Story: its Books and their Speech," "The Processes of Sculpture and Moulding," "Changes from Within," "The Story of Past Ages," "On some Theoretical Questions." The first part contains introductory chapters on geology and physical geography, such as can be found in any text-book; but they do not seem to be carefully welded together, or to form parts of a connected whole. The second part is better done, and the author treats in a thoroughly systematic manner of the changes that take place on the earth's surface. Whenever it speaks of mountains, or of phenomena occurring among mountains, the book becomes interesting, and the illustrations also are better selected. The parts relating to glaciers, for instance, are very good; though the author would, perhaps, have spoken less confidently as to origin of lake-basins through irregular subsidence if he had seen Mr. A. R. Wallace's paper in the last *Fortnightly Review*. Leaving out of account theoretical questions, upon which opinions may differ, we have not noticed many serious mistakes or omissions in this part of the book. Fig. 34, fossil rainprints, if it represents anything of the sort, which we doubt, must represent, not the rainprint itself, but a cast of the print seen from below.

The third part, "Changes from Within," contains accounts of earthquakes and volcanic eruptions, including several important ones that have taken place since the publication of the last edition of

Lyell's "Principles." It also gives an outline of certain recent discoveries in mountain structure, and on the origin of the crystalline schists; though this part is scarcely up-to-date.

The fourth part commences with an account of meteors and the earth's beginning, leading to chapters on historical geology. All this section seems to be compiled from various well-known text-books, and would be improved by more thorough revision. The final section, "On some Theoretical Questions," contains four disconnected chapters, which we cannot help thinking would be better placed in the sections to which they properly belong, for other equally theoretical questions have been discussed in various parts of the volume. The four chapters thus isolated refer to "The Age of the Earth," "The Permanence of Ocean Basins and Land Areas," "Climatal Change: its cause and history," and "The Distribution and the Descent of Life."

We have, perhaps, criticised this book somewhat more severely than we should otherwise have done if the author had not challenged comparison with Lyell. The mantle of Lyell has not descended to Professor Bonney; but if unscientific readers wish for a popular "Story of our Planet," we can safely recommend the present work.

Dr. H. G. Bronn's Klassen und Ordnungen des Thier-Reichs. Band. vi., Abtheilung iv. Aves. II. Systematischer Theil. By Hans Gadow, Ph.D., F.R.S. 8vo. Pp. 303.

Dr. Gadow, in the concluding parts of the above-mentioned work, adds the keystone to his long labours, which, it is not too much to say, will prove of incalculable benefit for all time.

Those who are familiar with the anatomical section of this book will naturally turn to the present volume with great expectations; and assuredly they will not be disappointed, for they will find that, what has ever proved a subject of extraordinary difficulty and complexity, whether regarded from the limited horizon of the Ornithologist, or the more extended range of the Biologist, has been treated with a thoroughness that will claim at once the gratitude and the admiration of all workers in this field.

By reason of the plan adopted by Dr. Gadow of presenting us with tables of comparison between the various orders and families and pithy "conclusions," it is possible to trace, step by step, the ground over which the author has passed in the construction of his present scheme—a boon which we shall not sufficiently appreciate till we recollect the painful groping in the dark, and fruitless pursuit of phantom probabilities, that must necessarily have been involved in a research of this nature.

Substantially, the present arrangement is the same as that which appeared in the *Proc. Zool. Soc.*, 1892, enlarged and improved.

Thus the Class Aves is now divided into two sub-Classes, Archæornithes and Neornithes; and three divisions, "Neornithes Ratitæ," "Neornithes Odontolcæ," and "Neornithes Carinatæ." The third division is divided into two brigades of two "legions" each, the Colymbomorphæ and Pelargomorphæ comprising the first, and the Alectoromorphæ and Coraciomorphæ the second brigade. To the Colymbomorphæ belong the Ichthyornithes, Colymbiformes, Sphenisciformes, and Procellariiformes: while the Pelargomorphæ embrace the Ciconiiformes, Anseriformes, and Falconiformes. The Alectoromorphæ contain the Tinamiformes, Galliformes, Gruiformes, and

Charadiiformes; and the Coraciomorphæ, the Cuculiformes, Coraciiformes, and Passeriformes.

Such are the main divisions of Dr. Gadow's scheme. To pursue it further, would be neither permissible nor desirable here; but we think, in justice to our task, we should indicate some of the principal features of the remainder of the book; which, as we have previously hinted, is simply teeming with information, not of the "handy reference-book" order, but facts, skilfully marshalled.

Dr. Gadow commences with a short definition of the Class Aves, in which he admits the derivation of birds from reptiles; though from which sub-class cannot of course be proved. We are reminded that the distinction between birds and "not-birds" is unmistakable; yet it is only a question of time for some fortunate palæontologist to bridge over the gap, since gap there must be, for such remarkable structures as feathers, and the modification of the fore-limb into the characteristic Avian wing, cannot have come suddenly into existence. *Archæopteryx*, the most archaic bird we know, has attained a high degree of development; so that there must have existed a long chain of unknown forms connecting it with the reptiles. For such intermediate forms the term "Herpetornithes" is proposed.

The Neornithes are probably the direct descendants of the Archæornithes; but whether *Archæopteryx* was a direct ancestor, or only a small side branch, is a matter for speculation. The Neornithes seem to have become well developed by the end of the Jurassic period; in Cretaceous times they still retained teeth, but had even then developed into flying forms with a pygostyle, and flightless forms without either a carina sterni or pygostyle.

After discussing the characters, whether primitive or pseudo-primitive, which distinguish the Ratitæ from the remaining birds, Dr. Gadow proceeds at some length to dilate upon the relation of the Ratitæ to the Carinatæ. He opens his argument by very properly disposing of the mythical relationship, hitherto considered by some to exist between the Ratitæ and the Dinosaurs on the one hand, and the Carinatæ and Pterosaurs—through *Archæopteryx*—on the other, as "profitless dreaming"; pointing out that, if the similarity of the hind-limb existing between certain of these reptiles (the Dinosaurs) and the Ratitæ be held to be a proof of relationship, then all birds must be derived from the same stock, since in all birds the component elements of the tarsus are the same. Proceeding, the author next discusses the mono- or polyphyletic derivation of the Ratitæ, and this section will require very careful reading. Dr. Gadow's conclusions have led him to regard the Ratitæ as monophyletic. He proposes to retain the "Ratitæ" as a separate group, "upon practical taxonomic grounds."

The division "Neornithes Odontolcæ" appears to have been made with some diffidence to contain the Hesperornithes and Enaliornithes; but, it is urged, the arrangement must remain until Jurassic or Cretaceous birds are discovered, which possess a carina sterni and teeth standing in a groove.

The third and last division—"Neornithes Carinatæ"—contains all the remaining birds. Of brigade 1 it is noteworthy that the Colymbomorphæ (= legion 1) include the Ichthyornithes—and, we presume, but for special reasons, the Hesperornithes would have been included also. Passing on to the Coraciomorphæ, for space will not permit us to slowly meander as we should wish through the intermediate groups, we notice that the author confirms his earlier paper both in placing the Hornbills as a sub-family of the Hoopoes (Upupidæ), and retaining the Striges in close proximity to the Caprimulgi, instead of reverting to their time-honoured position, with the Accipitres.

Both cases will, we anticipate, create some discussion. In the case of the Striges, we fail to see how anyone, after he has carefully and impartially gone through the mass of facts which have been collected, as if for the very purpose of converting sceptics (pp. 235-241), can conscientiously stand by the old arrangement.

"The division of the Oscines into families is as yet very unsatisfactory," and we are referred for the present to the British Museum catalogues. The Australian region is to be regarded as the birthplace of the Oscines, from whence they have overspread the whole habitable earth.

Towards the end of the book some fifteen pages have been devoted to the Geographical Distribution of Birds, and extremely interesting reading it proves. The systems of Sclater, Wallace, Huxley, Newton, Sharpe, and others, are briefly reviewed, and then follows a short "Examination of birds as to their utility for dividing the earth into ornithological regions," which is fitly terminated by a contribution from Dr. Gadow himself, in which he recognises two main regions, A—Notogæa, and B—Arctogæa; the former embracing an Australian and Neotropical region, the latter a Palæotropical and Periarctic region.

Now that Dr. Gadow has said his last word, the question for the Ornithologist in the future will be not how much *is*, but how much is *not* known on any particular question upon which he may require information. The author is to be congratulated on the way in which he has fulfilled his most difficult and laborious task. W. P. P.

Horns and Hoofs; or, Chapters on Hoofed Animals. By R. Lydekker. 8vo. Pp. 411, with 82 woodcuts. London: Horace Cox, 1893. Price 15s.

This is a popular work, comprising a series of articles originally contributed to the *Field* and *Land and Water*, and now reissued in collective form, with some revision. The volume is beautifully printed and well illustrated, and will prove of interest not only to the sportsman, for whom it is primarily intended, but also to the naturalist who happens to be unfamiliar with the latest discoveries and most advanced views in reference to "Big Game" of all kinds except elephants and Carnivora. The first chapter deals with the Wild Oxen, which are all included by Mr. Lydekker in the genus *Bos;* and the various groups are described under the headings (1) aurochs and zebus, or true oxen; (2) gaur; (3) yak; (4) bison; and (5) buffalo. The musk-ox (*Ovibos*) is placed separately at the end. The second chapter treats of the Wild Sheep, which are essentially mountain animals, and are especially numerous in the highlands of Central Asia. They are subdivided into (1) the bighorns of North America and Kamschatka; (2) the argalis of Central Asia; (3) the urials of Asia, with the moufflons of Asia Minor and Europe; and (4) the bharals, as represented by the true bharal of Little Thibet and the Barbary sheep of North Africa. The Goats are next discussed and arrayed in five groups, as follows:—(1) The ture of the Caucasus, with the so-called Spanish Ibex, the sheep-like goats; (2) the pasang, or true goats; (3) ibex; (4) markhor; and (5) the tahr, or *Hemitragus*, of India. The Antelopes and Deer are treated at great length, incorporating in a general way the latest results of systematic zoologists; and the volume concludes with two chapters on Pigs and Rhinoceroses. Unlike most authors who furnish Zoology for the general reader, Mr. Lydekker makes numerous allusions to the extinct forerunners of the "Big Game" he describes; and there is a pleasant tinge of philosophy in "Horns and Hoofs" which one rarely meets with in works of its class.

Conchyliologie Francaise. Les Coquilles des eaux douces et Saumatres de France. By A. Locard. 8vo. Pp. 327, with figures in text. Paris: J. B. Ballière & Son, 1893. Price 18 frs.

The present volume is one of a series by the same author on the shells (not the mollusca, be it noted) of France. Its scope is sufficiently indicated if "recent and quaternary" be added to its title. The work is an admirable example of the modern French school at its very worst, and is eminently calculated to dishearten any student who should attempt to use it, and cause him to abandon all pursuit of the subject in disgust and despair. The figures are, compared with the number of "species" described, few and poor; the descriptions are inadequate and confusing; while the whole work is superficial to a degree. Every slight variation in the form of the shell is held sufficient ground for making a distinct "species," and as such most synonyms and bad varieties are consequently ranked. The rows and rows of these under *Lymnæa*, *Planorbis*, *Pisidium*, and *Unio* are, for instance, bad enough, but the author fairly "beats the record" under *Anodon*. Where Isaac Lea, who was no mean hand at species-making, could only see one, Locard makes two genera with 279 species! Further comment is needless.

British East Africa or Ibea: A History of the Formation and Work of the Imperial British East Africa Company. By P. L. McDermott. Pp. xvi., 382, with map. London: Chapman & Hall, 1893. Price 6s.

At a time when the system of the extension of the Empire by means of Chartered Companies is on its trial, this history of one which has had a rather unfortunate career is very opportune. The book is almost entirely political, and is an *ex parte* statement of the case for the Company against its foes, both official and unofficial. It gives but little information about the country; what little there is has been written in such an optimistic spirit, and the statements are so vague and general, that one may be excused for distrusting it. One could have wished that some of the lengthy quotations from leaders in *The Times* had been replaced by extracts from the unpublished reports of the various experts, geological, agricultural, and mining, who have been employed by the Company. As the future of the district must largely depend on its economic resources, the public would be in a better position for judgment had such materials been placed before it instead of the story of the Company's past discussions with the Foreign Office. As the work has been written by a paid official of the Company at the instance of its chairman, we have no right to expect impartiality and the insertion of matter that is not to the credit of the Company; and we have not got it. For example, we are told about the station at Dagoreti as if it were still flourishing and in existence; as a matter of fact, it was abandoned by the Company's officers and immediately burnt by the Wakikuyu some years ago, and a new one has since been built at Kabeti to replace it. Mr. McDermott has certainly done his work well, and given us an interesting history and ingenious defence of the Company; but we fear he will only strengthen the general feeling that the Company's record shows that a mixture of philanthropy and business seldom pays. Had the Company stuck to one or the other, and especially if it had confined its attention to administration pure and simple, and the utilisation of the available resources of the district, this book would probably never have been written, for an apology might then have been unnecessary.

REPORT OF THE SECRETARY OF AGRICULTURE, 1892. 8vo. Pp. 656, with 71 plates. Washington: Government Printing Office, 1893.

ON the back of the title-page of this somewhat bulky volume there is printed a copy of a public resolution:—"Resolved by the Senate and House of Representatives of the United States of America in Congress assembled,—That there be printed 500,000 copies of the Annual Report of the Secretary of Agriculture for the year 1892"; and also "That the sum of 300,000 dollars, or so much thereof as may be necessary, is hereby appropriated . . . to defray the cost of printing said report."

Three hundred thousand dollars is, roughly, £60,000. Our Transatlantic cousins have a vastly higher opinion of agriculture as a national concern than we ourselves if they are willing to spend £60,000 in taking the first step to make public the results of one year's work. But then, as Mr. Rusk, the Secretary, observes, "The great blessing which this country enjoys from the fact that it is far less than some other countries the home of large landed proprietors," presents certain difficulties which it is the province of the Department to remove. That is to say, the absence of large landowners, commanding extensive capital, throws the burden of experiment and investigation of agricultural problems on the shoulders of the Agricultural Department. This, of course, explains the bulky volume, the perusal of which we would recommend to large landowners in general, as an incentive to the publication of those results of experiment and investigation which we have a right to expect from the possessors of extensive capital.

The general report of the Secretary occupies sixty pages, and gives an idea of the scope of the Department and the possibilities of future development. Unfortunately, we find it hampered by "the inadequate compensation which it is authorised to offer to the men of talent, scientific education, and experience which it needs to carry on its most responsible duties," in which its "facilities will be found to compare very unfavourably with those of the other Departments of the Government." We know of parallel cases. It does seem somewhat incongruous that, while 300,000 dollars are voted for printing reports, the herbarium, including the largest collection of American grasses in existence, and containing type specimens of nearly all the American species described during the last fifteen years, should be housed in a non-fireproof building. Meanwhile "Congress saw fit to extend an appropriation, covering the present fiscal year," to provide for experiments on the production of rainfall by explosives, but Mr. Rusk does not think that his facts relating to this subject justify the anticipations formed by the believers in this method of artificial rain-making.

After a short report by the Assistant Secretary on the divisions directly under his charge, follows a series of detailed reports by the specialists in the various divisions. These are the Chief of the Bureau of Animal Industry, the Chemist, the Entomologist, the Ornithologist and Mammalogist, the Botanist, the Chief of the Division of Vegetable Pathology, the Pomologist, the Microscopist, the Chief of the Division of Forestry, the Special Agent in charge of Fibre Investigations, the Superintendent of Gardens and Grounds, the Statistician, the Chief of the Seed Division, the chiefs of various publication and financial divisions, the Director of the Office of Experiment Stations and the Chief of the Weather Bureau. Finally, there is a special report on tea-raising in South Carolina.

We cannot discuss these reports individually. They certainly contain a great deal of interesting and valuable matter. Thus, that of the Chemist begins with a warning against black pepsin, a preparation of pepsin and sugar, designed to increase the yield of butter, but which merely gives a compound which is not the genuine article, but an incorporation of butter with about an equal weight of other substances. An extensive examination has been made of canned and preserved foods, and it is pointed out that in some cases the tin employed to coat the cans contained over 10 per cent. of lead, which, in contact with the natural acids of fruits and vegetables, might lead to the formation of lead salts highly injurious to health. Particular attention was paid to the examination of green-coloured peas, beans, and other vegetables. It is a common custom to use a copper salt, presumably the sulphate—in canning such materials, to preserve or intensify their green colour, and the consumer may be certain, when eating very green canned peas, beans, etc., that he is consuming large quantities of copper, which, as the Chemist observes, must be condemned on hygienic grounds. This report also gives information on the detection of adulteration in honey, and describes experiments with sugar beets and sorghum. The Entomologist discusses various insect pests, such as the potato-tuber moth, the ox warble, the rose saw flies, and others, and gives an account, illustrated by three plates, of the Insectary.

The report of the Pomologist contains some brightly-coloured plates, depicting varieties of different fruits suitable for cultivation. The Eldorado blackberry looks very luscious. The Microscopist figures some edible mushrooms and also gives methods for their culinary preparation and simple means for detecting poisonous species. And so on; but we have said enough to give an idea of the contents of the report and for further details must refer the inquirer to the original.

Illustrated Guide to British Mosses; with Keys to the Genera and Species. By H. G. Jameson, M.A. Published by the Author, 6 College Road, Eastbourne. 8vo. Pp. 80, with 59 plates. Price 7s. 6d.

We are always glad to welcome a good book dealing with any phase of British botany. Questions of general morphology, anatomy, physiology, and the like occupy so large a proportion of the energies of the modern botanist that the flora of his own country is neglected or left to workers whose want of opportunity, training, or ability often forms a serious hindrance to success. Happily, the present is not a case in point. It is evident from his preface and the style of the whole work that Mr. Jameson has himself felt a want, and then done his best to supply it for the benefit of others. The scope of the book is well expressed in the title. It does not profess to take the place of such works as Hobkirk's synopsis, but to meet the difficulty of the beginner, who is often at a loss to know whereabouts in these books he is to look for the description of his unknown and unnamed specimen. By the aid of carefully elaborated keys he arrives first at the genus and then at the species, and the specimens once identified, can be studied in detail in the larger works. The keys hitherto published have been founded almost entirely on fruit characters, which, as the author observes, leave the student quite at a loss with regard to some of the commonest and most easily distinguished mosses, which will probably be among the first gathered, but are not likely to be in fruit. By the present arrangement, however, most of the Pleurocarpous mosses and many of the Acrocarpous may be readily determined even in the barren state. These keys were originally published in the *Journal of Botany* during the year 1891, but have been thoroughly revised and in great part re-written for the present work.

The first 20 pages of the guide are devoted to a short but useful introduction. This, with the help of the illustrations, comprised chiefly in Plates I.–VII., to the figures in which ample reference is made, forms an excellent glossary, besides giving a good general idea of the external structure of a moss. In section VII., on the practical examination of specimens, the beginner will find all necessary instructions. Under each genus in the keys to the species, the author gives some introductory remarks which, while not professing to be a generic description, call attention to points characteristic of the British species, and sometimes include information on synonymy or recent additions to the British Moss Flora.

The great features of the book are the 59 plates, which comprise, in fact, two-thirds of the whole. Mr. Jameson is his own artist and lithographer, and we heartily congratulate him on the result. Drawings of the entire plant are rare, but those characters are given which are especially useful in distinguishing the species, namely, the form of the leaf, leaf-apex, leaf-cell, and often also of the fruit.

We hope the Guide will meet with the appreciation it deserves, and add stimulus to the study of a somewhat neglected but highly-interesting division of our Flora.

The Jurassic Rocks of Britain. Vol. iii. The Lias of England and Wales (Yorkshire excepted). By H. B. Woodward, F.G.S. 8vo. Pp. xii., 299, with map and woodcuts. Memoirs of the Geological Survey of the United Kingdom. London: Printed for Her Majesty's Stationery Office, 1893. Price 7s. 6d.

It is with irate feelings that we peruse this book; not, we hasten to add, on account of anything with which the author has connection. Our anger is roused by the "get up" of the volume. Badly printed with inferior type often set awry, on decidedly third-rate paper—material so thin that the printing of one side of the page seriously interferes with the other—the work is neither a credit to its printers nor to the British Government. Placed on our desk by the side of Government publications of other countries, it does much to lower our national pride, and it sets us wondering why our Government should take such pains to show how badly they can publish a work. The book is embellished with woodcuts of sections, which the printing has made none too clear, and with figures of fossils which, from the same cause, can hardly be identified, notably on p. 44.

In striking contrast to the above are the contents of the volume, which are, for the most part, worthy of the painstaking ability of the author. The chapters on economic geology are undoubtedly the best part of the work; they contain much information valuable to others besides geologists. The stratigraphical portion of the volume displays the writer's general knowledge of the Liassic deposits to the best advantage; and it gives a remarkable amount of information for which every geologist will be thankful. Had this information not been marred by an unfortunate abundance of obvious palæontological inaccuracies, we should have had nothing but praise for this work. Unhappily, a considerable laxity in the use of specific names, and a too great reliance on out-of-date records, has, we regret to say, rendered the palæontological information to a large extent untrustworthy. We need not warn the field-geologist; a very little investigation will tell him that as regards the zonal records, both in the body of the work and in the appendix, it will be safer "to divide by four and disbelieve the quotient." In such case, however, the descriptive portion of the work becomes hardly more than a guide-book to the quarries and to the beds that they contain; but a volume on which so much labour has been bestowed is surely worthy of something higher than this.

It would have improved the work immensely, in our opinion, if the lists of species had been compared with those of good continental authorities, and if records on which doubt was thus cast had been expunged. A healthy scepticism as regards the insular idea that this country can show associations of species which the rest of Europe cannot produce should certainly be encouraged. We may pass the inevitable mistake of calling *A. falcifer* by the name of a generically different fossil, *A. serpentinus;* but such records as *A. semicostatus* and *A. raricostatus* together "above their appropriate zones" (p. 66), *A. subplanicosta* and *planicosta* in the same bed (p. 67), *A. semicostatus* and *subplanicosta* together (p. 165), *A. birchi* and *A. oxynotus* in conjunction (p. 148), and the table at the end of the volume having *Amm. planicosta, raricostatus*, and *semicostatus* ranging from the *Bucklandi*-to the *Jamesoni*-zone, *A. striatulus* from the *Annulatus* to the *Jurensis*-zone, and *Rhynchonella calcicosta* from the *Planorbis* to the *Spinatus*, may well excite suspicion as to the trustworthiness of the palæontology. The specialist, from his knowledge of the labels which *Ammonites* often bear, will no doubt be able to translate some of the above, as, for instance, "*A. planicosta*" with *A. sirius* (Reynès), and "*A. raricostatus*" with the young of *A. sauzeanus* (d'Orbigny); but the general geologist will, no doubt, be fogged.

The wisdom of the division between Lower and Middle Lias adopted in this work, contrary to general palæontological opinion, and contrary to what obtains in the companion Survey volume on Yorkshire, may well be questioned. In order to make the disproportion between Lower and Middle Lias less conspicuous, the author has had recourse to a "lumping" of the zones between those of *Angulatus* and *Capricornus*; while, on the other hand, a more than usually full recognition is accorded to the zones above the latter. As a consequence of the lumping, the zonalist will find in the appendix-tables a curious admixture of zonal species besides those noted above. Perhaps, however, what will most surprise him in this connection is that six species of Ammonites are said to pass from the Lower to the

Middle Lias; while no less than seventeen species are stated to go from the Upper Lias into the Inferior Oolite. This peculiar result is, of course, due to the author's method of treatment of the Upper Lias in Dorset and Gloucestershire; and it will be interesting to note in the Oolitic volume whither the author will be led by this pursuit of lithological uniformity in defiance of palæontological evidence.

From mistakes other than those of identification, and from misprints, the work seems to be creditably free. *Dactyloceras* is given throughout the Appendix instead of *Dactylioceras*; and a species called *Ophioderma milleri* on p. 192 is alluded to as *O. tenuibrachiata* on p. 198; while "mutations of sub-genera" (p. 328) certainly puzzles us.

A certain conservatism has prevented any attempt to classify *Ammonites* according to genera; but it has not been extended to Gasteropods, for new genera like *Pseudomelania* and *Nortonia* are admitted. There is the same conservatism in the matter of Ammonite-species. We are told that "many of the species are so split up that the multitude of names is simply bewildering, and they become of little or no service to the stratigraphical geologist" (p. 328). Now, we were under the impression that from the days of Oppel onwards the best stratigraphical work done on the Continent and in America had been accomplished by those who were strict in specific identification. But here, again, this conservatism is only applied to *Ammonites*: in Brachiopods there are catalogued under *Spiriferina* all those species which Davidson was so doubtful about admitting. This is surely inconsistent.

In conclusion, we must express our sincere regret that a volume which contains an immense amount of valuable work should have been disfigured by palæontological inaccuracies arising from a laxity in the use of specific names. We regret it for the author's sake; because it too often happens that inaccuracies in the part about which he can form an opinion induce the reader to condemn the rest, of which he knows naught. Though excusable, this is often unjust.

S. S. B.

Poems. By Arthur Christopher Benson. 8vo. Pp. xvi. and 192. London: Matthews & Lane, 1893. Price 5s. nett.

Scientific people are often said to have no care for literature. This is surely a libel; at any rate lovers of nature will do well speedily to make the acquaintance of this little volume. In days when so many write for the sake of writing, and to be read by other writers, it is a pure pleasure to chance on a poet who takes us back again to the simple, strong heart of the world without intervention of Grub Street fripperies. Other poets have incidentally cast flashes of light on our ordinary surroundings, making for us beauty where none was seen before; but Mr. Benson takes the common objects of the field as the very text of his songs. Berries of Yew, Old Nests, The Mole, The Dandelion, Knapweed: such are some of the subjects on which he writes with the insight born of love. Not often does he deal with the deeper questions of natural science, but the following lines from the very beautiful poem addressed to A Child touch on the mysteries of inheritance:—

Old signs are written in thy tender face,
  Desires, regrets that thou hast never known.
Thou art the heir of thy aspiring race,
  Heir of a troubled throne,

Of hope, that hardly dost portend the morn,
  And sadness, that hast scarcely guessed at pain;
God takes the characters of fate outworn,
  And writes them fair again.

In his minute observations of nature, Mr. Benson reminds one of Gilbert White, and we venture to quote the following sonnet on the naturalist as of interest to our readers, and as giving some idea of our author's poetic method :—

Thou wast a poet, though thou knew'st it not
  Then, on a merry morning, when the thrush
  Fluted and fluted briskly in the bush,
And blackbirds whisked along thy garden plot,
Didst watch an hour beside thy hanger's foot
  The quivering kestrel hung aloft the skies
  To mark aught stirring, or with pensive eyes
In cherry-orchards didst forecast the fruit
And shall I deem it idle thus to scan
  The myriad life, and reverently wait,
  A patient learner, auguring, behind
  The restless hand, the unhesitating mind?
This was thy daily task, to learn that man
  Is small, and not forget that man is great.

Space does not permit us to quote more; but we cannot conclude without offering our thanks to Mr. Benson for the pleasure he has given us. F. A. B.

INDEX TO THE PERIODICAL LITERATURE OF THE WORLD (COVERING THE YEAR 1892). By Miss E. Hetherington. 4to. London: *Review of Reviews* Office, 1893 Price 5s.

THIS valuable reference book has reached its third year and, as Mr. Stead truly says, we owe much to the industry and enthusiasm of Miss Hetherington and her assistants. We do not propose to criticise so useful a book; and, limiting ourselves to our own department, we offer a few suggestions for the next year's issue. In the list of "English and American Magazines and Reviews," pp. 8–20, we fail to find either the *Annals and Magazine of Natural History*, the *Geological Magazine*, or the *Zoologist*, while in the "Classified Tables" we only find two of them. In the "Index to the Periodicals," pp. 72–180, also, these three periodicals are conspicuous by their absence. As they contain some of the best work in the natural history sciences, and are, moreover, among the recognised channels for British workers, this seems somewhat strange. They should appear in all the lists, and should decidedly be indexed.

In future editions the journal *Yn Lioar Manninagh* should appear under L, not Y.

"MINERVA, Jahrbuch der Gelehrten Welt," edited by Dr. R. Kukula and K. Trübner (Trübner, Strasburg, price 7 marks), has made its appearance for 1893-4. It is a most valuable book of reference for those who wish to know the names and addresses of their fellow-workers, although it does not profess to include those unconnected with some public institution. The present volume is as neat in its get-up as its predecessors, and is embellished with an admirable engraved portrait of Louis Pasteur.

"An Astronomical Glossary or Dictionary of Terms used in Astronomy," by J. E. Gore, has been issued by Messrs. Crosby Lockwood & Sons. Students of Natural Science, especially those interested in Cosmogony, and in theories of climatic change, may be glad of a handy book of Astronomical terms. The definitions are for the most part brief. In the case of meteoric stones—"stones which occasionally fall from the sky"—a little more might have been added. Moreover, we may add the three kinds, Siderites, Siderolites, and Aerolites, were named by Maskelyne, not Denning.

The new edition of the Tunicata in Bronn's "Klassen und Ordnungen des Thier-Reichs" is to form the supplement to bd. iii. (Mollusca), and is edited by Dr. O. Seeliger, of Berlin. Lieferung 1 (48 pp.) lies before us, and is devoted to the first four, and part of the fifth, sections of the historical introduction, which is treated in the same thorough manner that characterises the main section of the volume.

M. Paul Pelseneer's new work, entitled "Introduction à l'Etudes des Mollusques," will, we understand, shortly appear. It is to form a single 8vo volume with 146 figures in the text, and will be published by M. Lamertin, of Brussels, at a price (6 fr.) which should put it within reach of all students of Malacology.

The Royal Swedish Academy of Science has just issued part i. of a detailed monograph of the Silurian Crinoidea of Gotland. This work, on which Mr. F. A. Bather has been engaged for the past four years, should prove of service to the numerous collectors of our own Wenlock fossils.

We have just received a number of publications from the United States Department of Agriculture. That of the most recent interest is volume ii. of illustrations of North American Grasses, dealing with the grasses of the Pacific slope, that is, of California, Oregon, Washington, and the north-western coast, including Alaska. It was prepared by the late Dr. George Vasey, and was, probably, the last official work on which he was engaged, as his letter of transmittal bears a date but little prior to that of his death. It contains plates with descriptions of one hundred of the more important species. The former are among the nicest specimens of grass illustrations that we have seen.

We are glad to learn that Dr. William Fraser Hume's pamphlet on the Cretaceous sediments, which was reviewed on p. 228 of our last volume, has now been published, and can be purchased from F. H. Butler, 158 Brompton Road, London, S.W.

OBITUARY.

PAUL FISCHER.

BORN JULY 7, 1835. DIED NOVEMBER 29, 1893.

BY the death of Dr. Paul Fischer, malacologists have suffered a heavy loss, and one that will not be easily replaced. He was for many years assistant naturalist to the chair of palæontology in the Jardin des Plantes, Paris, also a prominent member of the Commission of Submarine Dredging, and a member of several scientific societies. He does not, however, appear to have been a very ambitious man; and was quite unknown to many of his correspondents except through his writings.

As an author he was most prolific, and although he occasionally wrote on some of the lower forms of vertebrates, the mollusca claimed practically all his attention. And he was not a mere describer of shells; it is quite clear that whenever the animal of an interesting genus fell into his hands, a contemporary journal invariably contained something original from his pen concerning its anatomy. His *Observations anatomiques sur les mollusques peu connus*, a series of articles written in the *Journal de Conchyliologie* in 1856-57; *Ueber die Respiration bei den mit Lungen verschenen Land-Gasteropoden; Anatomie du genre Septifer; Anatomie de deux Mollusques pulmonés terrestres appartenant aux genres Xanthonyx et Hyalimax; Note sur l'anatomie des Cyrènes Américaines*, and many other memoirs of a like nature all testify to his thorough acquaintance with the soft parts of his favourite group. Occasionally we find him writing about bryozoa, hydrozoa, sponges, brachiopods, etc., but his interest in them seems to have been merely a passing one, kindled, perhaps, by the contents of his dredge. Sometimes geology claimed his attention, though this was generally due to some collateral influence. Thus he gives us a *Note sur la géologie du Sud de Madagascar*, in 1868; *Sur l'existence du terrain tertiaire inférieur à Madagascar*, etc. Palæontology does not seem to have had much attraction for him in his minor writings, but his knowledge of the fossil mollusca was comprehensive enough, as we shall presently see.

Altogether he has written more than 300 separate memoirs and papers, and, in addition, 100 memoirs in conjunction with MM. H. Crosse (his co-editor), Delesse, Tournouër, Bernardi, and others, published for the most part in the *Journal de Conchyliologie*.

Among his more important works we may mention the description, in conjunction with M. Crosse, of the mollusca collected by the Scientific Mission to Mexico and Central America; with M. Tournouër, the invertebrate portion of the fossils of Mont Léberon, in Vaucluse; and accounts of the mollusca collected during the voyages of "Le Travailleur" and the "Talisman."

Dr. Paul Fischer, in spite of the numerous writings above-mentioned, is best known as the author of the celebrated *Manuel de Conchyliologie*, published in Paris (1880–87). The appearance of this work at once stamped the author as one of the most eminent malacologists the world has ever seen. It is based on the well-known manual of S. P. Woodward, and in fact the plates illustrating it are identical with those in the English work referred to; but although the plan is the same, it is naturally a much larger work, and must have entailed years of labour. It is here that we first become acquainted with the fact that Dr. Fischer knew the fossil mollusca quite as well as the living forms, and seeing how little he had previously written on the matter, this must have been a surprise to all but his most intimate friends. To say that the work is perfect is to ignore the insuperable difficulties of the subject; but it is now, and will for some years remain, the principal text-book on recent and fossil mollusca.

Dr. Fischer was a man of somewhat reserved habits, but was always willing to render assistance to those who consulted him, and they were not few. He had been ailing for a long time, and passed to his rest on the 29th November last.

G. F. H.

GEORGE GORDON.

BORN JULY 23, 1801. DIED DECEMBER 12, 1893.

WE regret to record the death of this veteran geologist, though of course, at his advanced age, his life could not long have been spared. He was son of the Rev. William Gordon, and was born in the old manse of Urquhart, near Elgin. Entering Marischal College, Aberdeen, in 1815, he graduated M.A. in 1819. After studying Divinity both at Aberdeen and at Edinburgh, he was licensed by the Presbytery of Elgin in 1825, and was presented to the parish of Birnie, by Francis, Earl of Moray, in 1832. For 57 years he was minister of Birnie, retiring in 1889 to Brae Birnie, a house in Elgin. He was made an LL.D. of Marischal College in 1859.

He had early developed a taste for Natural History and Antiquities, and eventually became one of the most enthusiastic of Scottish geologists. In 1839 he published "Collectanea for a Flora of Moray," and later on contributed to the *Zoologist* a series of papers on the Fauna of Moray.

In the great question of the age of the Elgin Sandstones, Dr. Gordon took the deepest interest, and to the last he maintained that they all belonged to the Old Red group, and that the Reptiles, generally considered to be Triassic, had appeared in that earlier period. To his energy we owe the grand collection of remains of these Reptiles, some of which were described by the Right Hon. T. H. Huxley, and others, even more remarkable in character, quite recently by Mr. E. T. Newton. One of the new genera has been named *Gordonia*. Dr. Gordon was mainly instrumental, some sixty years ago, in founding the Elgin Museum and Institution.

Until within a fortnight of his death, Dr. Gordon was in vigorous health for a man of his years. He was over six feet in height, and consequently a man of commanding presence; while his enthusiasm in Science was maintained to the last, and those who had the privilege of accompanying him to the Elgin quarries, when he was over ninety years of age, will never forget his wonderful energy, his geniality, and intellectual vivacity.

THE deaths are also announced of L. CHABRY, the well known investigator of experimental teratology; of HENRY RINK, author of geographical and ethnological works on Greenland; of D. SCOTT MONCRIEFF, an American ethnologist from Harvard University, who was accidentally drowned while travelling in Siberia; and of JUAN VILANOVA Y PIERA, the well-known geologist of Madrid.

NEWS OF UNIVERSITIES, MUSEUMS, AND SOCIETIES.

Dr. A. Baldacci, of Bologna, has returned from a botanical tour in Crete.

Dr. A. Terracciano has resigned his post as Conservator at the Royal Botanic Institute at Rome; Dr. O. Kruen has been appointed to fill the vacancy.

The prize of 1,000 fl. instituted in honour of Dr. T. Mayer has been awarded by the Academy of Sciences in Cracow to Dr. M. Raciborski for his work on the fossil flora of Polland.

The following awards have been made among French botanists: M. Gaston Bonnier to be "Chevalier de la Legion d'honneur," M. Leclere Savlon to be "Officier de l'Instruction publique," and M. L. Planchon to be "Officier d'Academie."

Professor E. D. Cope has been appointed to the Professorship of Comparative Anatomy and Zoology in the University of Pennsylvania, and Dr. A. P. Brown succeeds him in that of Geology and Mineralogy.

Mr. E. A. Minchin, B.A., Radcliffe Fellow of the University of Oxford, has been elected to a Fellowship in Biology at Merton College. Mr. Minchin's original work has hitherto lain chiefly among sponges and echinoderms; he has been engaged of late on an English translation of Professor O. Bütschli's monograph on the foam-structure of protoplasm, which has just been issued by the Clarendon Press. We understand that Mr. Minchin will reside in Oxford, continuing his researches, and giving lectures.

Mr. Arthur Willey, B.Sc., now lecturing in Columbia College, New York, has been elected by the special board for biology and geology of Cambridge University to the Balfour Studentship. The first award of the Walsingham medal, founded by the Lord High Steward for the encouragement of biological research, has been made to Mr. E. W. MacBride, who is well known by his work on Echinoderm embryology. Mr. Willey is being sent to New Ireland to investigate the early development of *Nautilus pompilius*. Could not Mr. MacBride be directed to start for Jamaica or Japan to study the embryonic and larval stages of *Pentacrinus*?

We have received No. 2 of the *Kansas University Quarterly*, which contains two entomological and two palæontological papers, and an account of some experiments on the delicacy of the sense of taste among Indians. The most important of these contributions are Dr. Kellogg's description of the head of a butterfly (*Danais archippus*), and Professor Williston's brief illustrated notes on the skeleton of Pterodactyls and a Mosasaur from the Chalk of Kansas.

THE Duke of Westminster has subscribed the sum of £1,000 to the extension fund of the Grosvenor Museum, Chester. The new portion of the building is already well advanced.

THE Manchester Museum has issued a second edition of its illustrated General Guide. Among the most recent acquisitions is a collection of the Coal-measure fossils from Lancashire, presented by Mr. Robert Cairns. A similar collection was presented some months ago by Sir U. Kay Shuttleworth.

THE Société Industrielle de Mulhouse has just issued a guide to the Mulhouse Museum. Among many other important collections therein contained, we may note the geological specimens of Kœchlin-Schlumberger; the plants and marine fossils of the Culm of Thann, collected by Albert Scheurer; the Debay collection of fossil plants from the Senonian of Aix-la-Chapelle; the quaternary mammals from the Mulhouse district; and the Mühlenbach, Rabenhorst, Schlumberger, and Han herbaria.

WE regret to learn from the recently-issued Annual Report of the Brighton Museum, of the retirement of Mr. Edward Crane from the chairmanship of the Committee. Mr. Crane has served on the Committee for twenty-one years, and was elected chairman eight years ago on the death of Dr. Thomas Davidson. During this long period he has not only rendered inestimable service to the Museum, but has also been one of the foremost promoters of the interests of Science in the town; and his resignation is only due to the feebleness caused by advancing years. There is appended to the Report a scheme for the continuation of the Booth Collection of British Birds. 220 species are already represented, and a special effort is to be made to gradually complete the series.

THE address of the President, Mr. J. F. Whiteaves, to the Royal Society of Canada, section iv., has just been issued separately. It is an account of our present knowledge of the Cretaceous Rocks of Canada.

THE Palæontographical Society announce the preparation of a monograph on the "Anthracosias and Anthracomyas of the Coal-measures," by Dr. Wheelton Hind. As Dr. Hind has already dealt with many of these forms in vol. xlix. of the *Quarterly Journal of the Geological Society*, we have good hopes that this monograph may actually, as the Council promise, "appear at an early date."

THE North Staffordshire Naturalists' Field Club has issued a concise and valuable report on the progress of geological and palæontological research in the district, with a bibliography from 1679 to the present day. It has been prepared by Mr. John Ward, of Longton.

THE Liverpool Geological Association have issued no. 5 of vol. xiii. of their *Journal*. It contains a paper by Mr. J. Herbert Jones on the influence of local geology on the commercial importance of Liverpool, and a short discussion of the metamorphic origin of granite by Mr. R. W. Boothman Roberts.

THE formation of Field Naturalists' Clubs in France seems to be on the increase. We learn from *La Feuille des Jeunes Naturalistes* (December 1, 1893) that a new Natural History Society has recently been founded at Mâcon, while similar societies are in process of formation at Bourg and in Haute-Saône. There is also an Entomological Association at Armentières, and an Union des Naturalistes de la Seine, which latter has its headquarters at Clichy, and for its principal object the study of entomology.

The Edinburgh Geological Society have just completed the sixth volume of their *Transactions*. The fifth and concluding part contains several papers of interest and importance, notably an anniversary address by Mr. H. M. Cadell, dealing with the geological changes wrought by man within the Forth basin, in which changes Mr. Cadell and his forbears seem to have played a prominent part. Mr. Cadell also publishes a map of the site of Edinburgh in ancient times, showing no less than seven lakes. This paper, as well as some Notes on a Shell Mound at Tongue Ferry, Sutherland, by Messrs. Peach and Horne, will interest archæologists as well as geologists. The latter authors also draw attention to some Shelly Boulder Clay in North Ronaldshay, Orkney, which bears on the development of the Scandinavian and Scottish ice-sheets during the climax of glacial cold. The part concludes with the first half of an important paper by Dr. H. J. J. Lavis on the Ejected Blocks of Monte Somma, which deals chiefly with those consisting of more or less altered stratified limestone.

The annual Soirée of the Croydon Microscopical Club was held on the 22nd November, at the Public Hall, Croydon. There was a good attendance, and the exhibits were up to the average of former years. The most noteworthy thing for criticism, however, is the lamentable falling-off in the exhibition of microscopes. Formerly the Croydon soirée was one of the best of the season, and not only did the microscopes fill all the tables in the large hall, but the exhibition of objects was first-rate. For the last few years the microscopes have been dwindling in number, and the exhibition has become poorer and poorer, until we now see one complete table in the hall filled with butterflies, and, with but few exceptions, as poor an exhibition of microscopy as can be imagined. The objects are inferior, the manipulation of light is bad, and all the old prestige of the Croydon as a microscopical club seems tottering to its fall. Cannot a few energetic members pull it together once again, give a few lessons in illumination and general technique to the members, and restore the microscopical and the more scientific element?

CORRESPONDENCE.

Emendations of Nomenclature.

With all due deference to the Editor, I must confess to agreeing with "Macaulay's Schoolboy," that in certain cases the emendation of generic and specific names is not only pardonable but imperative. Such small alterations as the addition of an aspirate or the change of a letter can scarcely affect the intelligibility of a name. Take, for instance, *Oxynoticeras* which should be *Oxynotoceras,—serrodens, serridens,—heterogenum, heterogenes*. These alterations are desirable, though I own that, copying others, I have allowed the incorrect forms to pass. Again, what warrant is there for the declension of *nanus* and *capricornus* as adjectives, giving them the endings *a, um* when they are substantives? Is not *Straparollus* derived from a man's name, and, therefore, to be written *Straparollia*, so as to avoid sending anyone on a wild-goose chase through Latin and Greek dictionaries for its derivation? As to more serious alterations, the proposed changing of barbarous compounds of a man's name with *ichthys* or *ceras* into mere *ia*, I personally agree with, but I consider, if they are to be carried out, that there should be a statute of limitations in those cases—say 20 years; and that older names should be exempt. Although scientific nomenclature is for scientific men, it is certainly desirable that they should do their best to conform to classical usage.

S. S. Buckman.

Elementary Zoology.

Can you or any of your readers recommend me a cheap but correct book dealing with the general anatomy of common marine animals, such as are commonly preserved in the fossil state? I would specially instance the mussel, cockle, oyster, whelk, cuttle-fish, sea-urchin, sea-anemone (as an example of an Actinozoan), crab, lobster, some brachiopod and *Flustra*, or any common Bryozoan. One is constantly being asked about some such book, but the few that I know are either too expensive, too old-fashioned, or too technical for the beginner.

207 Harrow Road, W. F. A. Bather.

TO CORRESPONDENTS.

All communications for the Editor *to be addressed to the* Editorial Offices, 5 John Street, Bedford Row, London, W.C.

All communications for the Publishers *to be addressed to* Macmillan & Co., 29 *Bedford Street, Strand, London, W.C.*

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NATURAL SCIENCE:

A Monthly Review of Scientific Progress.

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NOTES AND COMMENTS.

Education by Experiment.

THE young human animal is born into this world with a great curiosity and a great desire for knowledge. It longs to touch, to taste, to try in every way the properties of things around it. On its lips is from the first the catch-word of our race, the everlasting "Why?" What do we do with this inquisitive creature? We box it up in a room and set it to learn the A B C; we cramp its flexible hands with a pen; we dull its brain with verses and the multiplication table, both learned by rote; we tell it not to be tiresome and sternly repress all child-like efforts to see the wheels go round. Thus the great work of education progresses: mountains and rivers are learned in lists, sums are done by rule, geometry is repeated as an effort of memory. Then the boy, and sometimes the girl, must learn physical science. Soon he will know the laws of heat, the composition of the spectrum, the names and atomic weights of the elements, the succession of geological formations, and the classification of the animal and vegetable kingdoms; but he cannot get a fire to light, is ignorant that a tadpole turns into a frog, and gives himself a stomach-ache with a poisonous fungus. As for poor science, it is called "Stinks," and the teachers of it are naturally despised. The youth is turned out an ignorant prig or a learned trifler, the country goes to the dogs, and even the toys of the next generation are "made in Germany."

Thus we write to-day; but three centuries ago Montaigne said the same thing: "Seeing how we are taught, what wonder is it that neither pupils nor masters become more able, although they make themselves more learned. In truth, the care and expense of our fathers serve but to furnish our heads with knowledge; of judgment and virtue small news is there. . . . The question should be, whose learning is the best, not whose is the greatest." And yet it moves. Our children, if not ourselves, have already the benefit of a far more rational system of education; one that does really lead out and train up the natural faculties of the race and of the individual, instead of coldly crushing them.

Much, however, remains to be done—in the teaching of Natural Science, quite as much as in other subjects. We must not make a bogey of Nature, but a friend, one with whom our children can converse, whom they can question for themselves, and whose tales they may delight to hear. Of course, the old way was easier—for the teacher. The new way takes time, and its results will at first be hard to estimate in either marks or money. At the outset teachers must be taught and examiners instructed; we all want a guide.

With the hour has come the man. Our guide waits for us in the person of Mr. Hugh Gordon, the science demonstrator to the London School Board; while as a guide-book we have his "Elementary Course of Practical Science," of which part i. has just been issued by Messrs. Macmillan at the price of one shilling. This is a book to excite enthusiasm in the heart of every teacher worthy of his post. Slight though it be, it is a step, and a long step too, in the right direction. Mr. Gordon's method is the method of Nature; he would educate the child as Nature has educated the race. Take nothing for granted! Ask "Why?" Try for yourself! Prove each step! Be clean, careful, accurate! Check your results! Such are the precepts that Mr. Gordon shows us most admirably how to put into practice. Exactly how he does this we do not intend to divulge. The book, though it would take many weeks to work through, can be read in less than an hour; and no hour could be better spent by all who, whether as parents or teachers, have the inestimable privilege of bringing young minds into touch with this wide and wonderful world.

MATHEMATICAL BIOLOGY.

A DISTINCTION is often drawn between the exact sciences and the natural history sciences, on the ground that only the former are capable of mathematical expression and demonstration. Attempts have of course been made at different times to subject the growth or the form of animals and plants to mathematical analysis; but, as a rule, the amount of variation that is so characteristic of living beings has baffled the enquirer. Now, however, observers are attacking the elusive quantity itself, and endeavouring to define it in terms of mathematical precision. The last number of the *Proceedings of the Royal Society* contains two remarkable papers bearing on this subject. The one is "On certain Correlated Variations in *Carcinus mænas*" by Professor W. F. R. Weldon; the other, "Contributions to the Mathematical Theory of Evolution" by Professor Karl Pearson.

It is recognised that no two animals are exactly the same, and that their organs vary irregularly. Professor Weldon has, however, shown "(1) that the observed deviations from the average size of every organ measured are grouped symmetrically about the average, and occur with a frequency corresponding closely to that indicated by the probability integral; and (2) that the 'degree of correlation' between a given pair of organs is approximately the same in each of five local races of the species." (*Proc. Roy. Soc.*, vol. xlvii., p. 445; and vol. li., p. 2). He has now measured specimens of the shore crab in two lots, one from Naples and the other from Plymouth, and after an elaborate comparison of the correlated variations between different organs, he shows that, though variation may differ, yet the amount of *correlation* is the same for both groups.

The method followed by Professor Weldon in determining the degree of correlation between two organs was that proposed by Mr. Francis Galton in his paper on Family Likeness in Stature (*Proc. Roy. Soc.*, vol. xl., pp. 42–63), and it appears that the results obtained by that ingenious anthropometer are fully confirmed by the study of so remote a group as the Arthropoda. The suggestion has recently been made that "the method of composite portraiture, as developed by Mr. Francis Galton and others, might be employed with advantage to discover a type or standard from which degrees of variation within the limits of a species might be measured in positive or negative terms" (Bather, "Crinoidea of Gotland," p. 5). This, perhaps, is often impracticable, but the construction of a diagram from the average of numerous measurements would serve a similar purpose. Such a diagram of the carapace of the crabs in question is actually given by Professor Weldon. The diagram is drawn to scale, the right half representing a perfectly average Plymouth crab and the left an average crab from Naples.

Professor Pearson's contribution to the subject is a mathematical analysis of certain curves that may be constructed from a series of measurements of a number of objects of the same type. Such curves, which he terms *frequency curves*, are often abnormal, especially in biological measurements, such as those of Professor Weldon, or the similar ones of Thompson for prawns, and Bateson for earwigs. Although abnormal, however, they are subject to certain laws, and from a consideration of these Professor Pearson believes it possible to detect whether the individuals measured represent a mixture of two heterogeneous groups, or whether they represent one homogeneous species gradually being evolved into two differentiated species. Thus he finds that the Naples crabs are all of one species, but that they are breaking up into two varieties owing to evolution in their foreheads. Mr. Thompson's prawns, on the other hand, either have a small percentage of individuals deformed in the carapace, or else have a small but unstable giant population mixed with the normal population.

These modern mathematical investigations differ widely from the fine-drawn and metaphysical "pro-morphology," as Geddes calls it, of the old German nature-philosophers. As to their value, hear Professor Weldon:—"It cannot be too strongly urged that the problem of animal evolution is essentially a statistical problem: that before we can properly estimate the changes at present going on in a race or species we must know accurately (*a*) the percentage of animals which exhibit a given amount of abnormality with regard to a particular character; (*b*) the degree of abnormality of other organs which accompanies a given abnormality of one; (*c*) the difference between the death rate per cent. in animals of different degrees of abnormality with respect to any organ; (*d*) the abnormality of offspring in terms of the abnormality of parents, and *vice versâ*. These are all questions of arithmetic; and when we know the numerical answers to these questions for a number of species we shall know the direction and the rate of change in these species at the present day—a knowledge which is the only legitimate basis for speculations as to their past history and future fate."

JAMAICA AND SCIENTIFIC FEDERATION.

THE Institute of Jamaica has just issued its Annual Report for 1892-3. Under the late curatorship of Mr. T. D. A. Cockerell, the Museum seems to have advanced both in scientific importance and popular favour, although economic entomology has taken up much time that might otherwise have been devoted to collecting. The list of 32 specialists in various parts of the world to whom specimens were sent for identification occasions the following excellent remarks: "It is by means of this correspondence, and through publications, that the Institute becomes of international importance; and it is submitted that no museum can be efficient as a local exponent of scientific principles unless it is in this sense international. For this reason, although the Museum is supported by the people of Jamaica, it is felt that a naturalist in New Zealand or Japan is as much entitled to information or specimens (provided they are for the purpose of serious study) as a resident of this island. This principle is so well recognised among naturalists that assistance is asked of any specialist, with the full confidence that, if possible, it will be granted. To cite an example. The Institute has been continually indebted to the United States Department of Agriculture for all sorts of help, which has been given as freely as if Jamaica were United States territory."

How strong a contrast are these words to those which, on another page of the report, the Board feel compelled to use concerning the attitude of the people of Jamaica towards an institution that should be far more intimately connected with them! "The interest taken in the Imperial Institute in America is," they say, "of a very discouraging character." This is to be regretted, but also to be excused. What does a Jamaican arriving in London first learn of this magnificent building and its extensive organisation? He sees on a newspaper placard:—

IMPERIAL INSTITUTE.
SMOKING CONCERTS.

Counsel's Opinion.

Horace Woollaston Monckton, F.L.S., F.G.S., of the Inner Temple, Barrister-at-Law, has kindly sent us a reprint of some "Short Papers," samples apparently drawn at hazard from the numerous compartments of a many-sided mind. Among articles so diversely interesting to the man of science as "Fish Culture at Howietown," "Legitimation," "Trial by Wager of Battle," and—but no, we dare not add "The Bagshot Beds of the London Basin"—there is one on a subject we have occasionally dealt with, "Women as Fellows of Scientific Societies." As a presentment of the question in its legal aspect, this paper may save many of our learned paupers the lawyer's fee that they could so ill spare. Mr. Monckton's opinion is that, assuming women were not mentioned in the original charter, and had not for some 60 years been admitted to a given Society, then, if it were wished to admit women, a new charter would be needed to make their election binding in law. The author's words are Delphic in obscurity and Scottish in caution:—"There is a new charter necessary—some may be of opinion that is—but this seems going rather far—suppose every fellow of the society wished to alter the usage, and there is nothing in the charter against the proposed alteration—a renewal of the charter seems somewhat superfluous. It has, we believe, been suggested by high authority, that a meeting of the fellows specially called for the purpose, may decide the question by a majority of those present, and perhaps that is a fairly practical view of the question. In any case we may perhaps say with safety that if a majority of a fairly representative meeting, after full notice, decided to alter the usage and admit women as fellows, the courts would be slow to interfere with such a decision."

The Growth of a Madrepore Coral.

Mr. G. C. Bourne has returned to his early love, and in the *Scientific Transactions of the Royal Dublin Society* (vol. v., pp. 205–238, pls. xxii.–xxv.) gives an exceedingly interesting account of those young stages in the development of the Madrepore coral *Fungia* that succeed the embryo-stage. The extreme difficulty of investigating organisms in which the soft body-tissues are so closely inter-penetrated by hard skeletal tissues, or stereom, is paralleled by the difficulty of describing the results in brief yet intelligible language, and the difficulty is not lessened by the use of the new terms that Mr. Bourne has found it advisable to invent. To only one point can we now direct attention. The large, flat coral, which has been called *Fungia* from its likeness to the inverted head of a common mushroom, resembles, in its earliest fixed stage, the young of the ordinary cup coral, *Caryophyllia*. This cup-like form may remain solitary and gradually develop into the adult individual, or it may produce buds from its wall, which also develop into individuals and thus combine with the original individual to form a colony. In this way there is often produced a kind of stalk which carries many developing individuals. But after a time these latter become separated from the original stalk and set up for themselves, just as though Brussels sprouts were to fall off from the stalk on which they grew and to finish life as independent cabbages. Here is a difficulty: the various cups are joined to the stalk not only by soft living tissue but by solid, calcareous tissue or stereom; how, then, does this stereom become divided? Mr. Bourne finds that the coral is attacked, chiefly in this particular region, by various parasites, notably one of vegetable nature. The borings made by these and the limy matter deposited by them in place of the original stereom, render the junction opportunely brittle. It is, however, hardly likely that parasites should conduct their attacks solely for the convenience of their host, without some predisposing cause. Such a cause Mr. Bourne finds in the degeneration of the soft tissues in this region, and he infers that this degeneration of the soft tissues has some weakening effect on the stereom, whereby it is rendered more liable to the attacks of parasites. Similar changes are seen in shells removed from the influence of living tissue, but it is hard to learn the exact nature of the effect that the proximity of soft parts has on stereom. Mr. Bourne suggests "that the shell or coral is in some way affected by its contact with an osmotic surface, and that after separation a molecular change takes place, involving a re-arrangement of the crystalline structure." In the case of shells, however, it should be remembered that the calcite is deposited in organic membrane, which, it may be assumed, is more readily affected in this manner than would be the case if it were homogeneous as coral stereom is thought to be. It is possible that some such organic substratum may yet be discovered in the coral stereom, and this would render Mr. Bourne's explanation still more credible.

The vegetable parasite that proves so useful to *Fungia* is called by Mr. Bourne, *Achlya penetrans*. *Achlya*, however, is a genus of the Saprolegnaceæ, which are not known to live in the sea, and are in fact always destroyed by salt water. On the other hand, it has been shown that certain green algæ infest corals and marine shells in this manner, and we would suggest that the form described by Mr. Bourne is probably allied to the genus *Gomontia* of Bornet. It seems as though the botanists had kept their researches in this direction a little too much to themselves, and we hope to induce some authority on the subject to retail his knowledge in a future number of NATURAL SCIENCE.

Geology of New Zealand.

The Minister of Mines for New Zealand has recently issued his statement for 1892–3 (Wellington: 1893). The only portion of any scientific interest is an account by Mr. Alexander McKay of "Geological Explorations of the Northern part of Westland" (pp. 132–186). The country of Westland is on the west coast of the province of Canterbury, and includes the western slopes of the Southern Alps, and the lower grounds between the mountains and the sea from the Grey River to the northern boundary of Otago. The rocks exposed in the district, as shown on the geological map that accompanies the paper, are of very varied ages and character; they include Quaternary and Tertiary gravels, clays and sands, a whole series of Cretaceo-Tertiary limestones, sandstones, and marls, some diabasic ash-beds apparently of Triassic age, Carboniferous slates, slightly metamorphosed Devonian rocks, and other metamorphic and igneous rocks of which the age is uncertain.

While considering the disposition and origin of the auriferous gravels for the practical purpose of gold mining, Mr. McKay finds it necessary to investigate the former distribution of land in this portion of the South Island, and he concludes that all its great physical features are of Pliocene or post-Pliocene origin. He believes, indeed, "that a mighty mountain-range rose from the sea, possibly towering to heights far above the limits of eternal snow, since the Miocene period, and that its central and western parts were subsequently depressed, till the ocean removed or now rolls over its highest peaks." And he supposes that these changes took place as follows:—"During Tertiary times, up to the close of the marine deposits of the Miocene period, New Zealand was greatly depressed, and by far the greater part of its present area was below the level of the sea. At the period of greatest depression, Von Haast sketches us the South Island as consisting of a line of rock-islets formed by the outstanding higher peaks of the main range of mountains; but it is not clear that even these stood above the water-level. And if it be contended that a consideration of the fauna and flora of these islands at the present day, in comparison with what characterised former geological periods within the same area, necessitates the uninterrupted existence of land, it does not follow that this land must have been the crest of the Southern Alps. Such land may have lain to the westward of the present coast-line, but more probably it lay to the eastward in the line of the older axis of New Zealand, trending in a N.W. and S.E. direction. The N.E. and S.W. line of elevation is modern compared with this other, and probably was but feebly marked prior to the elevation at the close of the Miocene period."

In a previous report (1890–91, p. 1), Mr. McKay has dealt with the mode of appearance of the main chain and other mountain ranges of the northern and central parts of the South Island. "The manner in which the Younger Miocene and Cretaceo-Tertiary strata are tilted and faulted so as to form nearly vertical strata in contact with the crystalline and older sedimentary rocks between Kanieri Lake and Hokitika River, and the manner in which the same, and even younger beds, are involved along the western base of Mt. Greenland, and at the same time appear on the top of the mountain and far below sea-level, within a horizontal distance of some four to five miles, shows conclusively that very great displacements have taken place." Further, he claims that the various lines of dislocation prove the subsidence of vast masses of land, which formerly extended westward of Hokitika, and constituted the western wing of the great anticlime, if not the central knot of the whole mountain system. And it was this now vanished land that provided the materials of the older auriferous gravels.

Would that theory and practice might always walk so amicably hand in hand! But not every mining geologist is a McKay.

"A Naturalist's Notes off Mull."

In *Good Words* for December last, there is an article with the above title by one who gives the name of "Nether Lochaber." The writer remarks that "As Saint Patrick is fabled to have banished all noxious reptiles from Ireland, so, according to Adamnan, did Saint Columna banish all noxious reptiles from Iona, and so, according to a very old tradition, did Saint Maluac from the island of Lismore. It is a curious enough fact, account for it as we may, that not only is the viper not found in Iona, but even if captured ever so gently and conveyed to the sacred isle hale and hearty, from the opposite shores of Mull, where it is common, it will instantly sicken and die."

He goes on to describe how "a friend of our own, a well-known artist," carefully imported into Iona a couple of vipers. They were captured with an angler's landing-net and conveyed without injury to the island; and as soon as they were released they twisted and wriggled about in a lively-enough fashion. The artist stated that "As I was lighting my pipe, however, and preparing to sit down on a knoll above them, so as the better to watch their movements, what was my surprise to see one of them suddenly stretch himself out as straight and stiff as an ellwand, and with a visible shiver and single gasp give up the ghost! In a few seconds the other adder followed suit—died precisely in the same manner as its companion; . . . . I am now persuaded that a viper will not live in Iona."

It would be interesting to know more of the circumstances under which these observations were made. They appear to have been characterised by scarcely sufficient scientific acumen and caution to warrant so broad a generalisation.

The argument from fossils as to former climatic conditions, has often been recognised as exposed to many chances of error.

Another possible explanation of apparent tropical conditions is suggested by Dr. V. Ball in a paper on the folk-lore of the volcanoes and hot springs of India, published in the *Proceedings of the Royal Irish Academy* (ser. 3, vol. iii., pp. 151–169). No one who has travelled in volcanic districts, where hot springs are still active, can have failed to observe that they have considerable influence on the surrounding vegetation, and even, as has been pointed out by various writers, on the fauna, both aquatic and terrestrial. It is not only the lower animals, but also human beings, who, like the Maoris and the Japanese, flourish in the neighbourhood of hot springs where the purely climatic conditions would otherwise be too severe. Dr. Ball, then, writes as follows:

"Where the fossils of animals or plants are found which seem to indicate tropical or semi-tropical conditions of the climate at the time when they lived, may it not be possible to suggest, especially if there be any facts tending to prove the existence of different climatic conditions elsewhere at the same time, that there may have been widespread fumaroles or hot springs sufficient to have produced local hot-houses in which animals and plants may have flourished, which could not otherwise have existed in the normal conditions of climate belonging properly to the time and place?"

Under certain circumstances the explanation might be plausible; but we doubt whether such circumstances have as yet presented themselves to geologists. It must be remembered that such effects would be extremely local, and that thermal activity would probably leave other traces of its former existence in the shape of chemical deposits.

In the funnel of certain Cephalopods, several authors have noticed a peculiar cushion-like organ, situated a little behind the valve, and this has, for very insufficient reasons, been called "Verrill's organ" by Hoyle and others. Its function and homology have been the subject of some discussion. Ferussac and d'Orbigny confused it with a transverse muscle; H. Müller, in 1852, thought it was a stinging organ; Verrill, in 1882, considered it "the true homologue of the foot of gastropods"; Laurie, in 1888, from rather insufficient material, showed its glandular nature, and believed that it secreted mucus, but his observations were criticised by Brock; Hoyle, in 1889, believed that it served to close the funnel. That it is really a mucous gland is now proved by the careful observations of G. Jatta (*Boll. Soc. Nat. in Napoli*, vol. vii., p. 45, 1893), who has observed it in 32 species belonging to 21 genera, thus bringing the number of genera in which it has been found from 10 to 27. He describes and figures six main modifications of its arrangement, and gives excellent drawings to show its microscopic structure in different stages of its development. He concludes that this funnel organ is a mucous gland homologous with the pedal glands of other mollusca. If this be so, the organ must be somewhat archaic, and one would expect to find it in *Nautilus*, where, to the best of our knowledge, it has never been described.

Among the more important new arrivals at the London Zoological Society's Gardens are two leopards which represent the extremes of colouration to be seen in the Leopard tribe; one of them is the black variety of the common leopard, the other the so-called Snow Leopard or Ounce. The latter animal, presented to the Society, is a valuable acquisition, for the Snow Leopard is a costly animal to buy, and it inhabits a limited tract of country; hence very few specimens have been on view in the Regent's Park.

Signor G. A. de Amicis has just published (*Boll. Soc. Geol. Ital.* 1893), "I foraminiferi del pliocene inferiore di Trinité-Victor (Nizzardo)," an important contribution to our knowledge of the Pliocene Foraminifera of Italy. One hundred and twenty-six forms are recorded, to each of which a very full and interesting synonymy is given, while only two forms are recorded as new, an evidence of the extreme care bestowed upon his work by the author, who has swept away many varietal forms recently described as new by other authors from imperfect acquaintance with the literature.

Students of cell-division will find an interesting article by E. Overton on the reduction in number of the chromosomes in the nucleus of plants, published in the *Vierteljahrschrift der Naturforschenden Gesellschaft in Zürich* (Jahrg. xxxviii., pp. 169–186, 1893).

The *American Journal of Science* for January contains a paper by Mr. S. P. Langley on "The Internal Work of the Wind." The subject is not physiological except so far as connected with what the author calls the science of Aerodromics, which is nothing more terrible than flying. In the same number E. H. Williams, jun., concludes that they have had but one Ice Age in North America, and that one both short and recent. C. D. Walcott has a note on Cambrian Rocks of Pennsylvania, and J. B. Woodworth, while discussing the erosive action of blown sand in New England, finds it necessary to coin the word "glyptolith" for a wind-carved rock surface. Old England sees no necessity for anything less intelligible than good old English.

The *Midland Naturalist* ended its career, as announced, with the December number, and *The Field Club* is now incorporated with *Nature Notes*. We are pleased to learn that *Science Gossip*, which ceased to appear last autumn, is shortly to be revived under the editorship of Mr. John T. Carrington, assisted by Mr. Edward Step.

I.

Neuter Insects and Lamarckism.

MR. HERBERT SPENCER, defending Lamarkian views of heredity against Professor Weismann,[1] has to maintain that the special structures and instincts of neuter insects were first developed in fertile ancestors. He is driven to this assumption, because he holds that complex evolution cannot occur without the aid of the inherited effects of use and disuse; and such use-inheritance is obviously excluded in the case of neuter bees, ants, and termites, which cannot transmit acquired characters to posterity. Of course, many of the instincts and structures of neuter insects—such as those needed for obtaining food, sheltering and feeding the larvæ, and so forth—were already present in the primitive queens or fertile females of unsocial and semi-social stages. But in many other cases—and it is these cases which more particularly demand our attention—it seems hardly conceivable that the instincts and structures could ever have been possessed by fertile ancestors. A few examples will illustrate the improbability of Mr. Spencer's assumption.

1. In some species of ants there is a caste of neuters possessing "an enormously developed abdomen which secretes a sort of honey, supplying the place of that excreted by the aphides, or the domestic cattle, as they may be called, which our European ants guard and imprison."[2] Their abdomen is so distended with this honey that they become almost unable to move. Is it credible that parents were thus unfitted for the work of multiplication by becoming living honey jars, or factories and storehouses for the general use of the community or family? Can we believe that queens or drones first evolved so remarkable an unfitness for their special functions, while still continuing the nuptial flights, and retaining the reproductive fertility which would be necessary for transmitting the effects of use and disuse to posterity?

2. In the warrior caste of neuters among the termites—and in this caste alone—the head and jaws are more than a third of the total length of their possessors, and are "almost as big as the rest of their bodies." These huge, heavy heads are carried with apparent

[1] "A Rejoinder to Professor Weismann." *Contemporary Review*, December, 1893.

[2] *Origin of Species*, p. 231.

difficulty. The fighting instincts are developed to a remarkable degree, while the capacity and inclination for ordinary work have been entirely lost. Is it probable that the parents of the race ever evolved the structures and instincts of the warrior in so pre-eminent a degree—thereby correspondingly unfitting themselves for more indispensable functions? If it be alleged that the soldier type was evolved among the males or drones, we must notice that the evolution of heavy heads and of blindness and winglessness would be inconsistent with fitness for the all-important wedding flight, so essential for the diffusion of the species and its preservation from the evils of continued close interbreeding. Such evolution could apparently only take place in proportion as male functions degenerated and disappeared—that is, only as the evolving warrior became a neuter.

3. Among sundry ants there are *three neuter castes*—such as workers, warriors, and living honey-pots, or workers, warriors, and "overseers"—and these are quite distinct in structure, functions, and instincts. Were *three* varieties of instinct and organisation present in the original male and female? Will it be suggested that there were double forms of males or females, or that the soldiers, workers, and honey-makers of *Myrmecocystus mexicanus* are mere gradations?

4. The instincts and the emotions, if we may so call them, of neuter bees centre round the queen in an astonishing manner. The evolution of these special instincts would easily *commence* in fertile daughters who helped the queen-mother at the cost of delay or neglect of their own maternal functions (a step towards the formation of a neuter caste), but could not have been thus completed in the various details of the final stages. Thus, if we allow that the fertile females or queens once loved their rivals as strongly as they now hate them, we cannot also suppose that they encouraged and compelled these rivals to fight till only one of them survived. Females could not imprison both their queen and themselves, nor release themselves only on special and suitable occasions—as is now done by the neuters. Mr. Spencer seeks to explain the "swarming" of bees as a kind of inherited reminiscence of the nuptial flight. But these neuters or workers are imperfectly developed females. If the massacre of the drones was first carried out by queens, whose murderous hatred is now directed solely against their own sex, are we also to believe that a nuptial pursuit of a *female* originated in fertile females whose frantic jealousy of rivals now leads them to pull down cells to destroy even their own daughters? The queen, part of whose sexual instincts the neuters are supposed to retain, does not pursue another bee—the drones pursue her. Are we to suppose that the imperfect females inherit the instinct of pursuit from the males? If swarming is really due to an inherited but perverted sexual instinct derived from either parent, why do the neuters carefully abstain from following their queen during the actual nuptial flight? Why do they only swarm—or take abortive nuptial flights, as we are to suppose—on quite a

different occasion, when the queen is sent forth from the hive and founds a fresh colony? And what could have thus usefully perverted or modified the sexual instinct to such different aims and ends except Natural Selection? Why need we suppose that this great ruling factor has entirely ceased to improve or evolve instincts and intelligence in neuter insects ever since the period, however remote, when the queens began to lose the all-important instincts and capacities which are now preserved only in the neuters?

5. The sterility of the neuters and its intimate association or correlation with the many important characteristics confined to these sterile insects, obviously cannot have been developed in females while they remained fertile. Such sterility, combined with such perfect development in other directions, must evidently have been evolved by the favoured survival of such queens as produced the most efficient communities. The infertility of neuters shows in the clearest possible manner that important potentialities may arise and become established in parental germ-plasm without ever being developed in the actual transmitters.

Besides the difficulty of accounting for complex upward evolution or enlargement of parts in neuters, Mr. Spencer has also to meet the converse difficulty of accounting for equally complex evolution in the direction of a co-ordinated reduction or diminution of parts and instincts. If, as he would have us believe, the one form of evolution is impossible in neuters, the other should be equally so. Mr. Spencer cannot call in panmixia, since he does not admit the reducing power of this factor, but he alleges defective nutrition as a leading cause of downward or degenerative evolution in various organs and instincts in neuters. But we must not confound a merely proximate means with the great over-ruling factor which has utilised and perfected such means as skilfully as man converted rude flints into efficient tools. How could mere quality or quantity of food have proved so wonderfully adaptive in its effects? How could stinted nutrition fit the neuters so exquisitely for their various tasks in all details, positive and negative alike? Must it not have been Natural Selection, rather than poor food, which maintained the health, strength, and efficiency of the poorly-fed neuters and their specially large brain and superior intelligence, and all such instincts and organs as are requisite for their tasks? Must not Natural Selection have been the controlling or guiding influence which so advantageously determined what useful modifications should flourish in connection with certain modifications of nutrition, and what useless organs or instincts should dwindle and disappear? In one species of ants there are two castes of workers, and, in addition to other remarkable differences, the workers in one of these castes are only a third as long as the other, and the head and jaws are reduced to a still greater extent; which is as if one set of women in a nation were sterilised and reduced to, say, three feet in height by ill-feeding while another class of women were reduced by still poorer feeding to only one foot in height, their heads and jaws being diminished in still greater proportion. Yet these starvelings appear to be just as sound and healthy and as perfectly fitted in all details to their place in the social economy as the queens and males. Can we suppose that insufficient nutrition caused the neuters among termites and in various species of ants to become quite blind as well as wingless, while it had no such effect on the wings and eyesight of neuter bees and wasps? Will degree or quality of nutrition account for variations such as have turned two eyes into a single eye placed in the middle of the head, as happens in one caste, and in the one caste only, of certain ants? Of course, there will be some determining circumstance which decides what sex and caste each egg shall develop; and some of the varying susceptibilities of growing organisms to the influence of food might well be seized upon by Natural Selection, and might be intensified, corrected, and adaptively perfected.[3] But such an attainment of specialised fitness would be complex adaptation of instincts and organs in neuter insects by Natural Selection—a process which is hardly separable from the form of evolution which Mr. Spencer holds to be practically impossible.

If, as Mr. Spencer must assume, the workers, warriors, living honey-pots, and so forth, inherit their positive characteristics from fertile ancestors, in whom they were first developed, why has there been no similar transmission of the long-continued decay and disappearance of such capacities and structures in queens and drones? If the effects of use were transmitted, why are not the effects of disuse transmitted? If, in spite of underfeeding, the neuters, and the neuters alone, continue to inherit the former capacities of the richly-fed queen, why do they not inherit her present incompetence and inferiority? Surely underfeeding does not *strictly preserve* complicated instincts and massive organs which are no longer possessed or exercised by parents. It cannot be so discriminative or adaptive as this. Natural Selection has to be brought in as the only factor capable of thus counteracting the inherited effects of parental disuse. And if Natural Selection can effect complicated and discriminative preservation, why cannot it effect advance? If it can maintain innumerable structures of brain and body at a high level of efficiency in many essential points, in spite of the otherwise disastrous effects of parental disuse, why

[3] Mr. Spencer thinks that the sex of the drones is determined by the defective nourishment of the queen, whereas, in the case of bees, experimental observation shows that all unfertilised eggs yield drones, and that for a long time after fertilisation the queen appears to have the power of determining the sex of the eggs she lays—the female eggs developing, of course, into queens or neuters according to the food and treatment they receive. In the case of termites, Bates concludes that the soldiers and workers are distinct from the egg, and that the differences in these castes do not arise from any difference of food or treatment during their earlier stages. M. Lespès believes that he found imperfect males and females in each of these castes.

may it not in some cases raise the general level of efficiency, and so improve neuter insects independently of use-inheritance?

Those who hold that Natural Selection can preserve highly complicated efficiency by fully counteracting the lowering power of disuse (and underfeeding?) in innumerable co-ordinated points—and yet that it can do no more in the case of higher animals where no such opposition has to be overcome—must face the logical conclusion from their own premises, that the actual power of use-inheritance is precisely nothing—Natural Selection being exactly as powerful either with or without its opposition.

The cherished opinion that complex evolution is impossible without the aid of use-inheritance, is by no means widely accepted. Darwin and Wallace, co-discoverers of the principle of Natural Selection, have deliberately rejected the assumption. It seems, indeed, to be merely one of those artificial difficulties which philosophers in all ages have been wont to construct for themselves—much as Leibnitz convinced himself that the law of gravitation was impossible. The process of complex evolution may be compared to a series of competitive examinations, in which failure in any one of many subjects is fatal to success. Surely the standard of general efficiency must be raised by the rejection of the least efficient candidates. Otherwise, what is the use of competitive examinations? Selection, whether artificial or natural, cannot well be neutral in its effects. Evidently successful or selected candidates will display more than average capacity for carrying out the combined work exacted of them by the examiners. Surely a similar process in nature must similarly raise the level of the *minima* in all essential points or subjects without correspondingly preventing a raising of the *maxima*, which, of course, will often vary upwards, since organic variability is in all directions. Let us take another comparison. The strength of a chain is that of its weakest link. If chains with the weakest links are rejected, the chains that survive the test will manifestly be stronger than those that break. Rigorous elimination of weak links, without any correspondingly rigorous rejection of strong links, must improve the strength or fitness of the links in general, however numerous they may be. Organisms are such chains; and so long as defective links or *minima* are eliminated more often than superfluously strong links or *maxima*, the average of efficiency in all the links may well be a rising one. If defective parts are incessantly eliminated (together, of course, with the organisms which they ruin) Natural Selection may gradually raise the standard of efficiency in *all* the necessary co-operative parts or organs. Such a process cannot fairly be described as an oft-repeated "fortuitous concourse of variations"; for all that is needed is ordinary variations and their extinction, so far as they are hostile to general efficiency and success.

Mr. Spencer at one time represented the chances against complex evolution by Natural Selection as "infinity to one." He has since more moderately put down the chances against a certain combination as "millions to one," and against a still more complex combination as "billions to one." But a million millions are but ten multiplied into itself eleven times. The selection or survival of one out of ten during only a dozen consecutive generations, is equivalent to the selection or survival of one out of a potential billion. The survival of one out of two for forty generations gives a similar result. Allowing for atavism and many other hindrances which will seriously retard the rate of evolution of complex efficiency, what objection can there be to the supposition of slow complex evolution by survival of the fittest during, not a dozen or forty generations, but a thousand or a million?

Mr. Spencer contrasts the facts that varieties of dogs cannot be produced by differences of nutrition, and that differences of nutrition are known to determine the caste in some of the social insects. He holds that this proves that, in the case of social insects, "the production of their various castes does not result from the Natural Selection of varying germ-plasm." But what else could have evolved the highly peculiar potentialities, or sets of potentialities, of a germ-plasm capable of developing not merely into either of two sexes (which is common to dogs and other animals), but into one, or two, or three additional neuter castes besides? The absence or non-evolution of special susceptibilities to the influence of nutrition in dogs is no disproof of their evolution by Natural Selection in bees and ants. On the contrary, it seems to show that a long process of evolution must have been required for their development in social insects. No such additional complexities and susceptibilities of the germ-plasm appear in mammals, where there have been no special means or steps by which Natural Selection would be likely to adequately favour and evolve them. They only appear in certain egg-laying organisms which feed their helpless larvæ to maturity, so that the chances of the evolution of neuter helpers in the exceptionally arduous maternal task are of a highly favourable character. Delay or loss of the reproductive portion of the maternal functions in some of the offspring, if combined with early appearance of the nursing instincts, would be an advantage in rearing a numerous family of younger sisters and brothers, and this would greatly promote the success of the queen and her fertile progeny. A dog could not be thus readily or materially assisted by her pups either in the growth of embryos within her, or in the suckling or feeding of the young after birth. She does not rear completely helpless offspring to complete maturity; her family breaks up at an early period. The evolution of mammals has been on different lines. They feed their offspring for a time, indeed, but by no means to maturity, as is necessary where the entire larval or caterpillar stage has to be provided for until the full-grown imago or perfect insect emerges. As neuter castes are *only* found where Natural Selection has had special opportunities or facilities for such evolution, we may very properly infer that Natural Selection has been the determining cause of such evolution.

Neuter castes are confined to a few closely-related families of the social Hymenoptera, and to the termites, or "white ants," as they are popularly called. Seeing how exceptional the peculiarity of this complication is in nature, and yet how extensively it is diffused among the many species of these social insects, we may reasonably conclude that the peculiarity did not arise independently and separately in thousands of species of ants, bees, and wasps, even if it should have had a distinct origin in the case of the termites. Originating, as we may suppose, in exceedingly remote ages, and forming an advantageous basis or accompaniment of social forms of evolution, the peculiarity or susceptibility has been evolved and utilised to an extent which has allowed special scope for many important differences and complexities which otherwise could not have arisen. In some cases, as with some humble bees, comparatively solitary conditions, and widely-scattered nests or cells, may have aided or allowed survival, by the more effectual preservation of the honey and larvæ from marauding enemies. In such cases, Natural Selection may neglect or repress the social tendency and the intimately-related potentialities and instincts involved in the production of a neuter caste. Wasps, being carnivorous, and, therefore, unable to store and preserve food for the winter, have not evolved so thorough a division of labour and function as the hive-bees; for such solitary fertilised queens as survive the winter have to house and feed their first brood of neuters by their own efforts. Bees, ants, and termites commonly avoid this annual destruction of the community, their food being less perishable, so that stores can be laid up for times of scarcity. We find that intelligence, instinct, and special structures are most highly elaborated in the neuters of those species in which the queens and drones have most thoroughly lost such capacities or structures. The whole circumstances tend to show that Natural Selection has simultaneously effected increasing specialisation in neuters and queens alike in the direction of division of labour and the more perfect adaptation of each caste to its own particular functions in the community. The various neuter castes seem only to have been evolved in directions that have adequately aided the prosperity of the stirp; and the continued evolution or improvement of workers, warriors, and other neuters would promote the success of the stock quite independently of any similar development in queens or drones in whom it would be disadvantageous. There seems to be every reason for believing, with Darwin, that complex evolution *has* taken place in neuter insects, and that the case for the supposed necessity of use-inheritance in such evolution falls to the ground.

WM. PLATT BALL.

II.

Natural Science in Japan.

II.—PRESENT.

THE mere mention of the various institutions, in connection with which it will be convenient to describe the scientific development of modern Japan, is enough to show how enormous the advance of the last quarter of a century has been. They are. The College of Science of the Imperial University at Tokio, the Geological Survey, the Imperial Museum at Ueno Park, the Learned Societies, and various other educational bodies that have for part of their task the dissemination of natural knowledge. In the above order they will now be considered.

The Imperial University, or Teikoku Daigaku, consists at the present day of the six Colleges of Law, Literature, Science, Medicine, Engineering and Agriculture. These Colleges have had very various origins, and their rather complicated history is detailed in the University Calendar (Z. P. Maruya & Co., Tokio). The Science College, with which we are chiefly concerned, sprang, together with the Colleges of Law and Literature, from an institution of some antiquity founded by the late Tokugawa dynasty and revived by the present Imperial Government after the Restoration of 1868. Up to 1885 the College of Science undertook instruction in many practical and technical subjects; but in that year a Department of Technology was created, to which the courses in Engineering, Mining, Applied Chemistry, Naval Architecture and kindred subjects were transferred. Since then the College has devoted its entire attention to the pure sciences, without too curiously considering whether they were "required for the purposes of the State," as demanded by Article I. of the Imperial Ordinance.

In this College of Science there have been established seven courses of instruction, or what we should call Schools, each of which extends over three years. They are in Mathematics, Astronomy, Physics, Chemistry, Zoology, Botany and Geology; but the last three alone concern us now. Neither of these three courses offers any definite instruction in either Physics or Chemistry, such as would be the case at an English University. But since a student who seeks admission to any College has to produce a certificate from one of the Higher Middle Schools, or to pass an equivalent examination, it is probable that this very necessary training has been already supplied. In other respects each course is admirably broad, and affords a good grounding for each subsequent specialisation required of those who pass to a doctor's degree. This will be seen from the following sketch of the work done by a student in Zoology. During his first year he attends lectures on General Zoology, on Botany and on Geology, he does practical work in the Zoological and Botanical Laboratories, studies Physiological Chemistry with Laboratory work and learns how to determine Rocks and Minerals. In his second year he attends lectures on Botany, the Comparative Anatomy of Vertebrate animals, Histology, Embryology, Physiology and Palæontology. He does practical work in Botany, Histology and Embryology, and spends a few weeks at the Marine Laboratory. The third year is mainly devoted to work in the Zoological Laboratory, with two afternoons a week in the Bacteriological Laboratory during the third term. The student may also study Palæontology and certain special subjects. The work for a Botanical student is the same during the first two years; but in the third year the Botanical Laboratory is substituted for the Zoological, and a Botanical Colloquium takes the place of the special subjects of the Zoologist. In the same way the Geological student has lectures and practical work in Zoology and Botany, besides those more directly connected with his special subject.

At the end of these courses an examination is held, the passing of which makes the student a graduate of the University, but does not of itself entitle him at any time to the higher degrees. A graduate who desires to proceed to the degree of Doctor, which in the case of Natural Science is called *Rigaku-hakushi*, must attach himself to what is called the University Hall for a period of five years. During the two years immediately following his admission he must pursue a post-graduate course, which consists for the most part of special work either in the laboratory or the field. In the latter case his travelling expenses are defrayed by the College according to a fixed rate. After these two years he is free to devote himself to some special subject and to prepare the thesis that he is bound to present on applying for his doctorate.

This system of specialised practical and field-work, both in close connection with the University, is an admirable one. By its means, in the first place, a set of men are forwarded to the Geological Survey and similar scientific posts already thoroughly trained for their work; secondly, the collections of the University are increased and what is of more importance thoroughly worked out; while, lastly, any papers that may be published by these students pass directly under the eyes of the professors, and therefore do not manifest that inexperience in the art of description and exposition which too often mars the work of our own younger writers and which I have suffered from too much myself not to sympathise with in others.

The teaching organisation of the College of Science is, like that of all the others, very complete. In the subjects with which we are concerned the professors and lecturers are as follow,—in Zoology, Professors Kakichi Mitsukuri and Isao Ijima; in Botany, Professor Jinzō Matsumura and Assistant-Professor Saburō Ōkubo; in Geology, Professor Bunjirō Kotō and Assistant-Professor Yasushi Kikuchi; in Palæontology, Professor Matajirō Yokoyama; and in Seismology, Lecturer Fusakichi Ōmori. Physiology may appear a curious omission, but this is amply provided for in the College of Medicine.

The chief buildings of the University, including the offices, the Library, the Colleges of Law, Medicine, Engineering, Literature and Science, the First Hospital of the College of Medicine and the Dormitories of the Colleges, are situated in somewhat park-like grounds in the north of Tokio, which formerly belonged to the great Daimyo, or Lord, of Kaga. The buildings connected with the Natural Science Schools contain admirable laboratories, workrooms and museums, through which I was shown, with great kindness, by Professors Mitsukuri and Ijima.

The Museums that now concern us are two: the Zoological, and the Geological.

The Zoological Museum, which is under the direction of Professor Mitsukuri, is contained in one large room on the first floor. It contains not only specimens, dissections and models, intended for the instruction of the students, but also valuable collections of types described by graduates and professors, and a large amount of material from the lands and seas of Japan, that will be placed, as occasion offers, in the hands of those students who wish to take up some original investigation for the purpose of obtaining their doctorate. Hitherto many of the groups constituting the Japanese fauna have been worked out by Europeans; but it is hoped that in future this will be accomplished by the Japanese themselves. Among the noticeable collections in this room is one of the parasitic worms of Japan, which contains the types of Ijima and the specimens of *Tristomum* now being described by Goto. Here is exhibited a specimen of considerable human interest, namely a fine *Bothriocephalus latus*. This tape-worm was well-known to exist in Japan, and indeed caused great trouble in many districts; but its source could not be ascertained. At last Professor Ijima thought he had traced it to a fish called *Masu*; but the only way in which he could prove that the parasite infesting that fish was indeed the larva of *Bothriocephalus*, was by swallowing it. The experiment was successful. Twenty-two days afterwards the full-grown worm was obtained, and it now graces the shelves in the Museum of that University of which its erstwhile host is still a living ornament. Another fine collection is that of the Japanese birds, which is very complete and contains the types of Ijima and Stejneger. The collection of fish is also unusually good, a fact which is easily accounted for by the very various kinds of fish that serve the Japanese as food. A walk through the Tokio fish-market about four o'clock in the morning reveals a wonderland to the eyes of the naturalist. Every possible and impossible variety of fish, flapping and twisting and twining in shallow tubs; sharks and threshers, waiting to be cut up into steaks or pounded into a kind of pemmican; large octopods and cuttlefish angrily writhing in buckets and vainly changing their colours; shell-fish of every shape and hue, but chiefly *Arca* and the beautiful *Haliotis*. Nothing seems to be thrown away, and the consequence is that many rarities are secured for the University, while ordinary dissecting material may be had almost for the asking. Before leaving the Zoological Museum, we must notice some admirable anatomical models by Matsutaro Kikuchi, especially those representing the blood-vascular system of *Bufo japonica* and the blood-vascular and nervous systems of *Palinurus japonicus*. In such work as this the handiness and extreme delicacy of the Japanese are seen to the best advantage.

The Geological Museum is in a large T-shaped room on the ground floor. It has been arranged by the Geologist Koto, the Mineralogist Kikuchi and the Palæontologist Yokoyama. The minerals are arranged in two distinct sets; one to illustrate their physical properties, the other according to their chemical composition. Accompanying them is a catalogue, written in English. As in the British Museum, the general collection of fossils is arranged in zoological order, while the specimens found in the country itself are kept separate. These latter include the types of von Mojsisovics, who has described so many of the Triassic fossils of Japan, and the types of Yokoyama. Owing to the volcanic nature of the Japanese islands, such fossils as do occur are for the most part in a very altered condition, and are neither numerous nor well-preserved enough to be advantageously arranged according to a zoological classification; they are therefore disposed stratigraphically and according to their localities. The Museum also contains a general series of rocks. Besides the specimens of rocks and fossils at present exhibited, there are a large number that have been collected by students and are still kept in boxes downstairs awaiting identification. To judge from the state in which most of the fossils unfortunately occur, this will prove a difficult matter.

Connected with the Science College are the four following institutions, the Astronomical Observatory, the Seismological Observatory, the Botanic Garden and the Marine Biological Station.

The Seismological Observatory is the head-quarters of this branch of science for the whole world, and to this position it has been brought by the labours of Professors J. A. Ewing and John Milne. The instruments designed here and the results obtained by them are so well-known from the publications of those gentlemen and of Seikei Sekiya, the Professor of Seismology, that it is unnecessary to allude to them further in this place. It is enough to mention that the

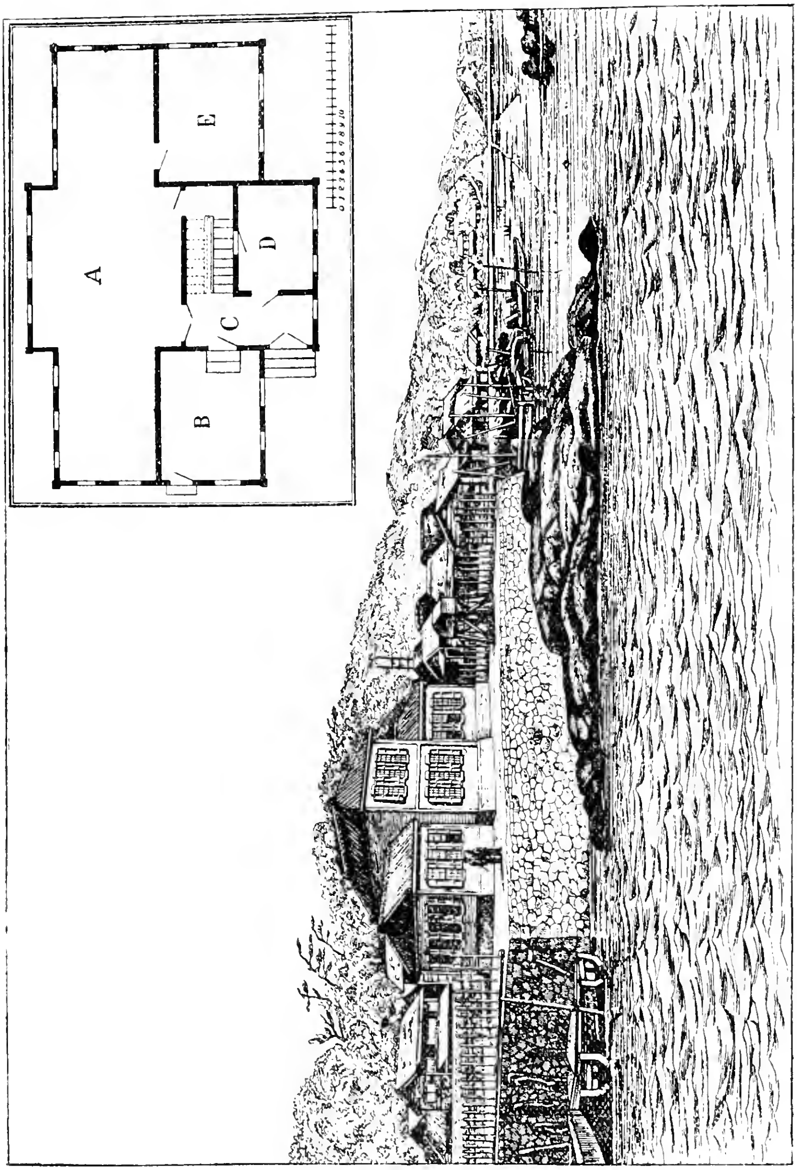


Fig. 1.—The Marine Biological Station at Misaki, in 1887.

investigations have already proved of great practical value, that the Observatory is open for consultation on all matters pertaining to earthquakes, and that the students of geology and other branches of science attend lectures from the professor and his assistant.

The Botanic Garden lies in a pleasant part of Tokio, about a mile from the University. It contains over three thousand species of plants, both native and foreign, which, in the main division of the garden, are distributed according to Bentham and Hooker's classification, as given in their *Genera Plantarum*. There are, however, minor divisions, such as a collection of medicinal plants, those plants that grow in shady places, various rare plants in pots, and a greenhouse with tropical plants. Besides plant-houses in various Japanese styles, there is also a pleasure garden with a building well suited for the social gatherings of scientific and other societies. How much pleasanter it would be for our learned societies to picnic at the Pagoda in Kew Gardens on a summer Sunday, instead of undergoing the boredom of a badly-served dinner in a London restaurant! From the garden, plants are daily sent to the University for the use of students, and on the other hand the students of Botany and Entomology spend a portion of their time in the garden. The Botanic Garden possesses a herbarium of considerable size, though not so complete as that belonging to the Botanic Institute of the Science College, which contains about 4,000 species of Japanese plants. Both the Garden and the Institute are always ready to exchange duplicates with foreign botanists, and the Botanic Garden is also ready to exchange seeds.

The Marine Biological Station is situated at Misaki, a small fishing-village at the end of the promontory that separates the bay of Sagami from that of Tokio. Opposite the village is an island, forming a sheltered strait over two square miles in extent and about eight fathoms in the deepest place. The laboratory, which was opened in 1887, is on the seashore fronting this strait (Fig. 1). The building is of wood, and one story high, except in the middle where it is two stories. The whole sea-front of the ground floor is occupied by the main laboratory (A), which is 48 feet long, 12 feet wide at the two ends and 18 feet in the middle, and is able to accommodate about ten workers. This room is fitted with small aquaria for the use of investigators. At the back of the main laboratory are a store-room (C), a library (E), and a room (B) with a cement floor for sorting out and preserving the specimens as they are brought in from the sea. From a tank outside the building, sea-water is conveyed into this last room and into the main laboratory. The first floor, over the middle of the building, is devoted to sleeping accommodation.

The situation of Misaki, between two bays and sheltered by the island Jōgashima, is extremely favourable to marine life. The strait itself, the neighbouring inlets, and the tide-pools on the ocean side of Jōgashima, furnish all kinds of bottom, while further out at sea there are beds from which the fishermen dredge up the beautiful glass-rope sponge *Hyalonema* and a magnificent Pentacrinid, the *Metacrinus rotundus* of P. H. Carpenter. According to Professor Mitsukuri (*Journ. Coll. Sci.*, vol. i., p. 383, Tokio, 1887) the following are the more important animals found in this locality. "Foraminifera are likely to furnish a great many species. . . . Of the Radiolarians we have seen some—mostly of the Acanthometridæ. Sponges are well represented. . . . Specimens of *Hyalonema* in museums of Europe and America are in reality mostly from Misaki, although they are marked as from Enoshima where they are bought and sold . . . *Tetilla japonica*, Lampe, is found in great abundance in the harbour of Misaki during the summer months. Of the Coelenterata, hydroid colonies are not very numerous, although we found one species of *Aglaophenia* in great abundance in December. Hydromedusæ, Acalephæ, and Sea-anemones are fairly numerous. Corals are found living, as also *Veretillum* and other Pennatulids. Of the Echinoderms, there are several species of sea-urchins, star-fishes, ophiurans and holothurians, some species being found in great number. A *Comatula* is also found. . . . The Mollusca are exceptionally abundant. Tide-pools etc. may be said to be alive with them in the spring, and their egg-masses form conspicuous objects at the same season of the year. Some of the more noticeable molluscs are *Chiton*, *Haliotis*, *Aplysia*, a curious *Tethys* and other beautifully coloured Nudibranchs, *Patella*, etc. Cephalopoda are caught in abundance by fishermen. Crustaceans are very largely, and worms fairly well, represented. *Lingula* is found here as in almost every part of Japan. The inlet of Muroiso is fairly choked with Ascidians, and their bright red egg-masses form striking objects at the breeding season. Surface collection also furnishes many interesting animals. Besides the usual number of the Crustacean larvæ etc. we have caught *Doliolum*, *Salpa*, Pteropoda, Heteropoda (*Atlanta*, *Pterotrachea*), *Actinotrocha*, *Tornaria*, Siphonophora, *Pilidium*, Loven's larva etc. *Physalia* and *Charybdea* are also found. The Kuroshio [" black tide," a warm current] which passes off the coast of Japan has no doubt some influence on the surface fauna of this part."

How such a description must make the mouths of our Plymouth brethren water! And it must also be remembered that these splendid opportunities are not merely open to advanced investigators, but that all students in the biological school of the University are required to pass at least one term at this station. This seems a feature in which we might very well learn something from Japan.

Now that we know something about the organisation of the College of Science, we have to consider what has resulted from all this. In 1893 the number of students said to be working at the natural sciences was about thirty. There were, as is usual in other places, a larger number studying physics and chemistry. How many of these graduated, I was of course unable to learn at the time I was in Tokio. In 1891, however, the graduates numbered one each in Physics, Mathematics, Zoology and Botany; and in 1892 they were one each in Mathematics and Astronomy, two in Physics, and one each in Chemistry, Zoology, Botany and Geology, making eight in all. These numbers are, perhaps, not large; at the same time they do not compare unfavourably with those of our old-established English Universities. Nor should we forget that the more practical Colleges of Medicine, Engineering and Agriculture, offering as they do more lucrative prospects, naturally draw many students away from pure science.

The researches carried out in the University laboratories have of late years been published in *The Journal of the College of Science, Imperial University, Japan*, 4to, Tokio. This was started in 1886, as a continuation of the scientific memoirs which had from time to time been published by the Tokio University, and as the channel through which the world at large might receive Japan's own contributions to the progress of science. The languages permitted in this publication are English, German and French; but so far, out of 71 papers, only 5 have been written in German and none in French. This is a contrast to the publications of the College of Medicine, which are entirely in German. Of this periodical a yearly volume is issued, containing about 368 pages and 30 plates in which the artistic patience and enthusiasm of the Japanese are beautifully displayed. In the earlier numbers of the Journal papers on physical and chemical subjects preponderated; but of late there has been a welcome increase of zoological papers. As writers of such we find the names of Goto, Hatta, Ijima, Inaba, Ishikawa, Kishinouye, Mitsukuri, Oka, Sasaki and Watase. In botany there are Miyoshi, Tanaka and Okubo; geological contributions are furnished by Kikuchi, Koto and Sekiya, while Yokoyama is at present the sole palæontologist. For me to express any opinion on the memoirs contained in these volumes would be presumption; enough to say that, in the words of the University Calendar, "they have been highly spoken of by various scientific journals of Europe and America, and many learned societies and institutions have expressed their desire for exchange," a desire, it may be added, which the Japanese are most willing to gratify. Of work done by Japanese but published in foreign journals, the names of Ito (Tokutaro), Iwakawa, Oka (Arajiro), Namiye, and Tsuboi, in addition to others already alluded to, are sufficient evidence, and it may be mentioned that, as its assistant professor of Zoology, the new University of Chicago has chosen Mr. S. Watase.

We pass now to consider the position of Geology in Japan, as exemplified chiefly by the Imperial Geological Survey.

The first portion of Japan to be examined geologically was the region known as Hokkaido, which includes what we Europeans call

Yezo and the Kuriles. In 1862, the Americans P. Blake and R. Pumpelly, who were engaged by the Tokugawa Government, made some observations in the southern part of Yezo; while from 1873 to 1875 various surveys were made under the superintendence of B. S. Lyman. Work was then suspended for thirteen years, till in 1888 Mr. K. Jimbō was appointed Chief Geologist of the Hokkaido and carried on the survey for the local authorities independently of the Imperial Survey, but in accordance with its methods.

Of Japan proper, the first geological survey was undertaken in 1878, by Mr. T. Wada, under the Geographical Bureau. In May 1879, the Imperial Geological Survey was established in accordance with the plans of Dr. Edmund Naumann, then Professor of Geology in the University, who was appointed its head. After some changes, the Survey finally assumed the title of "Chishitsu-chō-sajo," or Geological Survey Institute, T. Wada was appointed Director and E. Naumann Chief Geologist. In 1885 Dr. T. Harada succeeded Dr. E. Naumann, as inspector of both geological and topographical surveys, while the chemical laboratory was transferred from the direction of Mr. O. Korschelt to that of Mr. J. Takayama. At present the only foreigner on the staff is Dr. Max Fesca, the adviser of the agronomical survey.

The work of the Survey is distributed among four Sections,—Topographical, Geological, Agronomical and Chemical.

The Topographical Section makes and publishes maps upon which the geological features may subsequently be laid down. The original survey is done on the scale of 1 : 50,000, and in the office these sheets are reduced to the various scales required for the published maps. Simple topographical maps are published, both in Japanese and English, on the scales of 1 : 200,000 and 1 : 400,000, and each is constructed after the modified Flamsteed's projection, with the middle meridian 136° E. of Greenwich and the middle parallel 36° N. Of these maps, the large scale have contour-lines at distances of 40 metres, and the small scale at distances of 100 metres. Naturally the work of this Section has to be a stage ahead of that of the Geological. In the summer of last year, out of 97 sheets, the surveys of 53 had been finished, 29 sheets had been issued and 6 were in course of preparation.

The Geological Section makes a systematic geological examination of the whole country, with special regard to economic requirements. The surveyor examines the geological deposits and their structure within the region to which he has been appointed, and collects specimens of rocks, minerals and fossils from that region. He makes sketches of the routes he has traversed on the scale of 1 : 500,000, and puts on them detailed geological information, as well as the position of available economic materials. He also sketches profiles and sections, whether artificial or natural. On the return of the geologist to the office, the specimens that he has collected are determined by the palæontologists and by the Chemical Section, and he himself sets to work to construct a geological map of the surveyed region on the scale of 1 : 100,000, with the help of the maps already prepared by the Topographical Section. He also constructs horizontal sections on either a true or an exaggerated scale. The published geological maps are on two scales, the same as those of the topographical maps. On them the geological formations are shown by different colours, while the positions of marked varieties of special economic substances are represented by conventional signs. Accompanying each map is an explanatory text, which is written in three chapters, the first dealing with the topographical features, the second describing the geological formations, and the last treating of the economic products; and this text is often illustrated by many profiles, sections and maps. There are also published, in conjunction with the other Sections, bulletins, which contain the results of investigations conducted by the Survey. All these are written in Japanese. Up to the beginning of last year 37 sheets out of 97 had been geologically surveyed, and twenty-six sheets had been issued of which all but three were accompanied by explanatory texts; 11 more sheets were in preparation. Of the five maps of the small scale or Reconnaissance survey, three had been published and two were in preparation.

Besides this regular series of maps, detailed surveys have been made of coal fields, oil lands and various mines; of the raw materials of various porcelains; of the sources of water supply for the towns of Tokio, Sakai and Kumamoto; of the geological structure of the Bay of Tokio, with a view to the formation of a harbour; of certain districts shaken or destroyed by landslips or earthquakes; and lastly of the region devastated by the violent eruption of Bandaisan in 1888. The bulletins explanatory of these are, like the preceding ones, in Japanese. Foreigners, therefore, who wish to learn something of Japanese Geology must refer to Dr. E. Naumann's paper "Ueber den Bau und die Entstehung der japanischen Inseln," two papers by Dr. T. Harada, "Versuch einer geotektonischen Gliederung der japanischen Inseln" and "Die japanischen Inseln," and the Explanatory Text and Geological Sketch of Hokkaido by K. Jimbō, which are both in English. Besides these official publications, the student may refer to papers by J. C. H. Godfrey (*Quart. Journ. Geol. Soc.*, xxxiv. p. 542, 1878), C. Gottsche (*Science*, i. p. 166, 1883), R. von Drasche (*Neues Jahrb. für Mineral.* 1879, pt. i., p. 41), D. Brauns (*Memoirs Science Dept., Tokio*, no. 4, 1881), H. van Chappelle (*Tijdschr. Nederl. aardrijkskundig Genootsch.*, iii. p. 436, 1886), H. B. Guppy (*Journ. N. China Branch Roy. Asiatic Soc.* [2] xvii. p. 25, 1882). It is to be hoped that some day the valuable observations buried in the Survey bulletins will be rendered more accessible, and this will be the case if, as the *American Geologist* informs us, they are eventually to be translated into German and English.

When the Geological Section has done its work, it is succeeded by the Agronomical, whose province it is to construct maps showing the various soils, to examine those soils with the view of discovering means by which their fertility may be preserved or improved, and, more especially, to survey those portions of the Empire that are not yet under cultivation, to see how far they are capable of it, and to investigate the quality, abundance and accessibility of the various mineral manures. Although not unknown in other European countries more advanced than ourselves, and although the British government geologists have of late begun to publish maps showing the surface geology, still we have but a small idea of a survey so thoroughly scientific in its working, so eminently practical in its application and so completely fulfilling those promises that were held out to the public when our own Geological Survey and Museum of Practical Geology were first started. For these reasons, an account of the Japanese Agronomical Survey, more detailed than has been given of the other Sections, may be of value as well as interest.

It is recognised that the nature of the solid rocks of any country has directly but a slight effect on its agricultural conditions; and this is especially the case in districts where there is a large amount of alluvium or of drift. On the contrary it is the *soils*, that is the weathered products of the solid rocks, often far removed from the original rock, that have most influence on the fertility of the land. The main object of the agronomical survey in its relation to geology is, therefore, to divide the soils derived from the different kinds of rocks into as many types as possible, and to judge the relative capabilities of those soils for cultivation. Hence the survey is not confined to the cultivated land, but is extended to regions that appear capable of cultivation and also to the forest ground.

First comes the field-work. On the maps already prepared by the Geological Section, on a scale of 1:500,000, the surveyor sketches the distribution of the various soils. He notes the relations of the soils to their mother rocks at different stages of weathering, and collects typical samples of both. The following notes are also made:— the mode of origin and the petrographical character of the soil; the nature of the subsoil, illustrated by sections and borings, to a depth, if possible, of three metres; the height of the land above sea-level; the configuration of the land; the underground water level; local climatic conditions; the registered value of the land; the conditions, methods and results of the farming actually carried on, with particulars as to rotation of crops, manures and similar agricultural details.

The samples of soils collected are next investigated in the laboratory, to find their mechanical composition, chemical constitution, physical properties and absorptive power. To determine its mechanical composition, each sample is quantitatively separated into thirteen parts according to the size of the grains, thus:—

1.	Size of grain larger than 10 mm. in diameter.			Gravels.
2.	,, between 10 & 8	,,		Gravels.
3.	,, ,, 8 & 6	,,		Gravels.
4.	,, ,, 6 & 4	,,		Gravels.
5.	,, ,, 4 & 3	,,		Fine soil.
6.	,, ,, 3 & 2	,,		Fine soil.
7.	,, ,, 2 & 1	,,		Fine soil.
8.	,, ,, 1 & ·5	,,	Fine-earthy part.	Fine soil.
9.	,, ,, ·5 & ·25	,,	Fine-earthy part.	Fine soil.
10.	,, ,, ·25 & ·1	,,	Fine-earthy part.	Fine soil.
11.	,, ,, ·1 & ·05	,,	Fine-earthy part.	Fine soil.
12.	,, ,, ·05 & ·01	,,	Fine-earthy part.	Fine soil.
13.	,, smaller than ·01	,,	Fine-earthy part.	Fine soil.

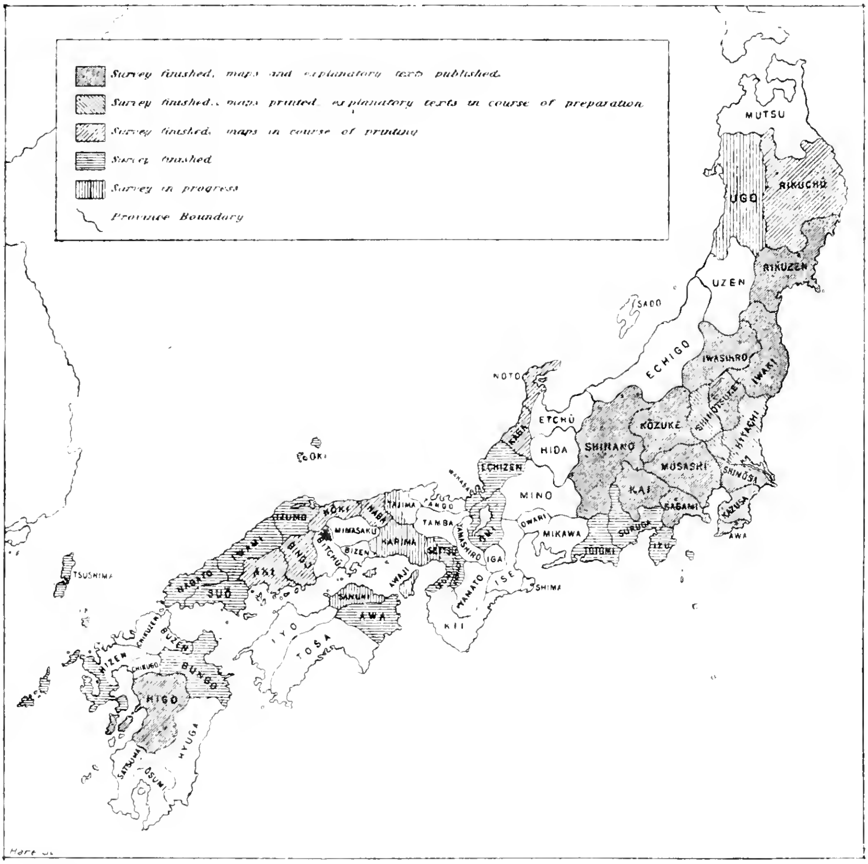
A sample of soil is first passed through a sieve with meshes 4 mm. in diameter, and the fine soil thus separated is mechanically analysed by Schöne's apparatus, by which the soil particles from 11 to 13 are washed out one after another with the respective pressures of ·2 mm., 2 mm. and 7 mm. velocity per second. The soil remaining in the cylinder of the apparatus is then separated by a set of sieves which have meshes with the respective diameters of 3, 2, 1, ·5 and ·25 m m.

For the chemical analysis a sample of soil is treated with concentrated hydrochloric acid, having a specific gravity of 1·2, by which the available constituents of soil can be well detected. The fine-earthy part of the soil is boiled in the acid for an hour and, after passing through the usual operation, an extract is made from which Alumina, the Iron oxides, Manganic oxide, Lime, Potash, Magnesia, Soda, Phosphoric acid, Sulphuric acid and Silica (soluble in hydrochloric acid and sodium carbonate) are successively determined Iron in the ferrous state is estimated by the "copper method" (Fesca, *Journ. für Landwirthschaft*, 1884, pp. 407–421) and, for a soil rich in humus, Carbon and Nitrogen are estimated, and in some cases Chlorine is determined. In order to examine the character of clay and its contents in the soil, the insoluble residue left after treating the soil with hydrochloric acid is fluxed with sulphuric acid, and the quantities of Alumina and Silica contained in it are then estimated.

The systematic examination of the physical properties of soil is fully described in Dr. Fesca's "Abhandlungen und Erlaüterungen zur agronomische Karte Provinz Kai," pp. 3–19. Briefly, the weight and permeability have to be noticed. The volume- or absolute weight and the specific gravity of the soil are estimated ; and as the volume-weight of the soil varies directly as its porosity, the weight of each sample of soil is thus ascertained either in a loose or a compact state. The permeability of the soil to air and water is examined by ascertaining the water capacity and air contents of the soil, and by observing its imbibing and capillary powers during the process of experimenting.

To answer well the practical questions on manuring, the absorption of phosphoric acid and nitrogen in the soil must be examined. This is effected in the ordinary way, by means of the "bottle method,' using as absorbents monocalcium phosphate and sal ammoniac. However the use of the above absorbents has recently been found unsatisfactory, and at present ammonium phosphate is employed, although its exact standard has not yet been absolutely determined.

The maps published by the Agronomical Section are based upon those already prepared by the topographers, on a scale of 1 : 100,000.



Instead, however, of being separated into squares, as are the ordinary geological maps, they follow the lines of provincial and prefectural boundaries. On these maps the geological formations are represented by the usual colours, while the characters of the soils, classified according to physical conditions, are shown by inclined lines of different colours or crowded spots of various sizes in darker colours. Sections of the subsoil are delineated on one side of the map, and the spots where they were observed are denoted on the map by corresponding Roman numerals. In the summer of last year 27 prefectures had been surveyed and the maps of 12 published, as shown in the above figure.

With these maps explanatory texts are published, each divided into three chapters. The first describes the topographical features of the district, with special attention to the situation of the agricultural land and its transport facilities. The second contains a general view of the agricultural land with respect to its geological formations, and a detailed account of the soils investigated in the laboratory and of special mineral fertilisers. The third discusses the soils as factors in agriculture and their relations to plant growth, and compares the fertility of soils arising from the different geological formations.

Besides the regular work of the Section, the relations of the principal agricultural products to some of the more important local conditions have been studied in various parts of the Empire, and the results of this work have been embodied in "Beiträge zur Kenntniss der japanischen Landwirthschaft" and "Ueber die landwirthschaftlichen Verhältnisse Japan's und die Kolonization Hokkaido's etc."

The various analyses required by the Agronomical Section are carried out in its own laboratory. The Chemical Section therefore is chiefly occupied in analysing the minerals and rocks and in assaying the ores collected by the Geological Section. Analyses and tests are also conducted, according to a fixed tariff, for the benefit of the public, and materials of technical importance, such as potter's clay, kaolin, lubricating oil, cement and building stone, are examined. Besides the results published in the ordinary bulletins, this Section has issued special reports on Japanese fireclays, coals, limestones, cements, indigoes, lacquer and lubricating oils.

The staff employed in carrying out the multifarious operations of the Geological Survey is constituted as follows:—exclusive of the director and of the adviser of the Agronomical Section, 4 Topographers, 6 Geologists, 10 Agronomists and 9 Chemists. Besides these there are 10 Cartographers and many subordinate assistants. The time allotted for field work during each year is four months, during which time it is reckoned that a single geologist can survey one sheet, and a single agronomist half the area of a prefecture. Among others of the staff to whom I had the honour of being presented, my thanks are especially due to Mr. Kochibé, the learned chief of the Geological Section, for much courteous help in my enquiries and travels.

Connected with the Geological Survey are two Museums. The one, intended for the private use of the staff and for constant reference, is in a large room at the office of the survey. A more elaborate collection is displayed, for public instruction, at the head office of the Department of Agriculture, and corresponds, at least in intention, to our own Museum of Practical Geology. The geological collections of more purely scientific interest are contained either in the museum of the College of Science, which has already been described, or in the geological department of the institution which we have next to consider.

F. A. Bather.

(*To be continued.*)

III.

The Influence of Volcanic Dykes upon Littoral Life and Scenery.

ALONG the coast of Jersey there stretch for miles great masses of rocky, weed-grown reefs, laid bare with every tide; reefs cut and hewn into every imaginable form; channelled, and divided and sub-divided by numerous broad, artificial-looking roadways, and by interminable, intricate, mazy runnels.

If we examine these, calling to our assistance pick, and shovel, and geological hammer, we find all these paths and bye-paths to be the outward and visible signs of the presence of volcanic dykes that everywhere, in this fire-visited island, intersect and pierce the mother rock. The latter may be diorite, syenite, or schist; all are treated alike, and the resultant features closely approximate. As a rule, the dyke material is diabase, but minette (micaceous porphyry) is not uncommon. This filling, sometimes softer, and always more joint-riven, is much more rapidly disintegrated than the surrounding rock. Exposed to a violent tide—rising sometimes fully 42 feet—and to a sea occasionally very stormy, the disintegrated matter is quickly removed, and a ditch, often extremely well marked, is formed. This may vary in breadth from a few inches up to twenty yards, or even more.

The faunal features of these wave-worn dykes vary considerably, consequent upon whether their direction is at right angles to, or is parallel with, the coast. The former are poor in life, barren, and often sand-choked, but of great value to the agricultural community as cart tracks in the wracking season—that harvest time on the shore, when every farmyard in the island sends out all hands and carts to levy toll from the bleak rock-reefs of their abundant weedy crop. Many of the more marked of the eaten-out dykes serve this purpose, and it is difficult indeed for those who know only shores with a narrow littoral, to appreciate the vast importance of these natural cartways on a coast such as that of Jersey, where a distance of from one-and-a-half to two miles frequently separates high-water mark from the Laminarian zone, whose weedy growth is more greatly prized by farmers than the higher growing and commoner fucus.

Besides thus serving as ready-made roads to the far-distant lower margin of the littoral, these dykes, piercing at their shore-end deep into the land, form natural passes on to the beach. Used from time immemorial, they now form the slip-ways or slips found in every parish in the island, and upon which the various parish assemblies have spent really considerable sums in improvement. I have examined a great number, and fully 75 per cent. of these slips mark the presence of an intrusive dyke running outwards to the sea.

Why these should be barren of life is easy of explanation. Their trend exposes them directly to the full fury of in-shore gales, which alternately with off-shore winds play a continual see-saw of removing and bringing back the surface layers of sand and shingle along the course of the dyke. Stability of environment, so necessary to the slow-spreading forms of littoral life, is wholly wanting.

In other cases, these dykes serve as determinants in the formation of many of the prettiest of the innumerable bays that line the coast. The great majority of such are small; sometimes independent inlets, but more generally secondary indents that go to make up the larger bays. In each the dyke originally formed a point of weakness, whereon the waves constantly pounding, first tore out a narrow pathway the width of the dyke-filling, and then, when the waves worked with greater force confined between the walls of this channel, the breach was gradually widened by the undermining and wrenching out of blocks of the mother rock. Given the initial weakness of the kind provided by such a dyke, it is difficult to set limits to the destroying, bay-making force of the waves acting continuously during a long lapse of time.

That this necessary time-factor has been present in Jersey, I am well convinced from many personal observations. At several points along the shore and high above the present sea-level I have traced unmistakable raised beaches composed principally of beds of loose, well-rounded pebbles (L'Etacq and along the North coast). I can also testify to *high-lying* sands and gravels, in some cases to be seen even resting upon the old beach pebbles. These sands, I feel certain, were deposited during a time of slow subsidence, and represent, I suggest and believe, the ancient soil and sub-soil torn from the land surface as the sea gradually gained upon the land by contemporaneous sinking. Apparently such deposits synchronise with the high-level (so-called glacial) drifts of Britain. Hence the bay-sculpture of Jersey took place *chiefly* during pre-Glacial times when the land was at a much lower level than at present, and was continued through a portion of the Glacial period when the island was slowly sinking still further. When upheaval came—as I believe it did—towards the close of that time, throwing the land much above its present level, and when a land-connection was brought about with France, the waves ceased to play havoc with the coast-line, retiring well to the eastward of the island. The beginning of this continental period was marked by the sojourn of Palæolithic man in Jersey, as evidenced by the flint implements found in a sea-worn cave, of raised beach horizon, high up the lofty cliffs east of Grosnez Point. This continental period coming to an end in early historic time, the carving work of the sea has practically but recently recommenced, and at a much lower level than formerly.

Entirely different is the case of those dykes that lie more or less parallel with the coast. Locally known as "gutters," these form systems of canals which, in connection with the dykes at right angles to the shore line, are the potent factors that determine the breaking up of the rock area into innumerable minor reefs and islets. These gutters, humanly speaking, are veritable death-traps. The unwary, penetrating far sea-wards in search of fish or the harvest of wrack, often have their retreat cut off by the filling of these natural ditches long before they become aware of the fact. So constant, indeed, is this danger, that watch-boats, State-paid, hover, during the wracking season, around and among the more dangerous reefs.

Gutters have two very divergent faunas. Where the channels are wide and sandy-bottomed, communicating freely with open water at either end, banks of green, waving, grass-like Zostera—luxuriant sea-meadows—make good the footing, binding the sandy bottom into stable ridges. Such may be termed "canal gutters," as distinguished from the "drainage gutters" that carry off the water from the higher parts of the reefs as the tide runs down. Of the two, the former are the poorer in faunal diversity—but withal they are wonderfully rich. Upon the leafy blades of the Zostera, zoophytes occur in myriads. *Campanularia angulata* disputes place with the feathery *Plumularia similis* and with the graceful *Clytia johnstoni*. And upon these in turn, at certain seasons, brown hosts of diatoms descend in enveloping swathes. *Haliclystus*, also, often decks the green blades with its lovely brown bells. Soft gelatinous compound Ascidians (*Aplidium gelatinosum*) also clothe the blades; and in the breeding months of spring, molluscan and annelidan spawn—*Trochus*, *Nassa*, *Phyllodoce*, etc.—give diversity. The vivid green of the Zostera has had less colour-influence upon its floating population than one would naturally expect. I know of two animals only that are affected, but both are of striking interest. One is the large emerald-hued *Hippolyte viridis*, most lovely of the Prawns; the other, equally brightly-coloured, is a species of the Labridæ or Wrasses.

Quite a distinct and characteristic fauna gathers at the base of the Zostera stems, and upon their half-decayed remains. Most obvious are colonies of the brilliant orange-red Ascidian, *Botrylloides rubrum*, lying profusely about like tiny coral-beaded truncheons, beneath the concealing tangle of green. Little less conspicuous, and growing together with the *Botrylloides*, are snowy-white delicate masses that bespeak to the practised eye the endlessly branching calcareous sponge, *Ascaltis contorta*.

But, after all, interesting and varied as is the life that swarms upon and among the Zostera, it is as nothing to that finding shelter in the half-loamy, half-sandy soil which the roots of the Zostera, in their increasing growth and decay, largely produce and firmly mat together. Very numerous are the worms. The tube-mouths of the shy *Sabella (Branchiomma) vesiculosa* open everywhere. Siphunculids protrude delicate starry crowns in equally large numbers. Errant worms, too, are plentiful, and great gaping holes here and there bespeak the residence of one or other of the burrowing prawns. Molluscs are everywhere.

Examining the fauna of a drainage gutter, we get a wholly different array of life-forms and a hundredfold greater variety. If the great channels traversing the littoral from high- to low-water marks be valuable economically as highways for the wracking carts; if the canal gutters be useful to the fishers as saving weary hours of pulling against wind and tide, it is the drainage gutters—the least important in geological origin—that have the most zoological value as the breeding and sheltering grounds of innumerable animals. With very many creatures the presence of the last-mentioned natural channels makes all the difference between plenty and scarcity—indeed, I am convinced that many species, quite abundant on these coasts, would be difficult to include in the local fauna were it not for the advantages afforded by these gutters. The dykes thus marked are less eaten out than the others I have noticed. The dyke matter often comes to the surface at their upper ends, from whence a rapid fall of level leads to the outlet on the reef margin.

Obliterate the traces of life around and all would betoken the presence of a mountain torrent. Boulders of every size and shape strew the steep and rugged bed; this huge angular one, with riven side, might but just have fallen with thundering din, detached by frost-wedge from a neighbouring precipice; these of lesser size, with smooth surfaces and rounded edges, bespeak a long period of tumbling and rolling hither and thither. Here, too, as in a mountain stream, are bend-corners where, out of reach of the influence of the swift central current, accumulate great patches of gravel and shingle. In these drainage gutters littoral life flourishes in its greatest luxuriance. They form the true centres of the life of the shore, whence proceed in regular and ordered sequence vast colourising swarms of free-swimming larvæ. Two causes contribute. One is that, as these channels run parallel with the coast, their inhabitants are protected from the direct attack of storms, an important direct consideration to the more delicate organisms, and indirectly to the larger, which, in turn, feed upon the lesser. The second cause, and the greater, is, that these gutters, as soon as the tide recedes below their level, become swift-flowing streams, charged with minute animals and food-particles that have drained from the myriad weedy surfaces and chinks that one by one are exposed. This drainage-water, too, is rich in life-giving oxygen, absorbed from the air by the films of water as they drain from the tide-forsaken rocks.

It is difficult to convey even a faint indication of the wealth of life that settles in these gutters relying upon the current bringing plentiful food-particles within the reach of ciliary lashing. A complete list would be impossible, for it would be the cataloguing of three-fourths of the littoral fauna. Sponges and compound Ascidians are strikingly conspicuous; in species multitudinous, in colouring of every imaginable tint and combination—snowy-white, grey, pale yellow, orange, pink, scarlet, lavender, purple, black with white marblings, black with gold stars. These in a thousand grades of tinting occur in mingled patches, of size and form as erratic as the colouring, and give to the overhanging surfaces of the boulders chequered mantles of richness such as even Orient looms never expressed, though governed by minds most subtly appreciative of Nature's brighter aspects. Less striking are the pendant festoons of Polyzoa, hanging half-concealing before and between the crusting Sponges and Ascidians. Among all, wander, and often, too, demand lodging, great hosts of worms and tiny crustaceans not conspicuous as the others, but ever present, ever greatly numerous. Zoophytes and anemones are comparatively few, though *Coryne* at times may occur somewhat plentifully.

These drainage gutters are thus most conspicuously peopled by Sponges, Ascidians, and Polyzoa—animals in all cases living upon very minute food-particles, captured, or rather directed within the body, by the incessant lashing of cilia. Why they are so wonderfully common is due to the fact that the water that rushes past them as the fucus-covered reefs uncover, is laden richly with tiny animals and *débris* just suitable to the lowly mode of feeding practised by these animals. Once established, these colonies attract swarms of the free-moving worms and crustaceans—tiny freebooters, ever on the watch for loot.

Frequently the gutters drain large pools or chains of pools. These nearly always have similar dyke origin, sometimes marking the widening of the dyke fissure, sometimes denoting the point of intersection with another dyke of different direction. Such pools are commonly rich in life of the same species generally as in the gutters, but in lesser profusion. More Zostera grows in the pools, and zoophytes grow in greater numbers. Fishes, too, are more numerous, for the Pipefishes (*Syngnathus*), Sticklebacks (*Gasterosteus spinachia*), and the smaller genera of the Wrasses (Labridæ), and Prawns innumerable find in the dense plant-growth of these quiet, and often deep pools, just the safe hiding places and food preserves best suited to their needs.

JAMES HORNELL.

IV.

The La Plata Museum.

(*Continued from page* 35.)

THE above are some of the most noteworthy of the fossil mammals in the La Plata Museum from the Pampean beds and the somewhat older deposits of the Parana and Monte Hermoso; and I now pass on to the consideration of a few of the more interesting types from the still older Patagonian beds. Putting aside the Edentates, which I had no time to examine in detail, my observations will be in the main confined to the Ungulates, of which I made a special study. The most abundant, and at the same time one of the most interesting, of these early hoofed mammals is the one to which Owen applied the name of *Nesodon*, this genus being represented in the Museum by a vast series of remains, including many perfect skulls, as well as jaws, teeth, and limb-bones. Allied in many respects to *Toxodon*, these Ungulates differed by the closer approximation of their cheek-teeth to the Perissodactyle type of structure; the name of the genus being derived from a well-marked island-like lobe found on the inner side of the upper molars. There are likewise important differences in the conformation of the cutting-teeth, and also in the structure of the skeleton in general, which in many respects is much less specialised than that of the allied Pampean genus. Moreover, all the three species of *Nesodon* which I can alone recognise, were vastly inferior in size to the gigantic *Toxodon*, the smallest of the three being not much larger than a sheep. Hitherto, not much attention has been paid to the limb-bones of this genus; but I have been fortunate enough to identify not only the "long" bones, but likewise the calcaneum and astragalus, and thus to confirm the presumed close relationship of *Nesodon* to *Toxodon*.[1]

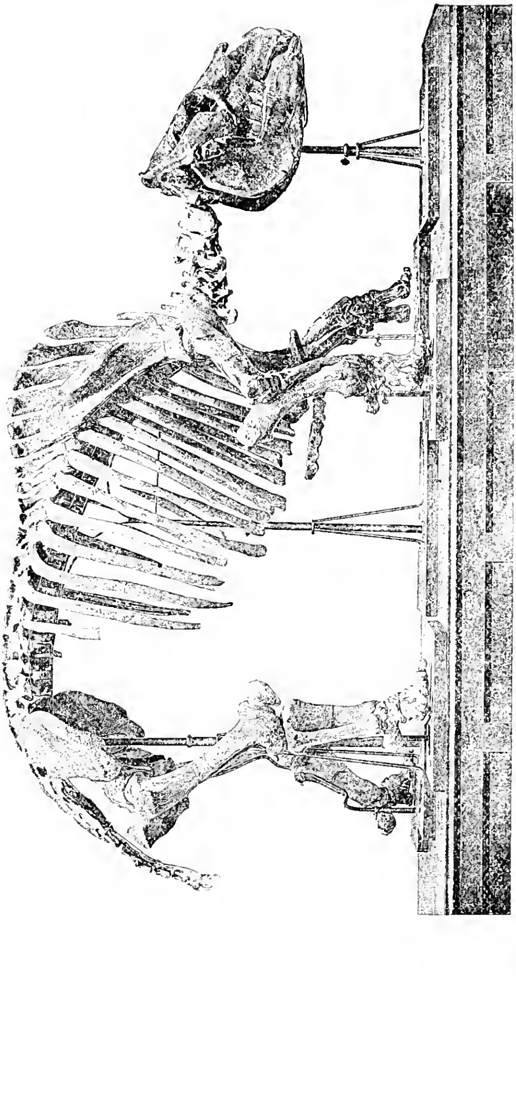
As our palæontological readers are probably aware, Owen described two species of the genus *Nesodon*, together with a third one which has been subsequently ascertained to belong to a totally different type of Ungulate. One of these two species (*N. imbricatus*) was an animal approaching the dimensions of a small rhinoceros, while the second (*N. ovinus*) was, as already said, not very greatly larger than a sheep. Between these two extremes I find an

[1] Some of these bones are described and figured in the forthcoming issue of the *An. Mus. La Plata*, containing an account of the results of my own work.

intermediate form which must apparently be recognised as a third species.

Having two imperfectly-known named species of a genus from a particular formation, one would naturally have thought that the object of the palæontologist would be to endeavour to complete our knowledge of those two species, and to hesitate to name new species (not to mention genera) from remains of the same group of animals from the beds in question, without the clearest possible evidence of their right to distinction. Such a method of procedure seems, however, to be utterly at variance with the views of certain South American so-called palæontologists, to whom the task of describing the fossil mammals in the La Plata Museum has been unfortunately from time to time confided. Instead of endeavouring to find out whether the specimens before them might not belong to one or the other of the two named species of *Nesodon*, they appear to have started on the assumption that almost every single bone or tooth that came under their notice must pertain to a totally new animal. In consequence, we have remains which clearly belong either to one or other of the two Owenian species, or to the above-mentioned intermediate form, assigned to something like a dozen genera (such as *Acrotherium*, *Adinotherium*, *Atrypotherium*, *Colpodon*, *Nesotherium*, *Gronotherium*, *Phobereotherium*, *Protoxodon*, and *Scopotherium*); while the number of nominal species must, I should think, be fully half-a-hundred. As a result of this extraordinary method of procedure, an enormous proportion of the specimens in the La Plata Museum are "types," whereby that institution is prevented from doing as much in the way of exchange as would otherwise be practicable. This remarkable ignorance of the first principles of odontological anatomy, and of the different forms assumed by teeth according to the ages of their owners, displayed by the palæontologists in question, surpasses belief, and there are certain specimens in the Museum bearing different generic names which even any ordinary student would say were identical. Indeed, on the principle (or, rather, want of principle) which appears to have guided the Argentine palæontologists, about a dozen species and some half-a-dozen genera might easily be made out of remains of the common horse. It is true that *Nesodon* displays an extraordinary degree of variation in the relative proportions of the large incisors in both jaws, but the gradual evolution of the adult from the young stage is indicated over and over again in the collection of the Museum; and with regard to the species founded on the evidence of the cheek-teeth, there is not the least excuse. This, however, is not all, for some of the so-called genera have actually been assigned to families apart from *Nesodon*; while the latter itself is separated, as a family, from the Toxodontidæ without the faintest shadow of justification.

I must, however, do one of the above-mentioned workers the justice of saying that he has at last partially seen the errors of his



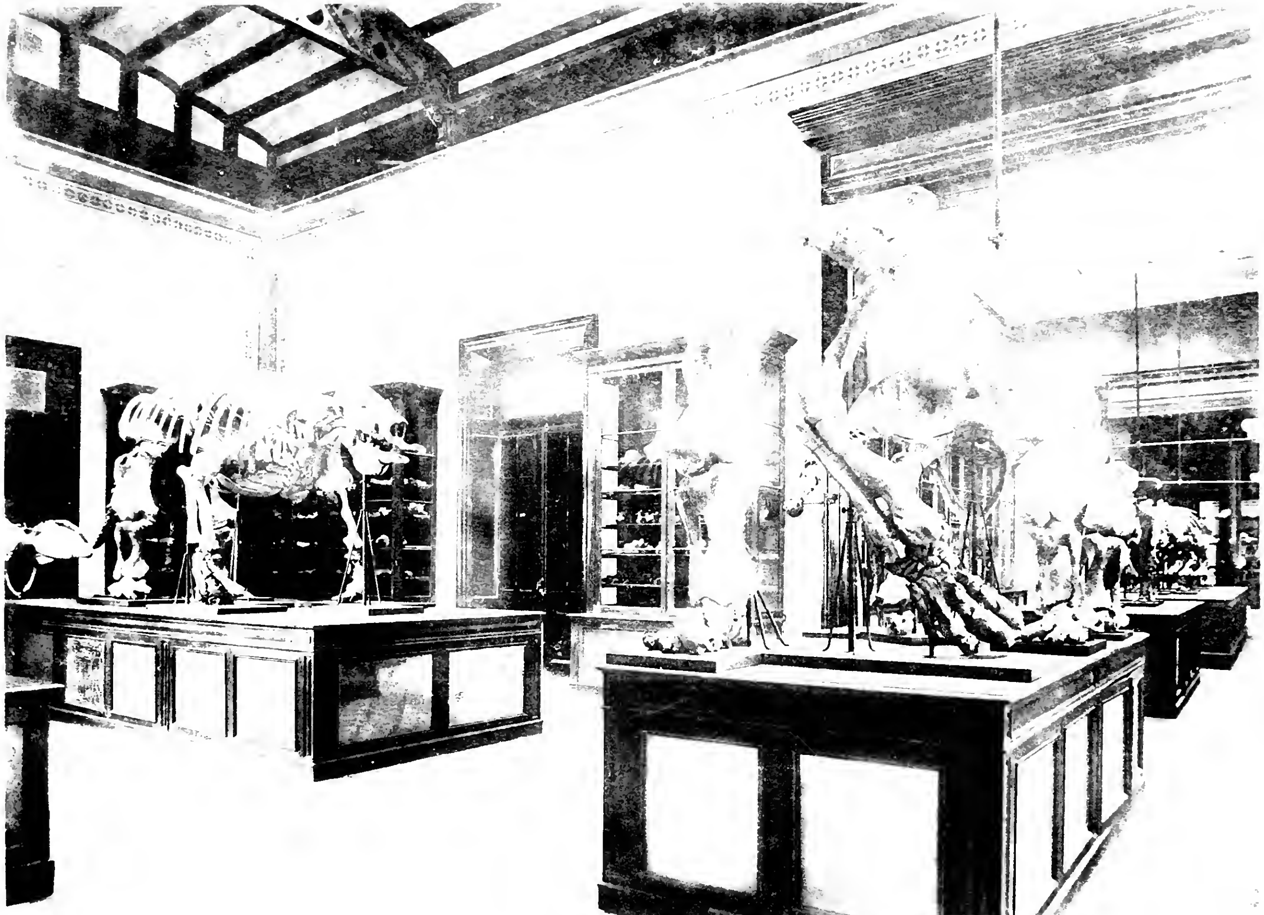
SKELETON OF *Toxodon*,

AS MOUNTED IN THE LA PLATA MUSEUM.

ways, and has tardily abolished some of the superfluous genera made by himself and his colleagues. His repentance comes, however, too late—after all the mischief has been done; and even then it is but half-hearted. He maintains, for instance, the genus *Acrotherium*, which is merely founded on specimens belonging to some of the three species of *Nesodon*, with a superfluous premolar tooth, probably caused by the first premolar having come up in front of the corresponding milk-molar, instead of replacing it; while the list of nominal species remains as long as ever. South American palæontological work has, indeed, already become a bye-word in England, but it is really far worse than I had any idea of previous to my visit to La Plata; and it may be worth the consideration of the Council of the *Zoological Record* whether it will not for the future be advisable to omit all mention of the majority or the whole of the names proposed by the Argentine palæontologists to whom I refer, as being mere useless encumbrances, instead of aids, to science.

Passing from this unpleasant portion of my subject to more agreeable matters, I may now call attention to two very remarkable members of the Toxodont Suborder, both being animals not larger than a rabbit, and exhibiting most marked rodent resemblances. The one of these is *Hegetotherium* from the Santa Cruz beds of Patagonia, and the other *Pachyrucus* from the deposits of Monte Hermoso. The latter of the two is distinguished from its ally by the tympanic bullæ being situated on the superior aspect of the skull and is so Rodent-like in general form and structure that it is almost difficult to believe that it is not an ally of the hares. It is, however, as shown by its teeth, clearly a member of the Toxodont Ungulata, and since it is perfectly evident that such an animal cannot have been the ancestor of the Rodentia, it follows that the Rodent resemblances presented by the more specialised Toxodonts must be due to parallelism.

By many writers the Toxodonts have been placed, with the Proboscidea and certain extinct suborders, in the Subungulata; they have, however, the alternating carpus of the Perissodactyla and Artiodactyla, coupled with the linear tarsus of the Proboscidea, while the astragalus is but slightly grooved, and the calcaneum carries a large facet for the fibula, as in the suborder last mentioned. These features clearly indicate that the Toxodonts (which are further characterised by some or all of their teeth growing for the greater portion or the whole of life) must form a subordinal group of equal rank with the Artiodactyla, Perissodactyla, and Proboscidea. Another subordinal group of extinct South American Ungulates, for which I have suggested the name Astrapotheria, is formed by the genera *Homalodontotherium* and *Astrapotherium*. Differing from the Toxodonts in having their teeth rooted at an early age, these Ungulates are further distinguished by having a perfectly flat astragalus with a head at the lower end for the navicular, while it is probable that both the carpus and tarsus were of the linear type. The cheek-



LA PLATA MUSEUM.

teeth are, moreover, exceedingly like those of the Perissodactyla, and more especially the Rhinocerotidæ, to which the members of this group approximated in point of size. Although there seems to be but one species of the first-mentioned genus and only two or three of the latter, the list of synonyms in the case of *Astrapotherium* is of the usual appalling length. As its name implies, the genus *Homalodontotherium* is characterised by the teeth being forty-four in number and forming an uninterrupted series, with the canines not longer than the incisors. Until recently this genus was known only by the teeth and jaws, but the La Plata Museum contains numerous specimens of the vertebræ and limb-bones. Among these, the humerus is remarkable for the great development of its deltoid crest, which recalls that of the wombat.

A very different animal is the gigantic *Astrapotherium*, the type species of which was originally described by Owen as *Nesodon magnum*. In this creature the dentition is reduced, and each jaw furnished with a huge pair of tusks, while the upper molars are extraordinarily like those of the rhinoceroses. There are no teeth between the huge upper tusks, which I have reason to believe are incisors; but in the lower jaw there are three pairs of small incisors, with curious spatulate crowns, situated between the pig-like tusks, which are here clearly canines. *Astrapotherium* has been placed among the so-called Dinocerata, but it is certain that such resemblances as it presents to that group must be attributed to parallelism, while its relationship to *Homalodontotherium* (as proved by the limb-bones in the Museum) is perfectly clear. It cannot, moreover, have any direct relationship with the Rhinocerotidæ, so that the resemblance of its molar teeth to those of that group is again apparently due to parallelism.

A third subordinal group of extinct Ungulates peculiar to South America is represented by *Macrauchenia* in the Pampean deposits, and by *Proterotherium* and certain allied forms in the Patagonian Tertiaries. These animals have been placed by some writers with the Perissodactyla, but it is certain that Professor Cope is perfectly correct in regarding them as representing a distinct suborder—the Litopterna. Agreeing with the Perissodactyles in having an odd number of toes, with the middle one symmetrical in itself, and likewise in the pulley-like upper surface of the astragalus, these Ungulates differ from that group in having both the carpus and the tarsus of the linear type,[2] and likewise by the fibula articulating to a small facet on the calcaneum (as in the Artiodactyla). Moreover, in those cases where they are known, the vertebræ of the neck are much elongated, and have the sides of the neural arch pierced by the canal for the vertebral artery in a manner now

[2] It may be well to mention that in the linear type of carpus and tarsus the bones of the two horizontal rows are set directly one over the other (as in the Proboscidea), whereas in the alternating type the bones of the upper row are placed over the divisions between those of the lower.

solely characteristic of the Camel family. Like the other suborders of extinct Ungulates peculiar to South America, the Litopterna further differ from both the Artiodactyla and Perissodactyla in having the bodies of the cervical vertebræ articulating together by flat terminal surfaces, instead of by a ball-and-socket joint. They likewise present the same strongly-marked similarity to the Perissodactyla in the structure of their cheek-teeth—a feature doubtless inherited from a common ancestor among the Condylarthrous Ungulates of the Eocene, but more or less specially developed subsequently by parallelism. The Litopterna are divisible into the two families of the Macraucheniidæ and Proterotheriidæ, the former being distinguished by the full and uninterrupted dentition; while in the latter the teeth are reduced in number and interrupted. An ancestral form of *Macrauchenia* is represented by the species of *Oxyodontotherium (Theosodon)* of the Patagonian Tertiaries, which were much smaller creatures than the Pampean animals, while an intermediate type existed in the Parana beds.[3] In this family, as well as in the next, I have again to deplore a superabundance of names, both specific and generic, as I have pointed out in the memoir referred to.

Among all these curious types of Ungulates, none are more remarkable than the Proterotheriidæ, as represented by the genera *Proterotherium* and *Diadiaphorus* of the Patagonian Tertiaries and the Parana beds. These were animals varying in size from a peccari to a tapir, with molar teeth more or less closely resembling those of the European Oligocene genus *Palæotherium*, but having only a single pair of tusk-like incisors in the upper jaw, and two pairs of lower incisors, one of which was much larger than the other. From the researches of Señor Ameghino, it is already known that in one member of this family (*Epitherium*), occurring in beds above the horizon of the Patagonian deposits, the feet were of the general type of those of *Hipparion*—that is to say, the middle toe was greatly developed at the expense of the two lateral ones, which were small and functionless. I find, however, from the evidence of the specimens in the La Plata Museum, that some at least of the Patagonian representatives of the family were likewise provided with feet of the same highly-specialised type, while I have no evidence that any of them had functional lateral digits.

This extreme specialisation of the feet of these otherwise generalised Ungulates is a feature interesting enough in itself, but it is of still more importance in regard to the relative age of the strata in which their remains occur. The Patagonian Tertiaries of Santa Cruz, from which the remains of Proterotheriidæ are obtained, appear to be nearly, if not quite, the oldest South American deposits yielding remains of land mammals. They are correlated by Señor Ameghino (who, by the way, suggests that *Proterotherium* and *Diadiaphorus* were

[3] For this form Señor Ameghino has proposed the barbarous name *Scalabrinitherium*, a term which may be changed to *Scalabrinia*.

animals provided with three functional toes to each foot) with the lower Eocene of Europe, while the Parana, Monte Hermoso, and other intermediate beds are assigned to the Oligocene and Miocene, and the Pampean deposits identified with the Pliocene. Now the fact that in the reputed lower Eocene beds we meet with animals having a foot as specialised as is that of *Proterotherium*, serves, to my mind, at least, to show the utter untenability of the hypothesis in question. We know that in the lower Eocene of both Europe and North America the Ungulates were all five-toed animals with brachydont, and generally tritubercular teeth; and if the South American Ungulates with feet of the *Proterotherium* type, hypsodont molars like those of *Nesodon*, or tusks of the length of those of *Astrapotherium*, were also of lower Eocene age, it would involve the existence of a mammalian fauna like that of the Puerco Eocene and London Clay in some part of the world during the Cretaceous epoch, from which the Patagonian Ungulates had originated. Of the existence of such a fauna there is, I need scarcely say, not only a total lack of positive proof, but likewise very strong evidence to the contrary. Then, again, the existence of a member of the existing genus *Dasypus (Zaëdius)* in the Santa Cruz beds renders it impossible to regard them as of lower Eocene age.

Moreover, in my forthcoming memoir on the fossil Cetaceans in the La Plata Museum, I have called attention to the circumstance that in one part of Patagonia there occurs a bed yielding Cetacean remains which appears to underlie the Santa Cruz deposits. Now this Cetacean bed most certainly is not of lower Eocene age, and is, indeed, probably Miocene, an identification which, if established, will at once overthrow the Eocene, or, indeed, Oligocene hypothesis of the Patagonian beds. Apart from this evidence, I am, however, quite convinced that the Patagonian Ungulates, owing to the specialisation of the feet in some cases and of the teeth in others, are not lower Eocene, or even Eocene at all, but are far more probably of Miocene age. The correlation of some of the beds lying between the Santa Cruz and Pampean deposits with the European Oligocene and Miocene likewise will not bear critical observation, and can, indeed, only be maintained by the creation of species or genera which have no existence save in the minds of their founders. For instance, I find it impossible to distinguish specifically the remains of *Typotherium* found in the reputed Miocene strata of Monte Hermoso from those of the typical Pampean form, while, as I have already shown, the so-called *Hipphaplus* of the supposed Oligocene Parana deposits is nothing more than a species of the Pampean genus *Hippidium*; and if we are to have Oligocene strata with a genus so close to *Equus* as to be doubtfully distinct therefrom, what possible grounds can there be for correlating them with the horizon so-named in Europe? I can believe, indeed, in the late survival of a generalised genus, but I utterly refuse to credit the occurrence of a specialised one on a horizon far below its proper one. The proposal to regard the Pampean beds (which are some of the most recent-looking deposits I have seen in any part of the world, and contain evidence of the existence of man contemporaneously with the extinct mammals) as of Pliocene rather than Pleistocene age, is on a par with the above wild conjectures—for I can scarcely call them theories. In my own opinion, indeed, the whole of the series of fossiliferous strata from the Cetacean beds and the Santa Cruz deposits of Patagonia to the topmost Pampeans, may in all probability be included within the period occupied by the Miocene (perhaps inclusive of the upper Oligocene), Pliocene, and Pleistocene beds of Europe.

Another Patagonian mammal of great interest is one for which Señor Ameghino has proposed the name of *Pyrotherium*, and which he places among the Eocene Coryphodonts, although I fail to see the reason for the association. The type specimens include a premolar and molar tooth, as well as a tusk, but I have reason to believe that the latter pertained to *Astrapotherium*. The molars of this gigantic animal resemble those of the Australian extinct *Diprotodon*, and the last two molars of the Proboscidean genus *Dinotherium*; and it hence seems that these teeth are insufficient to determine the affinities of this strange creature. The type specimens were obtained from Neuquen in Patagonia, but others in the Museum come from Chubut, in the same country. The latter were found in association with remains of *Astrapotherium*, *Homalodontotherium*, and *Nesodon*, thus showing that the horizon of these beds is identical with, or very near to, that of the Santa Cruz deposits. In a paper published some time ago in *La Revue Scientifique* by Dr. Trouessart, from notes supplied by Señor Ameghino, it is stated that *Pyrotherium* occurs in beds yielding Dinosaurian remains; but this must, I think, be now regarded as incorrect. Possibly a fragment of a very large tusk from Chubut of a Proboscidean type may belong to *Pyrotherium*, in which case the genus would probably have to be regarded as allied to *Dinotherium*. The section of this tusk is egg-shaped, with a maximum diameter of about four inches. As in *Dinotherium*, the dentine does not show decussating striæ.

Omitting any reference to the large collection of Edentates, Rodents, and Marsupials from the Santa Cruz beds of Patagonia contained in the Museum, we may pass on to the Cetacean remains mentioned above, all of which are contained in the same gallery as the land-mammals from Patagonia. Several of these Cetaceans are of especial interest, on account of their exhibiting generalised features unknown in any of their living relatives, and thus afford very important evidence in regard to the phylogeny of the two existing subordinal groups of this order. Although of less wide interest than most of the others, one of the finest specimens in this series is the nearly entire skull of a small baleen-whale, which, from the evidence of the tympanic bone, I have assigned to the European Tertiary genus *Cetotherium*. Like the other remains, this skull was obtained from a sandy deposit a short distance from the shore at Chubut. Most of the other remains are those of toothed-whales, among which a fine, though somewhat imperfect, skull of a small form allied to the sperm-whale claims special attention. As our readers are doubtless aware, the whole of the existing members of the sperm-whale family are characterised by the absence of functional teeth in the upper jaw, those in the lower jaw varying in number from more than twenty on each side to a single pair. The Patagonian skull shows, however, a full series of large conical teeth in both the upper and lower jaws, these teeth being not unlike those of the sperm-whale, although furnished with thin caps of enamel on their crowns. The skull has the same general form as that of the cachalot, displaying a large and deep frontal cavity for spermaceti. From the structure of the teeth I have identified this skull with the European Tertiary genus *Physodon*, which has hitherto been but very imperfectly known; and since its inclusion in the Physeteridæ would render that group very difficult to define, I have suggested that it should constitute a family by itself. Another member of the same family is represented in the Museum by a smaller cranium, to which I have assigned the name of *Hypocetus*. A totally different type of Cetacean is presented by a small skull with teeth of the type of those of the European Tertiary genus *Squalodon*, but differing from the latter in number. This difference alone I should not have regarded as of generic value, but an examination of the nasal region showed the presence of prominent nasal bones projecting over the nasal cavity in a manner quite unknown in any living member of the suborder, and I accordingly consider this form as the representative of a new genus, with the name of *Prosqualodon*. Precisely the same feature, although in a more exaggerated degree, is displayed in the nasal region of an exceedingly elongated and dolphin-like skull, with simple teeth, which I have described under the name of *Argyrocetus*. From its general characters, I refer this skull to the Platanistidæ, but it differs from that of the three existing genera of that family by the symmetry of the narial region, and the projecting, wedge-shaped, and roof-like nasal-bones. Although the discovery, sooner or later, of toothed-whales with projecting nasals and symmetrical skulls was a thing to be expected, yet the absence of any evidence of the existence of such forms hitherto has been regarded as a bar to the derivation of the baleen-whales from the toothed-whales. This obstacle has now been removed by the discovery of these two extinct genera in the Patagonian Tertiaries, and it is possible that future investigations will show that certain other features, which have been regarded as indicating a dual origin for the two groups in question, admit of another explanation. The inclusion of these two forms in the Odontoceti (and they certainly cannot be regarded as representing a distinct group) must, to some extent, modify the ordinarily-accepted definition of that suborder. The last of the Patagonian Cetaceans is represented by two skulls, which indicate a rather large member of the Delphinidæ, with a somewhat elongated snout. This form, which I have proposed to designate by the name of *Argyrodelphis*, differs, however, from all existing dolphins in that the hinder teeth are furnished with minute fore-and-aft cusps, thus showing another ancestral feature among the Patagonian Cetaceans.

Concerning the collection of remains of giant birds from the Santa Cruz deposits in the La Plata Museum, so much has of late years been written, and the plates accompanying the memoir of of Señores Moreno and Mercerat are so excellent, that it will be unnecessary to say much in this place. It is, however, certain that the number of generic names which have been published is much too large, and that the name *Phorosrhachus*, originally proposed by Señor Ameghino, has the right of priority. Apart from their gigantic size, these birds claim especial attention on account of the extraordinary size and massiveness of their skulls, as attested by the form of the mandibular symphysis, of which there are several examples in the Museum. Although, in the memoir referred to above, these birds were arranged under several family and generic heads, I am in accord with Señor Ameghino in regarding the whole of them as pertaining to a single family, the larger members of which may be subdivided into two genera, *Phororhacus* and *Brontornis*. In the former the symphysis of the lower jaw was long and narrow, its length when entire being probably about $7\frac{1}{2}$ inches, and its maximum width $2\frac{1}{2}$ inches. In the more massively built *Brontornis*, on the other hand, the sympyhsis was very broad and short, while the margin of the jaw was remarkable for its extreme curvature, the tip being sharply inclined upwards. The approximate length of the whole symphysis is $5\frac{1}{2}$ inches, and the width about four inches. This type of jaw seems quite unlike that of any living group of birds.

Of the cranium, the Museum possesses two fragments, neither of which are figured in the memoir of Señores Moreno and Mercerat. One of these comprises the occipital and parietal regions, imperfect on the left side, where it shows a cast of a portion of the brain ; while the other is a part of the left side of the cranial box, with the quadrate in position. From the latter I was fortunately enabled to detach the greater part of the quadrate, and was thus able to learn that this bone was articulated to the cranium by two distinct heads, and that it was apparently not overlapped by a descending process of the squamosal. Both these being essentially Carinate characters, it seems evident that the Stereornithes cannot be included in the Ratitæ; and that they must consequently either be placed among the Carinatæ or form a group by themselves.

This group, in which *Gastornis* may have to be included, will perhaps turn out to form the connecting link between Carinates and Ratites.

Their vertebræ were highly pneumatic; but the hollow leg-bones appear to have been devoid of pneumatic foramina, and during life were probably filled with marrow, like those of existing Ratitæ. In *Brontornis* the tibia has a length of 30 inches, while the metatarsus measures 15¾ inches in length, with a width of 5½ inches at the upper end, and 3 inches in the middle of the shaft. Although displaying a similar depression at the upper part of the front of the shaft, the metatarsus of *Phororhacus* is a much more slender bone, the length in one species being 15¾ inches, with a maximum width at the upper end of 3¼ inches, and of 1½ inches at the middle of the shaft.

The much smaller imperfect metatarsus figured under the name of *Palæociconia* is regarded by Señor Ameghino as inseparable from *Phororhacus;* but from the circumstance that the foramen between the third and fourth trochleæ perforates the bone at right angles, instead of descending obliquely so as to open inferiorly on the lower aspect of the bone between the two trochleæ, I am inclined to think that it has a right to generic distinction.

The whole of the remains noticed above are from formations of Tertiary age, but the collection of fossil vertebrates does not end with that period. From certain deposits in the districts of Chubut and Neuquen, in Patagonia, which are probably of Cretaceous age, there have been obtained a large series of Dinosaurian bones pertaining to reptiles rivalling in size their most gigantic European and North American allies. One of these creatures, although by no means the largest, I have referred, in a memoir about to be published by the Museum, to the genus *Titanosaurus*, originally founded, on the evidence of caudal vertebræ, from the Cretaceous rocks of India. These vertebræ differed from those of all other gigantic Dinosaurs in having a cup at the anterior end of the centrum, and a ball at the opposite extremity, thus resembling those of existing crocodiles. The large series of specimens in the La Plata Museum serves to show that *Titanosaurus*, as had been previously suspected, is really a member of that group of Dinosaurs to which the name of Sauropoda has been applied. This is clearly shown by a fine dorsal vertebra exhibiting the well-known lateral pits characterising that suborder.

In these vertebræ, it may be observed, the cup is situated at the hinder end of the centrum, and the change of type is effected by means of the first caudal vertebra, which, as in crocodiles, is biconvex. The bones of an enormous fore-limb, together with an imperfect femur and two caudal vertebræ, indicate a still more stupendous member of the same family, for which I have suggested the name of *Argyrosaurus*. In the type specimen the length of the humerus is nearly the same as in the gigantic humerus from the Kimmeridge Clay preserved in the British Museum, and mentioned in the *Catalogue of Fossil Reptiles* under the name of *Pelorosaurus humerocristatus*. A smaller Dinosaur, characterised by the slight development of the lateral pits in the vertebræ of the trunk, and hence named *Microcœlus*, appears to indicate a type unknown either in Europe or North America, while two vertebræ point to the existence in Patagonia of a Dinosaur more or less closely allied to the European *Megalosaurus*. With the discovery of these interesting Dinosaurs in Patagonia, we have now evidence that this extraordinary group of reptiles was represented during the upper half of the Secondary epoch by allied forms throughout the greater part of the world, their remains having now been obtained from Europe, India, Australia, South Africa, and North and South America. The vertebrate land fauna of the world seems therefore at that comparatively early epoch to have been much more homogeneous than it has ever been since, while there is no evidence of any marked distinction between the types of life inhabiting the northern and southern hemispheres.

To give an exhaustive account of all the treasures of the La Plata Museum would entail an amount of space far beyond that which is here available, but I trust that the foregoing brief sketch may convey to the palæontologists of Europe some idea of the richness and interest of the collections which are stored in the handsome building in La Plata. The Government are, indeed, to be congratulated on having founded such a noble institution as the Museum; and it is to be hoped that, when the scientific value and importance of its contents are more fully realised, they will not refuse such financial support as may be necessary for ensuring their preservation, and for making them known to the world at large by means of suitable publications.

It is not, however, solely as a geological, palæontological, and zoological institution that the Museum of La Plata demands admiration and support. It is likewise a great printing and chartographical establishment, where Government documents and maps are produced with a speed worthy of all commendation. The aim of the Director is, indeed, that the Museum should eventually display the entire evolutionary history and the whole of the natural products of Argentina; while it should at the same time be the depository of the whole of the data relating to the geography and topography of the country, and the place where all information on such subjects should be readily accessible to the public. For the success of this grand and noble scheme the Director has, as he deserves, our most cordial good wishes.

In conclusion, I have the pleasure of tendering my most hearty thanks to Dr. and Mrs. Moreno for the hospitality and unvarying kindness which I received at their hands during my brief but pleasant sojourn in La Plata.

Richard Lydekker.

Las Bandurrias, La Colina,
Buenos Aires,
November 3rd, 1893.

V.

Plant Diseases and Bacteria.

BOTANISTS have always been justly proud of the fact that they had a fully-established germ-theory of plant diseases at a time when this explanation of the diseases of man and animals was only beginning to dawn on pathology; that they showed the way, and in many cases (not the least important) invented the methods which the modern bacteriologist has re-discovered and certainly perfected. This botanical germ-theory was, in one respect, more obvious and easy of discovery than the animal one. It dealt with fungi, which though minute and elusive enough to defy all but the most patient and cunning investigation, are yet far more tangible organisms than bacteria. The brilliant work of de Bary and others in tracing the life-histories of parasitic fungi through generations inhabiting successive host-plants of diverse kinds has no parallel among the investigations of the bacterial diseases of man and animals. On the other hand, botanists must admit the reproach that, while they have concentrated their energies on the micro-organisms that produce the disease—naturally enough, since these are plants as well as the hosts—they have neglected the study of the diseased host, and that consequently plant pathology in the strict sense is in a comparatively backward state. This, fortunately, has shown signs in recent years of being remedied by increased attention; and one of the fruits of such attention most to be desired, viz., a better understanding of what is meant by *immunity* and *predisposition*, can be reached only by this path. There is hardly any subject in the whole of scientific literature and conversation about which there is more vague writing and talk than predisposition. There is a very small measure of bread and "an intolerable deal of sack." How it may be exactly with human beings and animals, I am not qualified to say, and I expressly exclude them from these remarks; but no burning and shining light on the subject has reached botanists from this source, and I strongly suspect, from my insufficient knowledge of the matter, that here too there is little to be said but much to be doubted.

Some years ago, when there was more public, and perhaps less private, attention paid to such subjects as the diseases of the potato, cereals, and other crops, it was a favourite view of farmers, gardeners, and even of more exalted personages, that these cultivated crops had developed, through what was vaguely called "over-cultivation," an inherent tendency to disease, just as we hear a great deal about the "diseases of civilisation," and so on. There may be something in this, but no one has ever proved that there is, and, meantime, one must be content with the apparently sufficient explanation that the cultivation of crops in close contiguity gives the parasitic organisms opportunities of spreading superior to those commonly found in nature (though not so much so as might readily be supposed), and also affords the spectator a better opportunity of witnessing the effects, and attracting his attention, from the fact that the diseased plants were valuable to him, much more than wild plants, for example. One cannot resist suspecting that some of the so-called "diseases of civilisation" are in the same boat. We know that such as are infectious are often infinitely worse among uncivilised communities, among whom they possibly originated, and such as are not infectious are sometimes, at least, imaginary ailments, or ascribed to civilisation on wholly inadequate grounds. But these things are leading me away. We certainly do not know that there is an "inherent tendency to disease produced by over-cultivation," and we do not even know if there be such a thing as an inherent tendency to disease at all. The fact that one species is taken by a parasite and another left, that one variety even may escape wholly or partially while others suffer, shows us that there may be something of the kind; but, on the other hand, the tendency is better described as on the part of the parasite; the predisposition may be in the environment of the host, and, lastly, need not be a sickly or enfeebled condition of the host, for that is generally what is meant.

It may not be too tedious if I venture to recall that these fungi and bacteria all gain their living as *parasites* producing diseases in living bodies of plants and animals, or as *saprophytes* feeding on their decaying bodies or dead organic substances. Between the *strict parasites* and *strict saprophytes* there are, however, intermediate forms, such as parasites that are *facultative saprophytes* and saprophytes that are *facultative parasites*. Finally, we have in the lichen-forming fungi, for example, cases of commensalism in which a lasting nutritive partnership is struck with the host instead of a one-sided arrangement, as in the other cases. It will be seen, therefore, that there is a considerable range of nutritive adaptations among these organisms—a certain elasticity of accommodation. Among the parasites, which principally concern us, we have such as are facultative saprophytes and the converse, and we have others that are almost omnivorous parasites, attacking plants of diverse groups; others confined to an allied group of species; others to a single species. Among them there are noteworthy instances of parasites that attack hosts outside the group mostly affected, and others again that exempt particular species and even varieties within the group of hosts. Consideration of such instances rouses curiosity as to the exact cause of immunity, or of predisposition, on the one hand; or, to put the matter otherwise, as to the gradations in the aggressive behaviour of a parasite to the different varieties or even individuals of a host. It is just here that we leave sure ground in most cases, but there is one remarkable instance, at all events, of which our knowledge is sufficient—that of *Pythium*, which, as a facultative parasite, attacks flowering plants. The host here displays degrees of predisposition or power of resistance in proportion to the amount of water it contains—a condition not in itself sickly. We know further—it is abundantly evident that sickliness is not always necessary to predisposition in plants, but, on the other hand, it may frequently be so. At one extreme we have the parasite which is the complete master of its host under favourable external conditions—as much its master as the animal that devours it in more summary fashion; and, at the other extreme, we have parasites which need such adventitious aids of access to their hosts as wounds and abraded surfaces, etc. The subject is a very wide one, and merely the salient points are being touched on here, but I must cite the facultative parasitism of moulds that grow on fruits, to be referred to again later.

One of the most interesting general truths in all this web of fact is the exemption of living plants from the assaults of bacteria. I reserve certain possible exceptions, such as Wakker's hyacinth disease. This exemption has been generally accounted for by the acid reaction of plants, and I might venture to suggest that, since more causes than one commonly co-operate in such matters, the comparatively strong illumination of the vitally active above-ground parts of plants may partially aid in this direction. Recent researches have demonstrated the exceptional powers of sunlight as a retarder and destroyer of Bacteria,[1] and Professor Ward, who has re-examined the whole question fruitfully, has pointed to the protective powers of the pigments of such parasitic fungi as Uredineæ, etc., against this influence—a protection not shared by bacteria.

The question of the relations of bacteria to plant tissues has recently been discussed by Dr. H. L. Russell[2] in a thesis for his degree at the Johns Hopkins University. He complains at the outset of the neglect or the sceptical reception by European writers of the case of the pear-blight caused by *Bacillus amylovorus* which, he contends, has been established by Professor Burrill, and he cites in an appendix tables of bacterial plant diseases, many of them, it is to be feared, in like case with the pear-blight. In some of these diseases the bacteria

[1] *See* Raum. "Der gegenwärtige Stand unserer Kenntnisse über den Einfluss des Lichtes auf Bacterien, etc." *Zeitschr. f. Hygiene*, Bd. vi., 1889. He cites some 150 papers dealing with the influence of light on bacteria, etc., and more or less agreeing in this—that light exerts an adverse influence on pathogenic bacteria, and a stimulating one on healthy processes in the animal body.

[2] "Bacteria in their Relation to Vegetable Tissues" (The Friedenwald Co., Baltimore).

attack the starchy stores of reserve-material or the sugary fruits of the hosts, and it is precisely here that, as has been mentioned above in the case of fungi, thin partitions divide the saprophyte from the parasite. On the other hand, there are cases, like the blight on oats, where all parts of the young plants are affected, and, in short, there is a pleasing variety in the organs attacked. I am far from denying all these cases, but in matters of this kind it is, above all, necessary to "prove all things," and I prefer to retain, at all events in some cases, a "skeptical" attitude, especially as the data we possess are "meager." Not so, however, with Dr. Russell's own experiments, which are a valuable contribution to the literature of the subject, and a most promising performance. Some of his statements are open to comment, if not to criticism, on minor points, but this is hardly the place for a discussion of methods, etc., and the whole thing is so interesting a study in immunity that I summarise his conclusions. "The artificial inoculation of higher plants with different micro-organisms (not known to be pathogenic for plants) reveals the fact, contrary to the usually-accepted idea, that quite a goodly number of different species are able to withstand the action of the living plant organism for a not inconsiderable length of time." Of these he finds saprophytes particularly prominent—but not all equally so. Facultative parasites on the animal body were not found to be adapted to live in plant tissue, with the exception of *B. pyocyaneus* and the Schweineseuche *Bacillus*. "The inoculation of plants, not taxonomically related to the natural hosts of bacterial plant parasites, with species of micro-organisms naturally parasitic on vegetable tissue, showed that while the bacteria were unable to spread, they could survive at the inoculation point in large numbers. . . . Not only were numbers of different species of bacteria able to *live* in the plant from 40 to 80 days or more, but many of them (mostly saprophytes) were able to *spread* throughout the tissue of the plant to a limited extent (20 to 50 mm. or more)." This spreading was generally intracellular, not intercellular, and always in an upward direction. Dr. Russell thinks that this was not owing to the transpiration stream, but to the actual growth of the micro-organism. In the case of bacteria entering by wounds, he thinks it possible that they could enter through lesions so small as to escape notice, and that they might even live in the tissue after the wound has healed over. "In the case of parasitic species on plants, they sometimes effect an entrance into tissues without the intervention of wounds of any sort." The exemption of plants from bacteria in general, he distinguishes as *resistance*; while he reserves the term *immunity* for "the ability of a certain group of plants to be refractory towards a disease germ that is able to cause a pathological condition in closely-allied forms of plant life." This certainly seems an unnecessary distinction, because it is scarcely possible in any case to draw the line for immunity unless one is a "harbitrary gent," though the idea that underlies this proposal is one generally recognised. At the present stage of our knowledge, or ignorance rather, of resistance, immunity and predisposition, it is hardly wise to introduce binding definitions of useful general terms. His other conclusions are of a more general and obvious kind, but the whole paper is permeated with the true spirit of research and experiment, and its author, if as yet somewhat credulous, deserves congratulation on a very promising piece of work.

George Murray.

VI.

The Causes of Variation in the Composition of Igneous Rocks.

FEW questions occupy a more important place in the mind of the physical geologist at the present time than why, within certain limits, the composition of eruptive rocks varies. Numerous opinions have at different times been expressed, but none of them have stood the test of time, nor have they at any epoch been universally accepted.

When we come to consider in general these different views—maintained, many of them, by both careful observers and clear thinkers—we find that they fall into two groups. There are those who hold the existence of two extreme pastes, the mixing together of which affords all the intermediate varieties of eruptive rocks; while the opposite school are equally confident that from a single original paste have been derived the numerous varieties of igneous rocks.

Numerous theories have been suggested to explain the differentiation of the two extreme pastes as held by the first school, and these explanations, with others, have been based on the action of the same agents as those which differentiate the common magma believed in by the second school.

Many of the hypotheses grade into each other, and some authors hold more than one agency at work; while others are somewhat mixed in their ideas as to the influence of one cause as separate from another.

As for the first school, they maintain that either whole or part of the fluid rock portion of our earth was, at one time or another, separated into a number of concentric shells, just as we find air separate from water.

This, at first sight, seems highly plausible; and I think we can concede they are right when they consider forms of matter of totally different molecular structure, such as air, water, oxides, and metals, just as we could confirm the same truth with such substances as mercury, chloroform, water, and oil, which remain separate when poured into a tube, in the order of their density, and, however much they are mixed together, separate again.

With volcanic rocks the question is somewhat different. The fundamental paste of these is composed almost entirely of oxides—some basic, others acid, but the complete intersolution or miscibility of which, in a fused state, has never been disproved, nor does it seem likely to be, as they all have a common tie in oxygen. When they cool, then other conditions are introduced, which do not concern us at present. Soret's principle will, no doubt, be urged against this statement; but in that case we have to deal with experiments on bodies much less nearly related, and under conditions of far less viscosity than those of an igneous paste, and with extremes of temperature far different to those likely to occur in masses of the enormous dimensions of the earth. Neither must we neglect the influence of tidal action, convection currents, and many other mechanical disturbances, such as shearing between the different fluid shells in the direction of the earth's rotation, supposing such continuous fluid shells to exist within our earth at present. In the case of localised reservoirs, there would be the absorption of water, vesiculation in the paste, currents sent up by the injection of earth fissures, or eruption of some of the material on the earth's surface, and other mechanical disturbances.

The oxides fused together in the manufacture of glass, which vary still more in their relative specific gravities than those which constitute igneous rocks, are not known to separate in the glass pots, however long they are left quiet. It may be objected that the depth, time, and even, perhaps, temperature are hardly comparable in the two cases, but we must not forget that even the most basic glasses are markedly viscous at high temperatures. These views may conveniently be styled the "differential paste and alloy hypothesis."

Mr. C. E. Dutton[1] says, "We know of no natural processes capable of separating the more acid parts of such a magma except the chemistry of the atmosphere acting at temperatures far below the melting-points of the silicates." He urges the following chemical argument against such a hypothesis:—The separation of a magma into two or more degrees of acidity is disproved by the low percentage of silica in basalt not being confined to the felspar and augite, but being also in the base, while the high percentage in rhyolite is in the felspar, and still more in the base. Hence the segregation must have affected the base more than the crystals.

The only way out of this difficulty is to suppose crystal segregation and refusion without subsequent mixing. I do not deny the possibility of such a process occurring occasionally; but to imagine that under every volcanic region, and under a large number of individual vents, there is an apparatus as complex as a chemical factory or an iron foundry, can only be relegated to those fantastic theories of volcanic magic that pass for science.

[1] "Geology of the High Plateaus of Utah," 4to, Washington, 1880, p. 124.

Neither is the idea of the segregation and settling down or deposition of certain crystals a very comprehensible one. It is hard to deny that such a process might take place, but it seems highly doubtful that any but very large crystals could undergo sinkage in a highly viscous medium; besides, it is not true that minerals separate in the order of their basicity or of their specific gravities, a fact I pointed out several years ago.[2] Leucite, for instance, is only formed in the open chimney of a volcano, and depends, like some of the augite, with probably sodalite, haüyne and nepheline (in some cases only), on the liberation of the alkalies and alkali-earths from their chlorides and sulphates by the dispersal and escape of their acid radicle vapours. These bases can then take up the silica from the residual basic glass, thus forming leucite and magnetite.

Again, we find that several mineral species become individualised contemporaneously. In many rocks, felspar and magnetite or augite, or again augite and leucite, were certainly separating at the same time; now if these sink together we shall have a rock of rather curious composition. Brögger and Vogt seem to believe that segregation takes place at certain points of a reservoir where the conditions are more favourable to the crystallisation of the one or the other mineral species. This much appears not improbable, and would easily explain the peculiar iron ores described by Vogt, and many rocks that have cooled in place, but it is hardly applicable to igneous effusive rocks in general.

Other suggestions that have been offered may be denominated the "fusion hypothesis," and the "osmotic hypothesis." Professor Sollas has demonstrated how, in some Irish igneous rocks, fragments of other igneous rocks of different composition and earlier date have been dissolved in a later magma.[3] Bäckström[4] and Fromm[5] have likewise described the local changes produced by quartz and felspar inclusions in basic rocks, but their observations are limited to the immediate neighbourhood of the enclosures. The former author found three kinds of augite in the enclosing rock. I have likewise shown that in basic and andesitic rocks of Stromboli quartz is fluxed down, forming with the residual basic glass an augite which becomes an important rock constituent.[6]

These facts in themselves are not of paramount value in the question, but they are clues to an important line of investigation that, when more carefully pursued, may afford valuable evidence as to change of composition in a primitive paste by adulteration with extraneous additions.

Ricciardi, on the evidence of his careful and elaborate analyses of

[2] *Scient. Proc. R. Dublin Soc.*, n.s., vol. v., p. 143, *et seq.*
[3] *Rep. Brit. Assoc.*, 1893.
[4] *Bihang t. k. Svensk. Vet. Akad. Handl.*, vol. xvi., pt. ii., no. 1.
[5] *Zeitschr. deutsch. Geol. Ges.*, vol. xliii., p. 43.
[6] *Rep. Brit. Assoc.*, 1893.

Italian volcanic rocks, suggested that the original paste was acid in composition, and that it became converted into basic rocks by the fusion of the Apennine limestone which supplied it with lime, magnesia, and iron. Herrick, Clarke, and Deming, although they do not go so far as Ricciardi, believe that basic rocks may be made more acid by the influence of the enveloping or "country rock," as they call it. They make no definite statement as to whether this is by fusion or chemical interchange.

The feeble point of Ricciardi's hypothesis is that, however magnesian or ferriferous be the Apennine limestone (for the numerous analyses of which we are indebted to that author and Abich), the amount of lime would be excessive in proportion to the other bases taken up by the lava.

For years I have been strongly impressed by the probability that, after all, we may have only one fundamental paste. It is not unlikely, admitting either a fluid shell between the earth's crust and nucleus, or even large isolated portions of such a shell, that this, during long ages since our globe consolidated, has been modified in composition by the rounding off of projecting inequalities of the undersurface of the crust or roof where thickenings and crumplings had taken place while cooling. Not only might the primitive cooled fusion-crust be reabsorbed, but the earlier sedimentary deposits might be likewise consumed, so that anterior to any fissure-filling a large extent of igneous paste would have changed in composition; but in such conditions I have little faith. Physicists will have it that our earth is practically a rigid mass; that pressure raises the temperature of solidification; and that therefore igneous rock at any considerable distance from the surface is solid, although at a very high temperature. In what way, therefore, can the "focal diffusion" and "segregation" processes have gone on? So far we have no evidence of segregation in a pure solid, but only in those solids wetted or permeated by a liquid. One escape from this difficulty is suggested by the last remark—namely, that perhaps this solidified mass of incandescent rock is composed of quite different minerals to those which reached the surface, undergoing liquefaction on the way; and that some silicates remain fluid and act as the diffusion agent. In fact, there is a complete analogy to what occurs in a marl, limestone, or clay, when water serves as the medium for the concretion of limestone, pyrite, flint, and other nodules; or for the more complete crystallisation of pyrites, selenite, hauerite, etc. But in all such cases the segregation is diffuse; by which I mean that in a stratum of marl we do not find the lime at one locality or part of the country and clay at another, but we encounter the resulting concretions scattered through the clay. If we imagine this to be suddenly fused, the resulting rock would have the composition of the original mud, and supposing that all issued by one vent, or cooled in place, we should not have a limestone rock here and a clay there.

But it will be argued that this segregation will occur in the primitive igneous material after it has liquefied by diminished pressure, and is on its way towards the surface. Then, it is true, it frequently occupies tortuous fissures where differentiation and segregation or sedimentation of crystals of the constituents might go on; but this could hardly explain the regular flow of definite but very different types of rocks from numerous points along a line of active vents, such, for instance, as the Lipari Islands. Here we observe, along a stretch of some 50 miles in length, a series of numerous vents from which outpours of basic dolerites and andesites simultaneously took place, and overlapped effusions of intensely acid lavas. In Vulcano for 2,000 years eruptions of an obsidian lava and a dolerite have been going on at vents only a mile apart. Is it conceivable that differentiation could progress, in the great fissure supplying these volcanoes, to such a complete extent that, without a difference of time, and in such a limited area, two extreme rocks could be poured forth and almost practically none of intermediate composition? What is said of this region is no less applicable to many others.

There yet remains one other possible cause, foreshadowed as far back as 1876 by the late Mr. J. C. Ward; that is, the interaction of the primitive igneous paste and the rocks it traverses or comes in contact with in its way into and through the earth's crust. Mr. Ward did not state clearly whether he meant by simple fusion of the walls of a volcanic canal or by a process of osmosis.

In my paper on Vesuvius and Monte Somma,[7] I drew particular attention to the subject, and in later writings those views have been extended and confirmed, but it will be advisable here to discuss the question in some detail. When we observe the denuded roots of volcanoes we find a certain amount of rock that has disappeared and has been replaced by the igneous intruder. We have little evidence in most cases to tell us whether the removal has been by mechanical export, fluxion, or fusion, though in many cases evidence points to the first as the principal means. I think it may be stated as a general law that contact metamorphism increases in intensity with the bulk of the igneous intrusion and the coarseness of its crystallisation. In other words, it is greater the larger is the amount of the heated medium, and the longer time this takes before solidifying, and, therefore, before its subsequent cooling. In contact metamorphism in regions which show evidence of being for a long time active volcanic centres, very marked chemical changes have been wrought in the solid rock—*elements have been introduced and* OTHER ELEMENTS HAVE BEEN REMOVED. All the elements introduced are derived, I presume no one will deny, from the neighbouring paste, which will have been modified in composition according to the percentages of those elements that passed into the cavity walls.

[7] *Quart. Journ. Geol. Soc.*, vol. xl., p. 54.

I claim, also, that the same paste has acquired those elements that have disappeared from the encasing rock. The change in composition of a lava by one only of these processes would not be very great, but when both are considered the change of an acid to a basic rock, or *vice-versa* is quite possible.

In my paper on the ejected blocks of Monte Somma[8] (I. stratified limestones) and that on eozoonal structure in the same, by Dr. J. W. Gregory and myself, now being published by the Royal Dublin Society, it has been shown that calcareous rock acquires silica and later alkalies, and loses lime and magnesia in such a way that the magma, actually cooling in contact with it, is often reduced to an ultrabasic one. Are we not to suppose, therefore, that a less intense change does take place at a greater distance and under less favourable circumstances than these extreme and rather localised ones? Again, when we examine great areas of intrusive acid rocks, we often find their peripheral regions becoming more and more basic, and, perhaps, cases may be recorded of the reverse, according to the country rock. That these gradations are irregular is nothing more than we should expect, for the country rock surrounding such a mass will also vary in composition, and then circulation of the paste towards volcanic vents may have been greater at some spots causing mixing or carrying away the material. For succinctness we may call this the "osmotic" hypothesis.

If we suppose a number of vents, scattered over such an area, to open, the outpouring lava would differ according as it was derived from the purer or from the altered paste. A vent might drain out all one kind of paste, and following this might flow another of a different composition. The order in the composition of the rocks that issued might depend, therefore, on quite accidental circumstances. That not uncommon order of some regions commencing by the emission of basic rocks that become more and more acid and then, after an interval, terminate by a final phase of very basic rock, is quite explicable on this hypothesis. Let us imagine a great laccolite of an acid rock taking up its position among limestones. During a considerable period interaction takes place and a peripheral layer of basic rock is formed, being naturally basic at the surface near the limestone. This outer layer also becomes more and more aquiferous by the assimilation of H_2O from the enclosing rocks, until its tension rises enough for it to burst its way to the surface. The first outpour will be eminently basic, but as this drains off, the more and more central and acid layers will rise and follow. When sufficient has escaped to reduce the tension of the whole laccolite, and this becomes so viscous as to be unable to issue, the volcano will become quiescent, during which basification of the acid rock and absorption of H_2O will still progress, rendering it more fusible, and then, becoming more fluid

[8] *Proc. Geol. Soc.*, 1888, pp. 94–96, and *Trans. Edinb. Geol. Soc.*, vol. vi., p. 314, 1893.

and of higher tension, it will burst forth, forming the final phase of the volcano.

What may be the composition of the fundamental paste is still an open question, but I believe that it differs in different regions, so that in one volcanic province potash may be a dominant alkali, and in another soda, and so on. So far as my own individual opinion goes, I believe it was a rather acid rock, corresponding to a trachyte, and that either extremes have been caused by chemical alteration.

In fine, I do not deny that the modern hypotheses may each in part explain the cause of differentiations of pastes, but I do maintain that neither the "focal diffusion," "segregation," nor "sedimentation" processes are sufficient by themselves to do so.

H. J. Johnston-Lavis.

SOME NEW BOOKS.

The Macleay Memorial Volume, edited by J. J. Fletcher. Published by the Linnean Society of New South Wales. Pp. lii. and 308, frontispiece, and 42 plates. 4to. Sydney and London: Dulau & Co., 1893. Price 3 guineas.

Sir William Macleay, who died on December 7, 1891, in his seventy-second year, was pre-eminently the patron of Natural Science in Australia. To his efforts were largely due the foundation and continuance of the Linnean Society of New South Wales, and to commemorate his munificence that Society now issues the present handsome volume, to which naturalists from various parts of Australia and New Zealand contribute a somewhat heterogeneous assemblage of articles of very various value.

The editor, Mr. J. J. Fletcher, prefaces the volume with an interesting account of the Macleays, and especially the eponymous William. As characteristic both of the man and of his biographer's literary style, the following description of an encounter with outlaws in 1864 may be quoted:—"His courageous conduct on this occasion and his commendable example in successfully asserting, rifle in hand, his right to travel on the high road when three desperate ruffians, Gilbert, Hall, and Dunn, one of them a recent murderer of police, held possession of it on the hill overlooking the inn, and having just finished with the Goulburn coach were actively engaged in the process of 'sticking-up' several teams and a number of travellers when Sir William, accompanied only by a boy who was driving the buggy, came on the scene and raised the siege, afterwards received official recognition by his being chosen one of seven gentlemen to whom in 1875 the Government awarded gold medals 'granted for gallant and faithful services' rendered during the period when bushranging was rife."

Professor W. B. Spencer contributes to our knowledge of *Ceratodus* a very thorough account of the blood-vessels of that interesting lung-bearing fish. He finds that both veins and arteries, while showing unmistakable connection with primitive shark-like types, have developed to a certain extent along lines parallel to those of amphibians. He considers that in the earliest forms in which lungs were developed for respiration, the mode of life was very similar to that of *Ceratodus*. The animal lived in water, and, at first at any rate and possibly for long, the lungs were only accessory to the gills. This condition is paralleled in the early life of the frog. In *Ceratodus* the lung is always in use, although the animal does not, as some have supposed, emerge from the water; but this organ is chiefly of service when the river water is thickly charged with sand or fouled by decomposing vegetation. The paper is illustrated by five plates in Mr. Spencer's admirably clear, though somewhat over-diagrammatic, style.

Captain F. W. Hutton follows with a systematic account of the Pliocene Mollusca of New Zealand, which he characterises as "the remains of an earlier fauna disappearing rapidly before the conquering host of the recent fauna, which had invaded New Zealand some time previously; and if this idea is correct we might expect to find some of the Pliocene forms, which are now extinct on the shores of New Zealand, still lingering in the outlying islands." This appears to be the case, but further investigation is necessary. We hope that the four plates accompanying the paper will be more satisfying to the eye of the conchologist than they are to that of the artist.

Professor W. A. Haswell monographs the Temnocephaleæ, a peculiar group of worms parasitic on the outer surfaces of many kinds of water animals, to which they adhere by a sucker. Like those of most parasitic forms, the affinities of this group are hard to determine. The author concludes that they are probably Trematode rather than Turbellarian, although he sees little reason against regarding them as aberrant Rhabdocœlous Turbellaria, specially modified for a peculiar mode of life. Mr. Haswell also describes, as *Actinodactylus*, a new genus of flatworm, found on the burrowing crayfish of Gippsland; its most remarkable feature is a retractile proboscis. This author's seven plates, drawn by himself, are both clear and artistic.

Professor T. J. Parker and Josephine Gordon Rich describe the muscles of the New Zealand sea crayfish (*Palinurus edwardsi*), a piece of work that should prove of service to Australasian students of the Crustacea. Their chief conclusion of general importance is that "the great ventral mass of muscle in the abdomen, usually considered to act exclusively as a flexor, gives rise to slips which, being inserted into the terga of the segments above the hinges, and pulling in an almost horizontal direction, must act as extensors." The drawings are remarkably clear.

In the course of two papers, Messrs. J. T. Wilson and C. J. Martin show that the name "duck-bill" as applied to Ornithorhynchus is somewhat erroneous, since the muzzle of that animal is neither horny nor even leathery, but covered with a soft skin, like that of a dog's nose, richly supplied with sensitive organs of touch. The object of this is evident when we remember that the animal usually procures its food by raking away in the mud at the bottom of rivers for small larvæ, shell-fish, insects, and worms. The snout is supported by cartilage, which the authors regard as a persistent prolongation of the embryonic cartilaginous skull. The papers are illustrated by five plates containing some excellent micro-photographs.

Professor R. Tate endeavours to show, from an examination of the floras, that Norfolk and Lord Howe Islands are connected with the New Zealand rather than the Australian region, a conclusion that harmonises with the results obtained from the birds and land-shells.

Mr. R. Etheridge, jun., contributes an interesting description of some of the implements and weapons of the Alligator tribe, Port Errington, N. Australia, which were sent to the Chicago Exhibition.

Eighty-two species of Nematode worms, mostly Australian and Fijian, are described by Mr. N. A. Cobb. About half the species are new, and considerable attention is paid to anatomical details. Many of these worms are hurtful to vegetation, and the paper may, therefore, prove of economic importance; otherwise it contains little of general interest.

The volume also contains notes by Baron von Müller, Mr. J. H.

Maiden, and Mr. C. Hedley. Besides being a worthy memorial of a notable man, it does great credit to the Linnean Society of New South Wales, to the printers and lithographers of Sydney and Melbourne, and to all our Australasian colleagues.

[THE EARTH BEFORE THE APPEARANCE OF MAN.] La Terre avant l'apparition de l'homme. Périodes géologiques, Faunes et Flores fossiles, Géologie régionale de la France. By Fernand Priem. Pp. 716, text illustrated. Large 8vo. Paris: Baillière & Sons, 1893. Price 12 francs.

THIS volume forms part of a series entitled *Merveilles de la Nature*. As one of these marvels a restoration of *Triceratops* now graces the title page; but the author might very well have placed his own portrait there instead. For, only last year he produced a companion volume, *La Terre, les Mers et les Continents*, noticed in NATURAL SCIENCE, vol. ii., p. 314, and now he has given birth to the present monster, which contains more matter than 13 numbers of this Journal. The explanation of course is that these volumes are little more than compilations from well-known works in other languages, such as Neumayr's *Erdgeschichte* and Suess's *Antlitz der Erde;* and as such they demand little notice from us.

In some respects Mr. Priem essays to do for the French public what Canon Bonney has done for our own in the book reviewed last month. His descriptions are, however, far more technical and he nowhere achieves that distinction of style so characteristic of the English writer. This one would expect to militate against the popularity of his work, did one not know how much greater the acquaintance of the ordinary Frenchman with such matters is than that of the ordinary Englishman. On the other hand, if Mr. Priem's book is intended for serious students, it is by no means careful enough. Facts of which he was ignorant when he wrote *L'Evolution des Formes Animales* in 1890, he remains ignorant of to-day, through no fault of his critics (see *Geol. Mag.*, Dec. III., vol. viii., p. 515: 1891).

It is, however, only the first 453 pages of the present volume that are devoted to the popularisation of geology. The latter part, which is far more valuable to the world at large, consists of an account of the geology of France. The method adopted, which is the most useful one for the foreign visitor, is to describe the various regions rather than the formations. First is described the Central Plateau, then follow the Western Massif, Ardenne, the Vosges, the mountains of Maures and Esterel, the Alps, the Jura, the Pyrenees, the Sub-Pyrenean plain, the Paris Basin and, lastly, the Basin of the Saone and Rhone. This part is illustrated by numerous maps and sections, and supplies a want, which, so far as we are aware, had not been previously filled. It can hardly be called a pocket guide; at the same time our readers will be glad to learn that the work has been published in 24 Series at 50 centimes, and in 4 Fascicules at 3 francs, and that each series or fascicule may be bought separately. For this last fascicule, at least, we predict a good sale.

As a picture-book the whole volume may attract some attention, since it contains no less than 900 figures. All, however, are not equally good. Most of the interiors of Brachiopods are wooden in the extreme. *Dinornis parvus* has a miserable appearance. Fig. 637, *Megatherium*, fig. 624, the Mammoth, and fig. 355, a Pterodactyl, would have been destroyed long ago by any right-minded person, so full of errors are they. Some of the blocks seem to have been put into a lucky bag, and drawn out at hazard at the last moment; thus we find *Osteolepis* masquerading as *Holoptychius* (fig. 164), while *Holoptychius* poses as *Osteolepis* (fig. 166); *Ctenodus* has lent his lower jaw to *Dipterus*, while *Coccosteus* and *Cephalaspis* have jumped into one another's shoes. It is to be hoped that no satire is meant when the author ascribes all these wrong determinations to Traquair. But Ammonites as well as fish have gone astray, so that on page 235 *Schlotheimia* and *Arietites* have changed places. Presumably Mr. Priem was already engaged in further stupendous labours that prevented him from seeing this work through the press. The man that takes all the world as his oyster will inevitably suffer from indigestion.

F. A. B.

SUICIDE AND INSANITY. By S. A. K. Strahan, M.D. 8vo. London: Swan Sonnenschein & Co., 1893.

THIS book, which Dr. Strahan calls a "Psychological and Sociological study," has been written to teach a lesson and to prove a theory. The lesson is one of charity and a broader sympathy with self-destroyers than the Church, and consequently public opinion, inculcate. The theory is one that has been gradually shaping itself in the minds of thinkers and gives the lie to the formal coroner's verdict, "Suicide while temporarily insane." Dr. Strahan divides suicides into two classes, Rational and Irrational. To the former belong those whose sanity has never been called in question. To the latter belong the vast proportion of those whose deaths are daily recorded in the newspapers or the registers of prisons and lunatic asylums, and are attributed to mental derangement. It is this class, naturally, that is subjected to physiological analysis. In a very lucid exposition of the causation of suicide, Dr. Strahan proves that suicide is no more an effect of insanity than are the criminal or homicidal impulse, epilepsy or alcoholism, but is, with these, a special manifestation of degenerate vitality of the race. In a tainted family we see, side by side with insanity and epilepsy, the predisposition to suicide. Each is a special form independent of the others, although a combination is frequently found in the same case. Starting from the two fundamental instincts of animal life, self-preservation and procreation of species, Dr. Strahan shows that voluntary death, being a confession of the absence of the former of these instincts, "becomes merely one of the eliminative processes of Natural Selection." In aiming at a popular style, the author sometimes seems to fall below the dignity of scientific dialectics. To give footnote references to well-known Shakesperian quotations, for instance, lends an unpleasant suggestion of amateurishness in literary work. This fault, and an unfortunate misprint, "*æsthetics*" for *anæsthetics* (p. 212), it would be well to remedy in a second edition. But these minor blemishes are lost in the soundness of Dr. Strahan's argument and the earnestness of his purpose. On the whole, his book is the most significant one yet written on the subject.

THE DISPERSAL OF SHELLS. By H. W. Kew, with a preface by A. R. Wallace, F.R.S., etc. (International Scientific Series.) London: Kegan Paul, Trübner and Co., 1893. Price 5s.

IN recommending this book to the public, Mr. Wallace, in our opinion, says rather more than is necessary. Many books, he remarks in effect, even when full of descriptions of scores of new species with anatomical details to match, and worked out in the most elaborate and accurate fashion, are of less interest to the philosophical naturalist than Mr. Kew's little book. Now Mr. Kew's book is the work of a diligent collector of facts bearing upon the means of dispersal possessed by land- and fresh-water Mollusca ; the facts are some of them new, but the general gist of the book is far from new; it is merely a slight extension of a matter which, in its main outlines and even in details, is already well-known. A naturalist, moreover, whose interests are limited to the phenomena of Distribution—important though that subject is—can hardly be called a "philosophical naturalist." If Mr. Wallace had not directly challenged comparison, we should have contented ourselves with an expression of opinion that Mr. Kew has done an extremely useful piece of work. But we must say now that it is neither highly original nor abounding in new and important truths. The fact of the matter is, that the kind of naturalist to whom Mr. Wallace refers when he uses the expression "philosophical," is apt to be alarmingly unacquainted with the structure of animals, and to be a dabbler in what is generally known as bionomics. There is a tendency, which we deplore, to unduly exalt trifling observations upon the "habits" and "intelligence" of animals. To make such observations needs comparatively little knowledge; to write monographs like those which Mr. Wallace passes over so lightly, needs not only skill of eye and hand, but wide knowledge, and, above all, reasoning power and a sense of proportion. We are far from thinking otherwise than well of Mr. Kew's book, but it is not exactly epoch-making.

ROMANCE OF THE INSECT WORLD. By L. N. Badenoch. London: Macmillan and Co., 1893. Price 6s.

THIS is a nicely got-up little book describing in a pleasant fashion some of the more familiar facts about insects. It is not quite obvious why what the author has to tell us should be deemed worthy of gilt edges and cloth sides; we should have thought that a magazine article or two would have sufficed to unburden the writer of his accumulated stores of information. A deliberate book calls for some special acquaintance on the writer's part with the subject upon which he proposes to enlighten his readers; but there is not much evidence of such a special—or, indeed, even a more general—knowledge in this work. The author should not venture upon the quicksands of technicalities without some more defensive protection in the way of fact than he appears to possess. Insects, for example, are defined as "animals formed of a series of rings or segments." This is, doubtless, perfectly correct; but the definition is truly, as he terms it, "broad." It is equivalent to defining man as an animal with a backbone. The concluding section deals with a much debated matter—the questions of "protective resemblance," "mimicry," etc. But Mr. Badenoch evidently has not the slightest idea that there are any debated points relating to the facts which he so glibly sets down. The facts, too, are of the most worn-out character, which have done duty again and again. Those over-worked Heliconidæ cause the gorge to rise in more than one sense. Mr. Badenoch seems to have read Mr. Poulton's "The Colour of Animals," but he should also have consulted Mr. Beddard's "Animal Colouration," which has at least the merit of impartiality. A "Glossary" at the end of the book contains definitions "of the principal scientific terms used." It may be necessary, though we should have doubted it, to inform the reader that *concentric* signifies "having one common centre"; but surely even the most benighted of "general readers" knows what *oval* means. If he does not he will not get very accurate information from Mr. Badenoch, who considers that it is the equivalent of "oblong"!

PÊCHES ET CHASSES ZOOLOGIQUES. Par le Marquis de Folin. Bibliothèque Scientifique Contemporaine. Pp. 330, 117 figures. Paris: J. B. Baillière et Fils, 1893. Price 3fr. 50c.

THIS is a charming little book on natural history, illustrated by quaint pen and ink sketches of animals, places, and apparatus. It is designed evidently to interest the amateur in the familiar objects of the animal world, and to guide him in the methods of looking for and capturing animals and plants. The reader is first taken to the sea-shore, and when he has spent an hour at the limits of the receding tide, his whetted curiosity is taught to satisfy itself with drag-nets and tow-nets. Thereafter he works his way through Algæ and Fungi and Flowering Plants, and then up through the animal kingdom from Infusoria to Mammals. Excursions to the bottom of the sea, discussions of phosphorescence and of animal electricity, enliven his progress, and a great deal of accurate classification and external anatomy is administered to him in gentle doses. A special and most valuable feature is that the book deals, so far as possible, with exact places, the special features of which are described, and the animals which may be found there specially mentioned. It is a book to be commended to local natural history societies for its method and treatment.

OUTLINE OF THE GEOLOGY AND PHYSICAL FEATURES OF MARYLAND, with a coloured geological map of the State and 16 plates and charts. By Professor G. H. Williams and Dr. W. B. Clark. 4to. Pp. 67. Baltimore: Johns Hopkins Press, 1893. Price $1.

THIS is an extra edition of the description of the Physical Geography and Geology of Maryland recently prepared for the World's Fair Book on the State's resources. It embraces the topography, climate, geology of the plateau, mountain and plain, and a brief account of the distribution of mines and minerals. This text is illustrated by a new geological map of Maryland, six coloured charts to show the distribution of rainfall and temperature, and ten full-page plates of various types of scenery having a topographic or geological significance.

The map, which is on a scale of 1:500,000, approximately eight miles to the inch, represents in twenty-nine colour distinctions the present state of our knowledge of Maryland's geology, and the harmonious arrangement of these colours renders it a most pleasing specimen of chromo-lithography. It is based upon the work of Tyson, I. C. White ,Geiger, Keith, Darton, and G. H. Williams, and contains much information never before published. It is accompanied by a tabulation of the soils belonging to the different geological formations by Professor Milton Whitney.

The work may prove of some general interest, since the State of Maryland contains geological formations in almost unbroken sequence from Archæan to Recent. The ancient crystalline and semi-crystalline rocks of the Piedmont plateau appear to be metamorphosed rocks of Archæan, Cambrian, and Ordovician age. Fossils, it is true, have not been found, neither is there any direct evidence of their sedimentary origin, beyond the fact that beds of different composition rapidly alternate, and have marbles and quartz-schists intercalated. The Appalachians and Alleghanies consist of folded Palæozoic rocks, from Cambrian to Carboniferous, with older eruptive rocks in places. The eastern part of the State is known as the Coastal plain, and is composed of slightly consolidated rocks of Cretaceous and Tertiary age. The numerous unconformities which these present are evidence of successive periods of elevation and depression. English students of the Tertiary rocks would be interested in the highly fossiliferous Pamunkey and Chesapeake formations, which contain many species of mollusca hardly to be distinguished from our own.

The charts are based upon a full investigation of all data relating to the climate of Maryland. Much information has been gathered on this subject, especially since the organisation of the State Weather Service, and these charts and the accompanying tables of observations, now for the first time bring the results together in a compact form. The climate, like the surface of the country, is greatly diversified, and the comparisons instituted will prove of interest to meteorologists. We miss, however, the promised section on Medical Climatology.

The style of the work is to be commended for its clearness and conciseness; it will probably obtain for it more readers than would have been found for a more ambitious and more technical description. After all a scientific work may be intelligible sometimes.

We may also add that we have received a "Guide to Baltimore," originally prepared by a local committee for the use of the American Institute of Mining Engineers at their Baltimore meeting. This contains an account of the geology of Baltimore and its vicinity, more detailed and more special than that in the work just reviewed. The account of the crystalline rocks is by Professor G. H. Williams, and that of the sedimentary rocks by Mr. N. H. Darton. This book is accompanied by two of the Geological Survey maps of the neighbourhood—one bringing out the features of the crystalline, and the other those of the sedimentary rocks.

F. A. B.

THE MINERAL RESOURCES OF WESTERN AUSTRALIA. By Albert F. Calvert. Pp. 179. London: George Philip & Son, 1893. Price 2s.

WESTERN Australia comprises about one-third of the great island-continent, but it is a colony which is said to have "slumbered for over fifty years." It is now slowly waking up, though its population in 1891 was estimated at a little under 50,000 persons, exclusive of Aborigines; or one individual to about every twenty square miles. There is room therefore for some of the unemployed who are prepared to do hard work in return for a moderate income; and there is room also for the capitalist whose aim would be to assist in developing the resources of the country, without seeking to make enormous profits. The colony is not well off for water; but this present drawback to progress can be overcome by the construction of reservoirs and the sinking of deep wells.

In the little volume before us Mr. Calvert gives accounts of each of the gold-fields of Western Australia; a subject which occupies the greater part of this work. In addition, there are brief notes on tin-fields, the Collie coal-mines, etc. He acknowledges assistance from the reports of the present Government geologist, Mr. H. P. Woodward, and of his predecessor, the late Mr. Hardman, in whose reports full particulars of the known mineral resources of the colony will be found.

There is no doubt that rich gold-fields exist, some of unknown extent, but enterprise has been arrested by the scarcity of water, and the want of railway communication.

WOODWARDIAN MUSEUM, CAMBRIDGE.—CATALOGUE OF THE FOSSILS IN THE STUDENTS' STRATIGRAPHICAL SERIES. By H. Woods. 8vo. Pp. 24 (interleaved). Cambridge, 1893.

THIS little pamphlet contains a list of the typical fossils of each formation, together with a note as to their class or order. We recall a collection of a similar nature in the Edinburgh Museum, which has been arranged by Mr. Goodchild, and at the present moment Mr. Etheridge is soliciting specimens for a like purpose in the British Museum. We would suggest that Mr. Woods, in his next edition, might add the authors' names to the species, for it is most important that the student should be trained to associate the literature of the fossil with its name.

LIEFERUNGEN 7 to 9 of the new edition of the Molluscan portion of Bronn's "Klassen," edited by Simroth, have just lately been received. They contain the completion of the Aplacophora and the first few pages of the Polyplacophora.

The following is the author's subdivision of the former order so far as the families are concerned :—

SUB-ORDER.	FAMILY.
I. Chætodermatina	1. Chætodermatidæ.
II. Neomeniina	1. Neomeniidæ 2. Proneomeniidæ 3. Dondersiidæ 4. Parameniidæ

We regret, however, to notice that new genera, subgenera, and even species are introduced and not always fully described. New forms, even in such a small group as this, should, we venture to think, be previously described elsewhere : their inclusion in the first instance in a work of this character, where they are out of harmony, is a mistake, and unnecessarily complicates the subject-matter, which should be kept strictly to its proper broad lines.

VERY useful to students of Ammonites is a pamphlet by Dr. J. F. Pompeckj (Beiträge zu einer Revision der Ammoniten des Schwäbischen Jura. Lief. i. Stuttgart: E. Schweizerbartsche Verlagshandlung, pp. 1–94, pls. i.–vii., 1893). This is nothing less than the translation of the remarkable trinomial and sometimes quadrinomial nomenclature, employed by Quenstedt in his great works on Ammonites, into the modern system. Thus, *Ammonites angulatus intermedius gigas*, as Quenstedt named one important species, is concisely rendered into *Schlotheimia intermedia*. The present part deals with the genera *Phylloceras*, *Psiloceras*, and *Schlotheimia ;* and besides the translation of its name, each species is critically considered, and mistakes in identification corrected ; while new species of Swabian Ammonites are described. Future instalments of the work will be awaited with interest. We only hope that the author will not treat *Arietites*, which he incidentally mentions, as a valid genus. It is forestalled by Hyatt's *Arnioceras*, *Coroniceras*, etc., whose limits and characters are distinctly defined, on correct morphological principles, in that author's "Genesis of the Arietidæ" (*Smithsonian Contrib.*, 673).

THE *Società Malacologica Italiana* has published in its *Bolletino* (xviii., pp. 73–108) a paper by Guido Bonarelli, which is of considerable value to students of Ammonites, being a descriptive catalogue of over thirty species, which the author unites under the new generic name *Hecticoceras*. The type-species of the genus is *A. hecticus*, Reinecke, while *A. lunula*, Reinecke, serves as type-species of a subgenus *Lunuloceras*. It is to be hoped that these new genera will prove to have been formed better than their names. Professor Bonarelli considers that *Hecticoceras* belongs to the family Oppelidæ, and that it was derived from *Oecotraustes*. This opinion is probably correct; but then *Oecotraustes*, as at present constituted, includes rather a heterogeneous assemblage of Oppelidæ, and would, in fact, form a worthy object for the learned author's further investigations. Meanwhile, the present paper marks one more forward step towards the true classification of the Ammonites.

THE Royal Scottish Geographical Society's Atlas of Scotland is announced to be published by the Edinburgh Geographical Institute (J. G. Bartholomew & Co.) next June. It will comprise a series of sixty-two plates of maps and plans, illustrating the topography, physiography, geology, natural history, and climate of the country; these being accompanied by an explanatory and statistical text. The completion of the publication of the Ordnance Survey Maps, the advanced progress of the Admiralty and Geological Surveys, and the large collection of data, produced by the recent activity of Scottish scientific societies, in the departments of Meteorology, Natural History, and Archæology, seem to make the present time most favourable for the production of an Atlas in which that valuable work shall be summarised and incorporated.

IN NATURAL SCIENCE, vol. ii., p. 385, we noticed M. Guinard's book, "Précis de tératologie"; we have now received a smaller volume, by Louis Blanc, "Les Anomalies chez l'homme et des mammifères" (Ballière, Paris, 1893, 328 pp., price 3 fr. 50), in which the student will find a great amount of useful and interesting information. The volume is fully illustrated.

IN referring last month (p. 77) to Mr. Minchin's translation of Professor Bütschli's work on Protoplasm, we erroneously ascribed its publication to the Clarendon Press. English-speaking students are indebted to the firm of Messrs. A. & C. Black for this enterprise, and the volume will probably be issued early this month.

CAPTAIN H. G. T. SWAYNE, who has made seventeen shooting and exploring trips into Somali Land, North-East Africa, is writing an account of the country, which will shortly be published by Rowland Ward & Co., of 166 Piccadilly, W.

MESSRS. DULAU & CO. have issued part xxxi. (Reptilia and Amphibia) of their Catalogue of Zoological and Palæontological Works. Numerous rare pamphlets are included in this useful sale-catalogue.

OBITUARY.

ARTHUR MILNES MARSHALL.

BORN JUNE 8, 1852. DIED DECEMBER 31, 1893.

THE Owens College and the Victoria University have suffered, by the sad death of Professor Marshall, an irreparable loss; in him they have lost not only one of their most brilliant professors, but also one of the most loyal of their servants.

Ever bright and cheerful, no difficulty ever daunted him, and no amount of work appeared to be too much for him. He was one of

ARTHUR MILNES MARSHALL.
(From a photograph by Warwick Brookes, Manchester.)

those rare men who are always working and never tired, although they do more work than any average man could do in twice the time—always busy, but never too busy to give help to those who needed it. His clear insight into the practical problems which had to be solved, combined with unusual foresight and tact, enabled him to avoid the difficulties in which others were constantly entangled; but when a serious difficulty was actually encountered, no man was more ready than he to attack it or give his aid to those by whom it had to be faced.

The obstacles which have to be surmounted in the founding of a university are familiar to those who have exerted themselves to promote the schemes for the foundation of the Victoria University, and of a teaching university for London, but those obstacles present very different aspects to the two bodies of men. When the difficulty has been overcome, the contemplation of it becomes a source of pleasure instead of a cause for anxiety. To Marshall, a difficulty ahead served as a pleasant stimulus; he rejoiced in overcoming difficulties, just as he rejoiced in climbing a mountain peak. Cautious and expert as a mountaineer, caution and expertness enabled him to contemplate a great difficulty, if not with pleasure, at least, without fear. Difficulty as a matter of history was familiar to him: unconquerable difficulty almost unknown. And to this, no doubt, his perennial happiness was largely due, for he was always happy.

Too clear-sighted not to see what was his own personal interest, he did not hesitate to sink that interest when it was necessary for the success of the undertaking; and the readiness and cheerfulness with which he did it led others to promptly make similar sacrifices. But he did not regard them as sacrifices, for his great aim was never personal gain, and he had the good fortune to be associated with others who equalled, though they could not surpass, him in unflinching loyalty to the College, to the new University, and to the cause of higher education generally.

The success of the Victoria University Extension movement has been due largely if not mainly to his efforts and his great power of organisation, and especially to his tact in adjusting conflicting interests. He thoroughly believed in the usefulness of the extension scheme, and threw himself heartily into the work—and the scheme has succeeded. He did not make it a success single-handed, but those who co-operated with him did so the more heartily because of his encouragement.

Many of the zoologists who knew him, and probably they alone, looked with disapproval upon this expenditure of his time—the energy did not much matter, for he seemed to have an unlimited supply of it. From a purely zoological point of view, this organising work was no doubt a loss to science. He himself ardently wished to find time for more scientific work, and he had at the time of his death already made preparations for new and elaborate researches. He was, however,—as befits a professor—always ready to devote his time to helping others in any kind of biological research.

Two volumes of "Studies from the Biological Laboratories of the Owens College" have already been published, and it was intended to publish another very shortly. Of the twenty-one papers included in these two volumes only four were prepared without his aid and inspiration, and of these three are botanical.

His enthusiasm was infectious, and he attracted large audiences to his popular lectures—audiences composed chiefly, not of "those who with itching ears run about after popular preachers," but of those who had been inspired with interest in biological science by his previous lectures.

The Manchester Microscopical Society, of which he was president for the last seven years of his life, is composed of enthusiastic naturalists, and it is largely because of the earnestness which his example has called forth that wealthy mill-owners and justices of the peace sit in the meetings of the society, unconscious of social inequality, cheek-by-jowl with poor men who work for a weekly wage; and to that same beneficent influence may be ascribed the fact that, under the auspices of the society, systematic courses of biological instruction are undertaken by teachers whose services are given gratuitously and willingly.

Marshall was only 41 years of age, and there was every reason to believe that in the next few years he would have accomplished far greater scientific work than he had as yet done; but there are few men who have done so much for the advancement of education in so short a time as he has, and yet have found time for even a little scientific work—and his scientific work is more than a little.

Like his friend, F. M. Balfour, who met with a similar untimely death on the mountains, he was a keen embryologist. He thoroughly believed in the theory of "recapitulation," and never lost an opportunity of convincing others of its truth. At Leeds, in 1890, he said:—

"That ontogeny really is a repetition of phylogeny must, I think, be admitted, in spite of the numerous and various ways in which the ancestral history may be distorted during actual development."

That sentence expresses the belief which formed the basis of his teaching. That theory was the source of the inspiration under which his latest published work was written, *i.e.*, his "Vertebrate Embryology," published only a few months before his death.

Of that work no review has appeared in the pages of NATURAL SCIENCE, but Professor Lankester, in reviewing it in *Nature*, says:—"It is not too much to say that he has produced a most valuable, clear, and masterly exposition of the known facts of the developmental history of leading types of vertebrata." It may be added that the book is very liable to give the impression to the reader that it is chiefly a compilation. But this is not correct. He repeated the observations of his predecessors wherever it was possible to do so, and published the results. It is not surprising that his predecessors were often right, and where they were right, he reproduced their accounts, and even their figures. Many of the figures, however, were corrected before they were reproduced, and the book contains considerably more than a hundred new ones, drawn by the author himself direct from nature.

Like other books which Marshall published either alone or conjointly, this was intended as a laboratory manual, and hence the "type system" had to be adopted; but it was really adopted for another reason. He was keenly alive to a source of error which is too commonly ignored—the assumption that what is true of one animal is true also of its allies, or nearly so. It is this assumption which seems to be taken implicitly as a justification for the description of changes in the course of development of man, which, whether they occur or not, have not been seen by those who have described them, or by those who have been quoted. It is this, also, that leads to the wholesale illustration of books on human anatomy by figures intended to illustrate the structure of man, though they have been drawn from animals sometimes as unlike man as dogfishes and birds. "Comparative Embryology" is one thing: the indiscriminate confusion of the embryonic development of one animal with that of another is another thing altogether. Marshall has produced the first book on the development of man and other vertebrates which is free from this confusion. He felt strongly the necessity for having a straightforward description of the development from beginning to end of a few typical vertebrates before attacking anew the larger problems of comparative embryology. That he did not live to attack anew those larger problems is a pity too sad for expression in words.

Besides this great embryological work, he published, alone and conjointly with others, several papers on vertebrate morphology, and especially on the morphology of the head. Other papers dealt with the development of the kidneys and fat-bodies, the abnormal conditions of the reproductive organs, and the development of the blood-vessels of the frog.

His chief invertebrate work was upon the Pennatulida, and one of the papers on this subject was written in collaboration with his father. He worked also upon the structure and physiology of *Antedon* (*Comatula*), and published a paper on its nervous system.

His published lectures and addresses are numerous, the presidential address to the Biological Section of the British Association (Leeds, 1890) and a paper on the morphology of the sexual organs of *Hydra* being, perhaps, the most important of them.

This may seem a small amount of scientific work for a man of his age, but those who knew Marshall best, know best how small a fraction it is of the work he did for the advancement of learning. They who would judge him by his published work would do him a gross injustice.

There is no great scarcity of zoologists who might efficiently perform the strictly zoological work of the professorship, but it is not probable that a successor will be found who is willing to devote so much time and energy to other business of the College and University as he did. It is even less probable that one will be found who is able to render such services with like tact and good humour.

"Few men have enjoyed life more, still fewer have used it better."

C. H. H.

RICHARD SPRUCE.

Born 1817. Died December 29, 1893.

THE botanical world has sustained an irreparable loss in the death of the famous botanist and traveller, Richard Spruce, who succumbed to an attack of influenza on the 29th of December last. Mr. Spruce was born in the year 1817, and was a native of the North Riding. It is nearly fifty years since he published his first paper, which dealt with the Mosses and Hepatics of Teesdale. Shortly afterwards he spent a year in the Pyrenees, collecting the flowering and cryptogamic plants of that region; his paper on the Mosses and Hepatics, published in 1849, was a very valuable addition to our knowledge of the European flora. In the same year he went out to South America, and travelled up the river Amazon, making extensive botanical collections. During two years he was, more or less, with Dr. Alfred Russel Wallace; and, when the latter came home, Mr. Spruce proceeded up the Rio Negro, crossed over to the Orinoco, returned to the Rio Negro, and exploring various of its tributaries, gradually made his way up into the Andes. Here he received a commission from the India Office to collect seeds and plants of the Cinchona, which was then rapidly becoming exterminated. In this he was most successful, and hundreds of young plants were safely transferred under the fostering care of Mr. Robert Cross from the western slope of Chimborazo to India, and established in the Himalaya. Mr. Spruce's travels are described at some length in the *Journal of Botany* between the years 1849 and 1864. He returned to England in 1863 a permanent invalid. His collections stand unrivalled, both in the immense number and the beautiful completeness of the specimens. His bad health prevented him from working out more than the Palms and the Hepatics. Mr. Bentham did the Phanerogams; Mr. Mitten the Mosses; the Rev. W. A. Leighton the Lichens; and the Rev. M. J. Berkeley the Fungi. Mr. Spruce's Hepatics of the Amazons and Andes occupies the whole of vol. xv. of the *Trans. Bot. Soc. Edinburgh*, and is a novel and most scientific treatment of the subject. The majority of his other papers were devoted to his favourite study—the Hepatics. The last thirty years of his life, rendered grievous by his chronic state of ill-health, were spent at Coneysthorpe, in North Yorkshire, where he died at the close of 1893, at the age of 76.

ROBERT BENTLEY.

BORN 1821. DIED DECEMBER 24, 1893.

THE late Professor Bentley was born at Hitchin, in 1821. After leaving school he was apprenticed to William Maddock, a chemist at Tunbridge Wells, and, having served his term, became an assistant at the establishment of John Bell & Co., in Oxford Street. He joined the School of Pharmacy in Bloomsbury Square at its foundation, and subsequently entered as a medical student at King's College, becoming, in due course, a member of the College of Surgeons. He commenced the study of botany during his apprenticeship, and when at Bloomsbury attended Dr. A. T. Thompson's lectures, and gained the first botanical prize awarded by the institution. His connection with the Pharmaceutical Society was almost lifelong, and it was to members and associates of the Society that he was best known. In 1887 he resigned the chair of Botany, and was shortly after elected Emeritus Professor. He was also for some time Professor of Botany and Dean of the Medical School at King's College, and Professor of Botany at the London Institution. He was twice President of the Pharmaceutical Conference, at Nottingham in 1866, and in the following year at Dundee, and for many years acted as chairman to the Garden Committee of the Royal Botanic Society, Regent's Park, where he annually gave a course of botanical lectures. His most important scientific work was that on "Medicinal Plants," which he shared with Mr. Henry Trimen, a most valuable book of deservedly wide reputation. Bentley also produced a small text-book on Botany, which passed through several editions, and was the author of numerous papers, chiefly of botanical interest, in the Pharmaceutical Society's *Journal*, the editorship of which he shared for about ten years. He was buried on December 30 at Kensal Green.

We are indebted for several of our facts to an obituary notice by Mr. O. Corder in the *Pharmaceutical Journal* of January 6.

THE deaths are also announced of SIR SAMUEL BAKER, the eminent African explorer; of PIERRE VAN BENEDEN, the veteran zoologist, of Louvain; of DR. J. BOEHM, the botanist, of Vienna, at the age of 62; of BARON KARL VON KÜSTER, the botanist; and of MAJOR JOHN PLANT, late of the Salford Museum. We hope to give some account of the work of SIR SAMUEL BAKER and other recently-deceased African explorers next month.

A LONG obituary notice of the late HENDRIK RINK, by Dr. Robert Brown, appears in the January number of the *Geographical Journal*.

NEWS OF UNIVERSITIES, MUSEUMS, AND SOCIETIES.

The Trustees of the George Henry Lewes Studentship in Animal Physiology, tenable for three years at Cambridge, London, or any Continental University, have elected Dr. John W. Pickering.

Among the lectures in Natural Science at Oxford during this term, the following are announced:—Professor Lankester and Mr. W. B. Benham, an advanced course on Reptiles and Birds; Mr. Benham on the Oligochaeta; Mr. G. C. Bourne on the History of Zoology; Professor Burdon-Sanderson and Mr. J. S. Haldane on the Physiology of the Nervous System; Mr. Haldane on Physiological Chemistry; Mr. E. B. Tylor on Races of Mankind, as classified by Language, Civilisation, and History; Mr. A. Thomson, the new Professor of Human Anatomy, on the Elements of Physical Anthropology as bearing on Classification of Races; Mr. H. Balfour on Progress in the Arts of Mankind, particularly as illustrated by the Pitt-Rivers collection. Professor Green lectures and gives practical instruction in Geology, Professor Vines in Botany, and Mr. M. S. Pembrey in Physiology and Histology, while Mr. Barclay Thompson lectures, as usual, on the skeleton of the Sauropsida.

The Natural History Laboratories of the State University of Iowa started a Bulletin about two years ago, which often contains papers of interest. No. 4 of vol. ii., which has just come to hand, includes "Observations on the development of the *hypophysis cerebri* and *processus infundibuli* in the domestic cat," by F. S. Aby, some papers on Coleoptera by H. F. Wickham, an interesting account of a botanical expedition to Nicaragua by B. Shimek, and studies of Myxomycetes by T. H. McBride. We have been greatly struck by the excellent applications of the half-tone process, sometimes known as "Meisenbach," to scientific illustration, and the plates, especially to the botanical papers, show what this process is capable of when the drawings are properly prepared, and the blocks carefully printed.

Toynbee Hall continues to do good educational work in Natural Science, as well as in the numerous other subjects with which its classes deal. The University Extension courses in connection with this centre are:—"Recent discoveries with the Telescope and Spectroscope," by Dr. A. H. Fison; "The Geology of the British Islands," by F. W. Rudler; and "The Senses and Nerves," by E. A. Parkyn. Classes are also held, in Botany by G. May, in Biology by Miss Mitchell, and in Geology by Miss Raisin, while Miss Hall takes a Sunday class on "Forms of Vegetable Life." The Toynbee Natural History Society announces the following papers:—On February 5, "African Experiences," by Dr. J. W. Gregory; on March 5, "Water Fleas of Wanstead Park," by D. Scourfield; and April 2, "Formation of Crystals in Rocks," by A. M. Davies.

A valuable herbarium has been presented to the Nottingham Natural History Museum by Mr. H. Fisher, late of Newark. Some idea of the nature and extent of the collection may be gathered from the following enumeration of the more important series included in it: (1) A complete herbarium of British plants, comprising about 2,000 species and varieties, and about 10,000 specimens. (2) A European collection, comprising many thousand species from France, Germany, Switzerland, Austria, Roumania, Russia, Norway, Sweden, &c. (3) Several thousand species from North America. (4) A very fine collection from the Bombay Presidency. (5) About 1,500 species from Natal, the Transvaal, and other plants of South Africa. (6) A small collection from Australia. Of the above collections that from Russia is of quite exceptional value and interest. It comprises species from all parts of the Russian Empire—from St. Petersburg, Lapland, and the Crimea, through Siberia to Kamskatka and Turkestan, also from the Trans-Caucasus and the Caspian region. The Spanish collection is an extremely fine and valuable one—probably one of the best in existence. In order to hand over the collection to the town in as complete and accessible a form as possible, Mr. Fisher is himself arranging and labelling the collection, a work which will take many weeks of continuous application to complete.

THE Royal Irish Academy has issued its *Proceedings* for 1893 (ser. 3, vol. iii., no. 1). Among other papers, it contains a list of the Hepaticæ of the Hill of Howth, by D. McArdle, and two papers by J. E. Duerden; the first on some new and rare Irish Polyzoa, and the second on the Hydroida collected by the Royal Irish Academy Survey of the south-west coast of Ireland, 1885, 1886, and 1888, both of which will be of importance to others besides British marine zoologists. Dr. V. Ball has an interesting article on the volcanoes and hot springs of India, to which we allude in another place.

WE have received the first and second parts of vol. iii. of the *Actes de la Société Scientifique du Chili* (Santiago, 1893). Among other papers in this number are Lataste's "Rhythme vaginale des Mammifères," Germain's "Coleoptères du Chili," and Grez's "Los jeroglificos de la Piedra de la Batalla," and "La Piedra del Olimpo," an interesting account of the picture-writings of the aborigines of Chili, with plates of the inscriptions. The concluding portions of Borne's paper on the spider *Latrodectus*, will shortly appear as parts 4 and 5 of vol. ii., and will complete that volume.

THE Royal Academy of Denmark have published *Oversigt over der K. Danske Videnskab. Selsk. Forhandlinger*, 1893, no. 2, which contains an interesting biological study of the leaf of the South American Vellosiacea, by E. Warming, and a systematic description of the larval forms of the water-insect *Acilius*, by F. Meinert. J. Lange continues his contributions to the Flora of Spain.

THE Wisconsin Academy have just issued vol. ix., part 1, of their *Transactions*. As a contribution to our knowledge of lake faunas, the paper by C. D. Marsh on the Cyclopidæ and Calamidæ of Central Wisconsin will be of importance. The other Natural History papers are mostly lists of local faunas and floras.

AT the fourteenth annual meeting of the Biological Society of Washington, the officers for 1894 were elected, as follows:—President, Professor C. V. Riley, U. S. Entomologist; Vice-Presidents, Dr. F. Baker, Superintendent of the National Zoological Park, Mr. B. E. Fernow, Chief of the Forestry Bureau, Mr. R. Rathbun, of the U.S. Fish Commission, and Mr. C. D. Walcott, of the Geological Survey; Recording Secretary, Mr. F. V. Coville, of the Department of Agriculture; Corresponding Secretary, Mr. F. A. Lucas, of the National Museum; Treasurer, Mr. F. H. Knowlton, of the same institution. The Biological Society is one of the oldest of the scientific societies of Washington, and devotes its meetings to the discussion of original scientific facts rather than to the popular exposition of biology.

The following awards have been made by the Council of the Geological Society of London, to be presented at the annual meeting on February 16:—The Wollaston Medal to Professor Dr. K. A. von Zittel; the Murchison Medal to Mr. W. T. Aveline; the Lyell Medal to Professor John Milne; the Wollaston, Murchison, and Lyell Funds respectively to Messrs. A. Strahan, G. Barrow, and W. Hill; and a portion of the Barlow-Jameson Fund to Mr. Charles Davison.

The Committee of the Natural History Society of Northumberland has organised a series of six popular lectures on Natural History, now being delivered on alternate Saturday evenings in the Newcastle Museum. This month Dr. G. S. Brady discourses on Natural History in Norway, and Professor M. C. Potter gives an illustrated lecture on Tropical Vegetation in Ceylon. Subsequent lectures relate to forest trees, the ancestry of the horse, and the history of photography. Mr. A. H. Dickinson has succeeded the late Mr. Dinning as hon. secretary.

The Palæontographical Society have issued their volume of Monographs for 1893. It comprises instalments of Fossil Sponges, by Dr. G. J. Hinde; Ammonites, by Mr. S. S. Buckman; Cretaceous Star-fishes, by Mr. W. Percy Sladen; and the Devonian Fauna of S.E. England, by Rev. G. F. Whidborne.

At the moment of going to press we learn of the election of Mr. Henry O. Forbes to the Curatorship of the Liverpool Museum, in succession to the late Mr. T. J. Moore.

CORRESPONDENCE.

Olive-Brown Seaweeds.

In the January number of Natural Science, Miss Barton has set forth exhaustively, if in somewhat severe language, the present state of our knowledge of the development of the cryptostomata and conceptacles of the Phaeophyceæ. I do not wish to dispute any single fact she has mentioned, or to question her presentment of the whole body of them, but since the matter is one of considerable interest, a little further discussion of the bearing of the facts and of her suggested interpretations may be profitable. At first sight, the discussion might appear to wear the aspect of a contention for the shell of a nut, while the kernel is despised—that the contents (when there are any) of these bodies might serve us better for discussion, but I do not find that this view, in effect, has been neglected, though, perhaps, she has presumed the reader to understand more than he commonly does. It might be objected also that this is, to some extent in any case, an affair of growing-points which hardly afford stable characters otherwise in the groups in question. Here, again, one might easily be misled, as there is no diversity of the kind unaccompanied by other characters. A third objection might be raised that, in some of the cases cited, the hairs of the cryptostomata may possibly be discharging the function of absorption, for example, and I may anticipate such an objection by saying that whatever their present function may be, it has little or nothing to do with what the original one may have been, if these are indeed "ancestral structures," as Miss Barton possibly considers them. So far none of these views seriously touch the matter, and I bring them forward to dispose of them merely as a supplement to her article.

I have no doubt merited Miss Barton's criticisms of my contempt for the ancestors of the Fucaceæ, since she shows that some observations of my own might be exhibited as having a genealogical interest in this direction. I think I have spoken of them elsewhere with respect. No one can, indeed, dispute the fact of seaweeds, like other beings, having had ancestors, but my faith has not given me the eye to see these interesting organisms gilded with the romantic attributes that Miss Barton has ascribed to them. Cold facts do not carry us far enough. It may be profitable to ask ourselves the questions with which she concludes her article, but we may also ask them of Nature. We shall certainly get no answer until we do. That may be, and no doubt is, a sententious remark, but without striking too decadent a note, one may at least give warning of the danger of applying such broad principles to an insufficient array of facts. In Miss Barton's case it is, no doubt, a symptom merely of the enthusiasm which will enable her to add to the facts she has already accumulated not the least by her own investigations.

George Murray.

Scientific Volapük.

In your useful article on "Scientific Volapuk," which should, by the way, be "Volapük" (World-speech), you quote Professor Hyatt's terms mostly from *Zoologischer Anzeiger* for August, 1893. You seem to have overlooked the original paper "Bioplastology and the related branches of biologic research" (*Proc. Boston Soc. Nat. Hist.*, vol. xxvi., pp. 59-125), of which the publication was begun in August and completed in September, 1893. Since this paper contains a few terms that you have not mentioned, I respond to your request for additions by sending them herewith.

Autotemnon (αὐτός, self; τέμνω, I divide), a single free Protozoon, so called in allusion to the common mode of multiplication, and in distinction to *zoön* which is the unit of the Metazoa.

Epembryonic (ἐπί, after; ἔμβρυον, embryo), a term characterising all stages of ontogeny after the embryonic.

Mnemegenesis was less correctly Mnemogenesis in the original paper.

Tachygenesis (ταχύς, quick; γένεσις, formation or development), the phenomenon previously known as "acceleration of development."

Tachygenetic, adjectival form of preceding, applied to normal types in which acceleration of development occurs.

It may also be noted that *Kinetogeny* of Ryder is merely a variant of *Kinetogenesis* of Cope, with the same meaning and corrupt etymology, only more so. Some people are never satisfied.

You are doubtless correct in criticising *Cotype*; for *typus*, though used by the Romans just as *type* is by us, was always regarded by them as a Greek word and they would certainly have used the prefix *syn-*. At the same time Oldfield Thomas is not altogether to blame, since he gives the credit (or discredit) for the word to C. O. Waterhouse, and merely retains for himself the credit of defining it more exactly.

Although one of those who have before now fallen under the lash of your criticism in respect of word-making, permit me to say that with this your last article I fully agree, and especially with the last paragraph of it which relates to the popularising of science. After reading the article that preceded it, I dreamed all night that I was a sorus of plurilocular sporangia and Laminarian paraphyses rolled up in a Fucaceous conceptacle to protect me from the attacks of oogonia, antheridia and filamentous cryptostomata.

F. A. BATHER.

FONA OR FUDDLEITE.—A NEW MINERAL.

A GOOD-NATURED friend has just drawn my attention to the note under this heading which appears in your last issue.

Mrs. French-Sheldon was kind enough to send me a copy of her interesting work, and, like your contributor, I was somewhat amused at, and for a moment exercised to understand, the extraordinary collocation of symbols which is there made to do duty for the formula of *Trona*, which, in my letter to the fair authoress, I had represented—or perhaps I had better say, attempted to represent—as

$$2\ Na_2O\ 3\ CO_2\ 4\ H_2O.$$

The matter, I think, is hardly worth the space it occupies in a periodical of the dignity and importance of NATURAL SCIENCE; but, in justice to the lady, may I suggest to your contributor, whose acumen would seem to lag behind his sense of humour, that he might exercise, and possibly even improve, his critical *flair* by ascertaining, *currente calamo*, how this expression could be calligraphically transformed into something akin to that which has so greatly puzzled and disturbed him.

T. E THORPE.

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NOTES AND COMMENTS.

Haeckel.

"It gives furiously to think," as the *Saturday Review* delights to put it, that Ernst Haeckel was born only sixty years ago; for those of us whose scientific education dates within the last two decades have been accustomed to regard him as a necessary pillar of the world of thought. Morphology, promorphology, the categories of individuality, the gastræa theory, the comparisons of vertebrate embryos, the natural history of creation, and the blundering incapacity of those who doubted it, were no small part of the intellectual pabulum of our scientific youth. We learned from him that the animal kingdom was a set of pieces to be arranged in orderly procession from Protista to Man; that to study the embryology of an animal was to unwrap an Indian puzzle-box, piece within piece, and each piece suggesting the animal next behind in the procession of all the animals. We learned from him to invent logically hypothetical ancestors, and to find living animals to tally with them. It was all so cogent and so stimulating, and now, with fuller knowledge, so easy to jeer at and discredit. No one goes now to Naples to discover in the development of an animal exactly what he knows should be there: even a new discovery of the ancestor of all the vertebrates is somewhat blown upon. We elaborate methods, work out details, and mutter sadly:—

> "Embryologists we,
> But we haven't got everything down in the sea."

It is a history common to all great ideas. They explain so much at first, open so many new vistas, lead to advances so great that they seem master-keys to all the secrets of nature. And then a time comes when the potent explanation becomes impotent; a time when one set of men seeing only how much it has explained, distort things it cannot explain into formal harmony, while another set, seeing only what it cannot explain, attempt to discredit it altogether. The cell theory and the recapitulation theory are now in this condition, and Haeckel, partly because of the intimate connection of so much of his work with the recapitulation theory, is, perhaps, less of a moving force in Biology now than ever he has been.

None the less, when the history of the Biological Renaissance comes to be written, the naturalist of Jena will be among the three or four most conspicuous figures. Since Johannes Müller at Berlin, no teacher has turned out so brilliant a set of pupils, has founded so energetic, so militant, so flexible a school. It is astonishing, but only at first sight, that his school should have been so flexible and the paths of his pupils so divergent. For those who have worked in his laboratory and talked with him under the lindens at his fascinating

Ernst Haeckel, from a photograph by F. Haack, Jena.

combinations of Seminar and Kneipe, know that Haeckel is a man not of one idea, but of ideas. However one may admire patient empirical work, it is not patient empirical work, but patient labour pointed by preconceptions, made alive by ideas, that is stimulating and aggressive, moving towards new branches of investigation. He is a dull man whom all speak well of, and it is dull work that evokes no antagonism. For the present, we are well content to cease from controversy, to let Calcareous sponges, the Gastrula, the "Plankton," and Haeckelismus take care of themselves, and to join hands in celebrating the festival of Haeckel. Hoch! Hoch! Hoch!

Von Zittel.

Another eminent German, just now receiving well-merited honours at the hands of both his and our own countrymen, is Karl Alfred von Zittel, the first palæontologist of the day. In another part of this number (p. 222) we review the great "Handbook of Palæontology," which he has just brought to a conclusion. Here we give a few facts of his personal history, which we hope may prove of interest.

Von Zittel's father was a Protestant minister and head man of the Liberal Party at Bahlingen in Baden. Here Alfred was born on September 25, 1839, and here, amid the volcanic mountains of the Kaiserstuhlgebirge, he passed the first ten years of his life. Then the father was transferred to Heidelberg, where he sent his son to the Lyceum and afterwards to the University. The young student came into very intimate relations with the Professors of Geology and Palæontology, Cesar von Leonhard and H. G. Bronn, and in 1860 took his degree as Doctor of Philosophy. The following year he spent in France and particularly in Paris, where he made the acquaintance of Elie de Beaumont, the Eudes-Deslongchamps, father and son, and many others then or afterwards leaders in the development of geology and the allied sciences. In 1862, Zittel joined as a volunteer the Austrian Geological Survey at Vienna, and during 1863 was employed as an assistant in the royal "Hof-Mineralien-Cabinet." In the latter year he became Professor of Mineralogy and Geology at the Polytechnic in Carlsruhe (Baden), whence, in 1866, he removed to Munich as Professor of Palæontology in the University. In this post he has since remained, adding to it since 1880 the duties of Professor of Geology. Professor von Zittel has travelled much in the interests of science, his most notable expedition being that to the Libyan Desert in 1873-4. In his Professorial capacity, as editor of *Paleontographica*, as editor and part author of the *Handbuch der Palæontologie*, and by his numerous original publications, he has probably done more than any living man to advance his favourite science. He is a member of the Royal Bavarian Academy of Science, Director of the Palæontological Museum at Munich, and Chevalier of the Order of the Crown. He served as Vice-President of the International Congress of Geologists at its Washington meeting, in 1889 he was elected a Foreign Member of the Geological Society of London, and at its Anniversary Meeting this year the same Society awarded him the Wollaston Medal, the highest honour in their power. Lastly, he has been appointed a Privy Councillor of the German Emperor.

In 1863 von Zittel married a daughter of Schirmer, the well-known Düsseldorf painter, then Director of the Academy of Arts at Carlsruhe. An excellent musician, and he is as charming and accomplished in society as he is profound in his own special studies. He speaks our language readily, and has more than once visited England, where he has a friend in everyone that has the honour of his acquaintance.

Darwin.

Meanwhile the bidding to "praise famous men" is not being forgotten by Englishmen. The inhabitants of Shrewsbury, in which town Charles Darwin's father practised as a physician and where he himself was born, have, in a numerously-attended public meeting, determined to establish some memorial of the great naturalist. At present nothing definite has been decided, as it was felt that the memorial should not be merely local but national and indeed world-wide. A committee has therefore been appointed to make arrangements for a public meeting of scientific men and others interested in the object, which meeting it is hoped to hold early in March. Any-one who wishes to attend the meeting should communicate with Mr. H. C. Clarke, Town Clerk's Office, Shrewsbury. The suggestions already made are mainly three:—First, to place a bronze statue of Darwin in front of the old school buildings, which are now used for a public library and museum; no more appropriate site could be imagined. Second, to found some scholarship in connection with Shrewsbury School; if the intention be to encourage science, we would suggest that the scholarship should be given to boys on leaving rather than on entering the school. Third, to erect and endow in Shrewsbury a hall for technical and scientific teaching. All schemes are excellent, but the last seems a little ambitious; a combination of the two former seems most likely to meet with general approval. However this may be, we wish all success to the good people of Shrewsbury, believing that such public and visible honour to great workers in science will stir future youth to follow their example.

Harvard Museum and Scientific Co-operation.

Mention of "the Pope of Jena," as Haeckel has been bitingly nicknamed by his eminent opponent in "plankton" controversies, Alexander Agassiz, reminds us that we have received the annual report of the latter as Curator of the Museum of Comparative Zoology at Harvard College. Unlike most museum reports, these publications of Professor Agassiz always prove very interesting reading, and this seems to us to arise from the fact that this Museum is not merely a place for the storing of specimens, valuable though its collections are, but is a growing and living institution actively connected with the acquisition of fresh knowledge in all branches of biological and geological research, and with the imparting of that knowledge to eager classes of university students as well as to the larger public. In these respects a museum attached to a university, with properly appointed laboratories and a staff of broad-minded investigators, must always have some advantage over an establishment that is a museum and nothing more. In museums of the latter kind there is an inevitable tendency to ignore the philosophical aspects of the natural history sciences and to exalt the purely systematic sides of them; and thus the curators of such a museum become finicking specialists, keener to find one spot more on a leopard's coat or one scale less on a butterfly's wing than they are to discover and exemplify fundamental features of organic structure. That this deficiency is due to no causes necessarily attached to museum work is clearly shown by the instructive and beautiful cases placed in the entrance hall of the Natural History Museum at South Kensington, some of which it is now intended to imitate in the Harvard Museum. On the contrary, we believe that the deficiency, where it occurs, is caused by the severance of the museum from the active workers, by the consequent absence of laboratories with proper facilities, and by the financial difficulties in the way of keeping up a complete library of other than merely systematic literature. The only way to overcome these difficulties, which we know to be in force in all parts of the world, is to bring about a more intelligent co-operation of the various government and private establishments with kindred aims, and to resolutely sweep aside the petty jealousies and red-tape restrictions that have no other effect than to hinder true progress.

In this very report before us is a case in point. "It is to be hoped," writes Professor Agassiz, "that some arrangement may yet be made between the representatives of the leading Universities and the Fish Commissioner by which the exceptional facilities for marine research now existing at the Fish Commission Station at Wood's Holl, may be made available for original investigation." The Fish Commission itself cannot spend money on questions with no direct practical bearing on fishery; at the same time it has at Wood's Holl an expensive plant, too extensive for its own needs. If, however, the government bureau and the leading universities could only be induced to co-operate, it would be possible to raise a fund large enough to relieve the Commission of its purely scientific work, and to afford sufficient means for its publication.

Birds' Eggs at the British Museum.

While alluding to the introductory educational series at the Natural History Museum, we should not omit to notice the admirably instructive exhibit of birds' eggs, with which Sir William Flower has recently enriched the central hall. After a description of the structure of an egg, illustrated by a diagrammatic section, the characters of number, form, size, texture and colour, are successively elucidated by specimens and labels. The number of eggs laid in one nest, and sat upon together, though tolerably uniform in each species, varies greatly in different species. Thus, the Manx Shearwater has but one egg, the Swift and Ring-dove two, while clutches of the long-tailed Tit and the red-legged Partridge are exhibited with nine and twelve eggs respectively. In form, eggs may vary from almost spherical, as in the Scops Owl, to different modifications of elliptical or oval. The latter form, in which one end is smaller and more pointed than the other, though not universal, is the most frequent, and distinguishes the eggs of birds from those of reptiles. If there are many eggs in the nest it is obvious that the conical form makes close packing more easy. Where only two eggs are laid they are seldom conical. Eggs having a pyriform shape, or narrowing very rapidly towards the smaller end are mostly those of wading birds (*Limicolæ*) which lay four in a nest, and are large in proportion to the size of the bird, as exemplified by four Lapwing's eggs. Their pointed ends being turned inwards, they occupy as little space as possible, and are thus more easily covered by the brooding parent. A conical egg placed on the ground or a ledge of rock is less liable to roll away from its place if disturbed, than one of a spherical form. The size of the egg has generally, but by no means constantly, some relation to that of the parent bird. It also depends very much on the degree of development of the young bird at the time of hatching. When the hatched young are immature and helpless the eggs are small relatively to the size of the parent. Such birds usually build carefully-constructed nests. But when the young are well clothed with down and can run and feed themselves, the eggs are large, and laid on the ground or in imperfect nests. The Curlew and Raven are instances of birds of equal size with differently-sized eggs. The Cuckoo, which lays eggs in the nests of birds smaller than itself, has a relatively smaller egg than any other bird. The surface of the shell varies much in texture in the eggs of different birds. Among other examples are the smooth polished egg of the Tinamou, the smooth and glossy egg of the Kingfisher, the dull and chalky eggs of the Ibis and Duck, the eggs of the Ani and Flamingo with a distinct calcareous film, and the rough, pitted egg of the Emeu. The colour of the egg has no relation to that of the parent bird. White is probably the primitive colour of birds' eggs, as it is that of the eggs of all reptiles. The eggs of birds laid in holes, either in the earth or trees, entirely concealed from the light, are mostly white. The larger number of eggs are variously coloured by the deposition of pigment on or near the outer surface of the shell. The colour may be uniform throughout the surface of the shell, or it may be in irregular washes, blotches, more or less circular spots or lines, upon either a white or uniformly coloured ground. The signification of the various modes of colouration is very little understood at present. It often happens that the different species of a natural group of birds present a general similarity in the style of colouration of their eggs, or in other words that nearly-allied birds have similar eggs, a fact exemplified by sets of Warblers' and Buntings' eggs; but the exceptions to this rule are very numerous as shown by eggs of different species of Thrush. In certain cases there is evidently an adaptation of the colour of the eggs to their natural surroundings for the purpose of concealment. Excellent examples of this may be seen in the groups illustrating the nesting habits of British birds in the Bird Gallery. Though the greater number of species of birds lay eggs all of which are of tolerably uniform character, varying only within narrow limits, there are some cases in which the eggs of different individuals of one species present a remarkable diversity, as shown by the eggs of the Guillemot (*Lomvia troile*).

This beautiful exhibit is rather hidden in a dark corner; but we hope that the rapacious schoolboy will ferret it out, and learn that there is something more to be done with eggs than merely to rob the nests of diminishing species. All who see it must acknowledge what beautiful results can be attained in museum work by any curator who spends little money, but much time and brains.

Deficiencies in Museums.

That is one side of the picture; but there is another, not so pleasing. At a recent meeting of the Geological Society of London an eminent palæontologist read a most interesting paper on the wonderful series of bones lately obtained by Mr. Lewis Abbott from a fissure-deposit, apparently of Pleistocene age. He had, however, occasion to lament that the value of his paper was considerably marred by the great difficulty he had met with in obtaining skeletons of many very common species for the purpose of comparison, and by the consequent uncertainty of some of his specific determinations. Some of his hearers were probably astonished to learn how large a number of our common British birds were unrepresented by a single bone in either our great National Collection or in that of the College of Surgeons. Among the species so conspicuous by their absence, the speaker mentioned the Swallow, the Song-thrush, the hairy- and feather-legged Buzzard, not to mention many species of Ducks and Gulls. Other of his hearers may have been filled with sorrow rather than surprise, remembering that this is not the first time such a complaint has been made. The Catalogue of Fossil Birds, officially published by the Trustees of the British Museum itself, remarks on the absence of skeletons of the existing species of *Anas*, and publishes a list of the fossil species which is, for that reason, avowedly imperfect and probably incorrect. Three years ago the author of this Catalogue said, at a meeting of the Zoological Society, whose President is, our readers will remember, the Director of the Natural History Branch of the British Museum: "With regard to the question of extinct species, the unfortunate imperfection of our English collections of recent avian skeletons renders it in some cases impossible to determine definitely the species to which the specimens belong."

It is all very well to attract the public with superb specimens of the taxidermist's art; it is most important that the collections should be enriched by the acquisition of type-specimens, of rarities and of bird skins from all parts of the world; we do not even grudge the spending of thousands of pounds on illustrated catalogues of these same skins: but surely a Museum that can afford to spend many pounds on a single specimen of a white rhinoceros, might set aside a few shillings for the purchase of skeletons of our common British birds. It is all very well to say that money must rather be spent on rare specimens such as are not to be had every day, that the common things will wait and that people can see them elsewhere if they take the trouble. It should be remembered that for one person who wants to study the rare thing, there are a dozen who want to study the common thing, that these things, common enough now, are rapidly becoming rarities themselves, and that the complaints here quoted are clear evidence of a difficulty actually experienced, not by amateurs, not by private students, not by tyros ignorant of the proper places to go to, but by experienced scientific men themselves in the employ of the State.

It is not for us to enquire who is right or who is wrong; we would merely point out that scientific investigations of the deepest interest, and of importance, even to museums, are constantly hampered by these lamentable deficiencies which might so easily be remedied. We commend the subject to that energetic body the Museums' Association, and especially to its President, Sir William Flower.

The Modern Museum.

We are pleased to learn from its report, that the Association just mentioned is in a very satisfactory state of life and growth. The number of museums officially connected with the Association has risen from 35 to 40, while the number of unofficial associates has risen from 28 to 63. This sudden increase was due partly to the last meeting having been held in London, and is therefore not likely to be permanent. It is more worthy of note that many colonial museums and curators are now to be found on the list. As yet there is only one foreigner, Dr. A. B. Meyer of Dresden; but we see no reason why this Association should not become in time the recognised centre of museum workers all over the world. Local branches and committees would of course be necessary; but if there were a single publication and a supreme council to assist in questions of exchange, the employment of specialists, the distribution of labels and the like, we cannot doubt that great advantage would accrue, not only to museums, but to the arts and sciences illustrated by them.

The report opens with the very interesting address delivered by the President, on Modern Museums. This is chiefly devoted to an examination of the changes rendered necessary in the construction and planning of museums by the altered ideas as to the functions of a museum that have come so much to the front of late years. These functions are two, as expressed by Dr. J. E. Gray at the British Association in 1864,—" first, the diffusion of instruction and rational amusement among the mass of the people, and, secondly, to afford the scientific student every possible means of examining and studying the specimens of which the museum consists." Sir W. Flower maintains that most local museums should confine themselves to the former function, and that only in national museums can the fulfilment of both functions in fairly equal proportions be expected. In connection with what we have said above on the deficiencies of museums, the following passage is of interest.—"As the actual comparison of specimen with specimen is the basis of zoological and botanical research, and as work done with imperfect materials is necessarily imperfect in itself, it is far the wisest policy to concentrate in a few great central institutions, . . . all the collections which are required for the prosecution of original research," especially collections "containing author's types . . . which must be appealed to through all time to settle vexed questions of nomenclature."

The address concludes with a plan suitable for any museum that proposes to follow up what is here called "the new museum idea." The chief features in this plan are the separation of the reserve collections from those intended for public exhibition, while retaining them in convenient proximity, and the separation of the officers' studies from the galleries in such a manner that they can stay at their work after the museum has been closed to the public. In a footnote, dated November 2, 1893, it is stated that a plan which "closely resembles" this "in essential features" has been found among the papers of the late Sir Richard Owen. It also has the advantage that the recent and extinct forms of each group, though not absolutely incorporated into one series, are brought into nearer relationship to each other than they are at present in the British Museum. We shall never cease to deplore that this plan of Owen's was not adopted, and we learn with interest that it is to be made public in the life of the great Anatomist, already announced by Mr. John Murray.

The House Beautiful.

But perhaps the most interesting paper contained in this report of the Museums' Association is that in which Mr. William White, the curator of the Ruskin Museum at Sheffield, gives an account of Mr. Ruskin's views on the function of museums; and the paper is interesting, not because the ideas in it are new, but because they were, for the most part, put forward by Mr. Ruskin so many as thirty years ago, and yet are a long way in advance of what has since been attempted in the larger number of museums. Indeed, so lofty is the height from which Mr. Ruskin looks at these matters, that we doubt whether even remotest ages will ever see some of his ideas put into practice. So long, for instance, as brains and body require proper nourishment, so long will the students and officials at a great public museum demand that it shall be furnished with a "cooking apparatus for carnivora."

When Mr. Ruskin requires beauty in a museum we are wholly with him. What can be better than this:—"The first function of a museum is to give example of perfect order and perfect elegance, in the true sense of that test word, to the disorderly and rude populace. Everything in its own place, everything looking its best because it is *there*; nothing crowded, nothing unnecessary, nothing puzzling." Or again, "Above all, let all things for popular use be *beautifully* exhibited." Such a sentence should be borne as phylactery on the apron of every curator. But when Mr. Ruskin restricts beauty to "creatures in their perfectness"; when he denies "anatomical illustrations to the general public"; when he writes such pure Ruskinese as this: "Neither must you ever show bones, or guts, or any other charnel-house stuff. Teach your children to know the lark's note from the nightingale's; the length of their larynxes is their own business, and God's"; then we do think that this honey-tongued prophet of beauty proves himself no true seer. The beauty of an animal or a plant is no more confined to its external form and colouring than are the so-called diagnostic characters which distinguish it as a species apart. A sea-urchin "in its perfectness" is a beautiful object, so is the single richly-ornamented spine of such an animal; but this beauty is entirely the expression of a complicated internal structure, which, when viewed under the microscope, reveals a further beauty that should compel admiration even from Mr. Ruskin. Take him on his own ground. He goes to the British Museum (in 1880) to see a duck's wing, and does not find exactly what he wants. Away, then, with the shells and the monkey skeletons; he must have a gallery full of birds in flight! "What on earth, or in air, is the use to me of seeing their boiled sternums?" Had Mr. Ruskin's flights ever extended beyond his rhetoric, he would probably have found a sternum quite as useful as a wing. Next he will be urging artists to draw ships in full sail with never a spar to desecrate their canvas; the length of their masts is their own business, and the shipwright's.

Apart from this feminine horror of "nasty skeletons," the paper contains much that is valuably suggestive, and it is to be regretted that no discussion took place on it. It is interesting to learn that Mr. Ruskin does not approve of the Sunday opening of museums, that while he would abjure all idea of financial profit, he would charge a small sum for admission in order to keep out "the utterly squalid and ill-bred portion of the people," and that, in his opinion, names of the donors of objects "should cease to encumber either the cases or the scientific guides to them." On points such as these the opinions of professional museum curators would have been worth recording.

In these matters it should be remembered that Mr. Ruskin is no mere visionary schemer. He has given evidence before Parliamentary Commissions on Galleries and Public Institutions, besides his museum at Sheffield he has arranged collections in various parts of the country, and the beautiful book reviewed in another part of this number reminds us how large a share he took in the establishment of the Oxford Museum. This latter was indeed an earnest-hearted attempt to produce a building, which, though devoted to Science, should be a true temple of the Muses, worthy in all respects to be called a House Beautiful. The attempt failed, many will say; failed before a concerted opposition and an unworthy economy. And yet we think that they who have on a summer evening walked in the meadows of the Cherwell, and have seen the pointed outline of the Museum dark against a sunset sky, have then beheld, among all the beautiful sights of Oxford, one that is second to none in either grandeur or beauty.

Winchester College.

One word more on Museums. In this number we are pleased to present our readers with the second article of our promised series on School Museums, in which that of Eton College is described by its present Curator. We hope it will not be long before we deal with the Museums of other of our great schools. But we fear that we shall have to wait long for any account of the Museum of Winchester College. In December last we alluded to the admirable scheme by which it was proposed to commemorate the quingentenary of the School. We regret now to learn that the proposal is not meeting with the warm acceptance that the patriotism of Wykehamists led us to expect. Up to the end of last year only 230 persons had subscribed. It is indeed to their credit that they contributed £3,367 between them, and since then a few more people have promised some £700. This, however, will not go very far, and one cannot help wondering what the many thousand old Wykehamists, who must be in existence, are thinking about. We cannot suppose a want of *esprit de corps* in so united a body; rather we infer a want of sympathy with modern educational needs, similar to that which accounts for the deficiency we have next to notice.

Absence of Experimental Psychology in England.

Some time ago, in reference to a preposterous magazine started by Mr. Stead, sensation-monger-in-chief to the British Philistine, we directed the attention of all interested in problems of mind and consciousness to the scientific organs for the discussion of these problems. In our Reviews for the month is noticed the first number of a worthy addition to these organs,—*The Psychological Review*, edited by J. McKeen Cattell, of Columbia College; and J. Mark Baldwin, of Princeton University, with the co-operation of many well-known psychologists. We welcome this new magazine heartily, and congratulate its editors on their excellent beginning. But an interesting if somewhat dolorous problem suggests itself here. A large part of modern psychology concerns itself with laboratory work of the kind known as experimental physiological psychology, the application of the exact methods of science to the problems of memory, sensation and so forth. Although this branch of science is comparatively recent, there are well-equipped laboratories for it all over the continent, and the greater colleges and universities of America are no whit beyond. We know of none such in England. It is true that valuable work has been done by Francis Galton, and others, and we may expect more from the new Professor at Owens College. There was a rumour that Professor Burdon Sanderson hoped to establish a new department in connection with the Physiological Laboratory at Oxford, where already a good deal of psychological work has been done under his auspices. But it remains a rumour, and indeed we cannot see how Dr. Sanderson, with a growing medical school and an increasing number of students and graduates engaged on pure physiology, can spare either time or space. England has the men; cannot it find the money? No doubt it is an excellent thing for the race that the distribution of the endowments of Oxford and Cambridge should promote early marriage among those who have distinguished themselves in the classical schools. But there are more excellent and directer methods of dealing with endowments intended to promote learning. One of these, as Natural Science has taken repeated occasion to say, is the assignment of fellowships for branches of learning and research that are of themselves valuable, but open no direct avenues to lucrative employment. So much for Oxford and Cambridge. For other seats of learning devoid of so many pious benefactors in the past, we must hope for practical benefactors in the present.

Theories and Facts in Biology.

Last month, under the heading "Mathematical Biology," we referred to several interesting studies on variation as it actually occurs. Professor Weldon's insistence on the necessity for accurate information about variation might well be extended to various other chains of facts that form the bases of theories of evolution. Books, papers, and controversies on evolution abound, and in all of them variation, influence of environment, heredity, effects of crossing are the tricks to be made as the cards are dealt and shuffled, shuffled and redealt. The giraffe, fancy pigeons, the tails of lizards, and neuter insects invariably are the court cards, and it would not be difficult to assign equally well-known examples to the plain cards. It is an excellent game, and, as each player holds a full pack and may begin betting when he chooses; the playing is as complicated as the rules are lax. But the giraffe is always the trump card. Lamarck first played it for use-inheritance, assigning its long neck to the inherited effects of reaching up to high branches; Darwin played it for Natural Selection; Herbert Spencer attempted to take one trick with its neck, another with its legs; Nägeli used it as a trump against selection; Weismann for selection; Professor Henry B. Orr, of Louisiana, U.S.A., in a book noticed among our Reviews, plays it for a system of his own. "The giraffe," he says, "seems to present the most remarkable illustration of the lengthening of the bones as the result of the frequent repetition of shocks. As is well-known, this animal feeds on the foliage of trees. From the earliest youth of the species and the earliest youth of the individual, it must have been stretching upwards for food, and, as is the custom of such quadrupeds, it must have constantly raised itself off its fore feet, and as it dropped must have received a shock that made itself felt from the hoofs through the legs and vertical neck to the head. In the hind legs the shock would not be felt." We are less sorry now that the giraffe is becoming extinct.

But, seriously, this fashion of dealing with the problems of evolution is the most degenerate formalism. No doubt the ingenious schoolman of the middle ages who introduced the burning question of the number of angels who could dance on the point of a needle, introduced it seriously to bring a metaphysical argument to an exact issue. But the example was taken up and argued through centuries till memory of the original question has been lost in laughter at the folly of early logicians. Let us make a concerted effort; let the giraffe be a name not to be named by the votaries of science. Else the laughter of our descendants will be at those word-spinners of the nineteenth century who, having seen no giraffe (save perchance in a menagerie), indulged in copious controversy as to whether or no it distorted its neck and legs by bumping and stretching.

A Whale-Fight in the South Atlantic.

Mr. R. Lydekker, who has recently returned from his journey to Argentina, favours us with the account of an interesting incident of his outward voyage. It is to be hoped that some of our readers, who may have witnessed a similar scene, will be able to throw light on points obscure to our correspondent, who writes as follows:—

"It was on the afternoon of September 9th in last year, about half-past four, that I was standing, in company with a lady fellow-passenger, on the poop of the Royal Mail Company's s.s. "Magdalena," watching the taking of soundings, the vessel being then off the coast of Minas Geraes, Brazil, at no great distance from the islands of Los Abrolhos, in long. 39° W., lat. 18° S. The soundings had just been completed when the attention of my companion and myself was attracted by the appearance of a whale and some other creatures at a distance of apparently something less than a quarter-of-a-mile from the ship. The whale was a 'finner,' of no very great size, and was seen spouting, and again descending. Immediately after its first descent there appeared above the surface of the sea what seemed to be the tail-fin of some animal unknown. This supposed fin was raised in a vertical position, where it remained vibrating for some seconds and then suddenly disappeared. In colour it was a pure glistening white; while in form it appeared to be laterally compressed, with sharp edges and an acute termination. It gave the impression of belonging to some animal which was engaged in attacking the whale beneath the surface; and I should estimate its height above the water approximately at five or six feet. Soon after the disappearance of this strange white object,—which, both to my companion and myself, seemed most weird-like,—the broad black head of what I presume to have been a killer-whale was seen above the water; and in a few seconds the whale itself again rose to spout.

"The speed that the vessel was going soon left the whole of the group behind; and on going forward I was informed by the commander of the ship (Captain Rigaud), who had been on the bridge during the scene, that one of the animals, which he described as being black, had leapt clean out of the water.

"That these black animals, which appeared to be harassing and attacking the whale, were killers, I have no reasonable doubt; but the question arises as to the nature of the animal to which the strange white tail-like object seen standing above the water could have belonged. My impression at the time was that it must be the upper lobe of the tail of some enormous shark allied to the threshers (*Alopecias*); and this impression has been confirmed by a subsequent examination of the stuffed specimens of that genus in the British Museum. The thresher is, however, a black shark; while, as pointed out by Dr. Günther, the minute size of its teeth seems to discredit the common accounts of its attacking whales. Still, however, I cannot imagine to what animal the aforesaid white tail could have belonged, unless to some gigantic shark allied to the thresher, but of a white colour, and probably armed with much larger teeth. If so, we have evidence of a fish at present unknown to science; and even if I am wrong in this conjecture, the animal to which the object in question belonged would still appear to be unknown, and, in this event, quite unlike any with which we are now acquainted.

"The whole scene, weird and impressive as it was both to my companion and myself, suggested how easily a story of the sea-serpent might have originated therefrom. The black head and body of the presumed killer would have done duty for the head and body of the serpent; while the glistening white object standing perpendicularly above the water would have served for the tail of the same."

ARMOURED WHALES.

THE foregoing narrative shows that we have yet much to learn about even the existing monsters of the deep. Meanwhile, our knowledge of the whales of old time is rapidly increasing. Palæontologists have recently been exercised to some extent regarding the affinities of those remarkable gigantic Eocene mammals known as Zeuglodonts, the remains of which have now been discovered in so many parts of the world. Till a short time ago, these animals were pretty generally admitted to be members of the Cetacean order, in which they were regarded as constituting a separate subordinal group —the *Archæoceti*. In a memoir published in the "Studies from the Dundee Museum" for 1890, Professor D'Arcy Thompson took, however, a decided exception to this view, maintaining that the Zeuglodonts had nothing whatever to do with whales, but that their affinities lay rather with the seals. Two years later, Mr. Lydekker, when describing in the *Proc. Zool. Soc.*, some Zeuglodont remains from the Caucasus, again discussed the question, and came to the conclusions that there was no justification for the proposed innovation, and that the Cetacean nature of the group in question was undoubted.

In a recent communication (*Palæontologische Abhandlungen*, ser. 2, vol. i., pt. 5, 1893), Professor Dames has "gone one better" than this, concluding that not only should the Zeuglodonts be classed among the Cetacea, but that there are no grounds for separating them as a distinct suborder from the Odontoceti. He accordingly proposes the following scheme of classification for the latter order :—

1. ARCHÆOCETI ;—teeth few and differentiated. (Zeuglodontidæ.)
2. MESOCETI ;—teeth numerous and differentiated. (Squalodontidæ.)
3. EUODONTOCETI ;—teeth numerous and uniform. {Platanistidæ. Delphinidæ. Physeteridæ.}

In the resemblance presented by their skulls to ordinary terrestrial mammals, coupled with the small number of their teeth, the Zeuglodonts are sharply defined from the Squalodonts, and thus form the most primitive of all Cetaceans. The Squalodonts appear, however, on the whole, to occupy an intermediate position between the Zeuglodonts and Delphinoids, and thus serve to connect the three groups of toothed whales.

Not the least noteworthy portion of the Professor's memoir is the one in which he describes certain bony plates found in association with Zeuglodont remains, which are believed to indicate the presence of a dorsal bony dermal armour. That such an armour may have existed in primitive Cetaceans, is rendered the more probable by Dr. Kukenthal's recent discovery of the vestiges of such a structure in the skin of the existing *Phocæna* (*Neomeris*) *phocænoides*.

Possibly the ancient Cetaceans were more exposed to such attacks as the one above described by Mr. Lydekker, and, for this reason, required greater protection. It is well known that the early forms of many groups of animals were provided with some such armour, or evolved some equally adequate means of defence. As instances, we may mention many of the Edentates of South America, the Carboniferous Camerate Crinoids, the fish of the Old Red Sandstone, the Cephalopods with external shells, and the Operculate Corals of the Silurian. The dermal armour of these ancestral Cetaceans may have been a secondarily-acquired character, from which no particular argument as to their relationships can be drawn.

Æpyornis.

Knowledge of yet another group of extinct monsters is rapidly progressing. Recent researches in Madagascar, of some of which we gave an account in Natural Science, vol. iii., p. 192, have brought to light many remains of the *Æpyornis*, a bird which some suppose to have suggested the Roc of Sindbad the Sailor. Some of these remains have found their way to the British Museum and have been described by Mr. Charles W. Andrews (*Geol. Mag.*, Jan., 1894). Others have reached Paris and fallen into the hands of Messrs. Milne-Edwards and Grandidier, who, apparently stimulated by the paper of Mr. Andrews, have published an all too brief account in *Comptes Rendus* for January 15. Names are here given to no less than four new species, but, though some measurements are published, we have sought in vain for any adequate diagnosis. Moreover, a new genus, *Müllerornis*, is proposed for three new species of more slender form than those referred to *Æpyornis*, but of this "genus" no further definition is attempted. It also appears that no particular bone is taken as the type-specimen, but that names are applied to collections of limb-bones which may or may not belong to the same species. If this kind of thing continues the confusion of nomenclature in the Æpyornithidæ will soon put into the shade that already obtaining in the Dinornithidæ. Our only remedy is to refuse recognition to all such undescribed "species." There is, however, much of interest in this paper, as it gives, for the first time, a description, though a short one, of the skulls, sternum, and coraco-scapula. The skull is said to be less depressed, longer and narrower than that of *Dinornis*; the temporal fossæ are deep and narrow, while the basi-sphenoid bears strong basi-pterygoid processes as in other Ratite birds. The mandible is straight and strong, with a long compressed symphysis, hollowed like a spoon. The sternum much resembles that of *Apteryx*, being a thin, broad, flat plate, with grooves for the coracoids like those of that bird. The coraco-scapula is much reduced and bears a slight depression for the articulation of a rudimentary humerus. It is to be hoped that we shall not have to wait so long as usual for figures and full descriptions of these important specimens. Meanwhile, it is more clear than ever that, if *Æpyornis* really is the Roc, then it was Sindbad's imagination and not the bird that flew away with him.

I.

The Fossil Plants of Canada as Tests of Climate and Age.[1]

IMPORTANT questions respecting the value of fossil plants as tests of climate and geological age have arisen of late and have been discussed in scientific periodicals and in special works, especially in Seward's "Fossil Plants as Tests of Climate," and Lesquereux's "Final Report on the Plants of the Dakota Group." A consideration of what we have already learned on these subjects from the fossil flora of Canada may therefore prove of service.

In the first instance, it will be necessary to glance, by way of contrast, at the condition of the vegetable kingdom in the Palæozoic period. In this part of the earth's history the problem is complicated by the peculiar character of many of the plants, as well as by the probability that the meteorological conditions were very dissimilar from those now prevailing. We may say in general terms that a flora of tree-ferns, giant lycopods and pines is akin to that of modern oceanic islands in warm climates. This is true; but the Devonian and Carboniferous plants did not grow exclusively on oceanic islands, but on continental areas of considerable magnitude. They flourished also in all latitudes, from the polar region to the equator, and though there are some generic differences in the plants of the period in the Southern Hemisphere, yet these do not seriously affect the general facies. There are characteristic Lepidodendroids, for example, in the Carboniferous of Brazil and South Africa and Australia, and though in the latter region there are certain ferns allied to those of Mesozoic Europe, this is merely a local difference, not materially affecting climate, and corresponding with the fact that the European Mesozoic flora originated in the south. Nor does the doctrine of homotaxis seriously affect the question. Each geological period was sufficiently long to permit plants to migrate to every station they

[[1] This article is extracted from the advanced proof of a paper "On the Cretaceous Plants of Vancouver Island," which will appear in the *Transactions of the Royal Society of Canada*, and will end, for the present, the valuable series of papers on the Mesozoic and Cainozoic plants of Canada, with which Sir William Dawson has since 1882 enriched that publication. The present portion, which we have the kind permission of Sir William to reprint, gives the general conclusions based on the whole series.—ED.]

could occupy, and in every case the temporary and local climate must be indicated by the local flora, while the succession in any one place may be relied on as holding good over a very extensive area.

Looking at the Palæozoic plants a little more in detail, we remember that coniferous and taxine trees grow now in very different latitudes and climates. There is, therefore, nothing so very remarkable in their occurrence. The great group of *Cordaites* may have been equally hardy, but it is noteworthy that its geographical distribution is more limited. In Europe, for example, the genus is much more characteristic in France than in Britain, perhaps in connection with the warmer climate to the southward. Ferns and lycopods and mare's-tails are also cosmopolitan; but the larger species now belong to the warmer climates, and nowhere in the present day do they become so woody and so complex in structure as in the older geological periods.

The natural inference would be that in the old coal period the geographical and other conditions must have conspired to give a somewhat uniform and moist climate over a great part of the earth's surface. The geographical arrangements, so far as known, indicate this, and the distribution of animals points in the same direction. In America, for example, the great eastern and western ranges of mountains were yet in embryo, and a large part of the continent was occupied with shallow water or with swampy plains scarcely above the sea-level. The batrachians and insects of the land and the varied forms of animal life in the sea alike point to a climate at least mild and uniform. We must also take into account the probability that there was a larger amount of carbon-dioxide in the atmosphere than at present, which would have greatly impeded radiation from the ground, while the moisture exhaled from the vast swamps and morasses of the period would have produced a similar effect.

It would, however, be a mistake to suppose that there were not local differences of climate. I have in my "Acadian Geology" advocated the theory that the great ridge of conglomerate on the northern border of the coal-field of Pictou, in Nova Scotia, may have been an ice-formed ridge on the margin of the deep morass in which the thirty-six feet seam was deposited. In this case a sea occasionally ice-laden may have approached within a short distance of forests of Sigillariæ and Lepidodendra, and this in the middle of the coal period. On the whole, therefore, we should postulate for the Palæozoic flora not so much a high temperature as uniformity and moisture. This seems also to accord with the prevalent character of the foliage and the structures of the remarkable acrogenous trees of this period.

As to the early Mesozoic flora, the indications are that it was an invader from the Southern Hemisphere, for which the intervening Permian period had prepared the way by destroying the preceding Palæozoic forests. This was probably effected through the agency of great earth-movements changing the geographical and climatal conditions. But as the Mesozoic ages advanced, the old conditions to some extent returned, and enabled the cycads, pines, and ferns of this age to push their way almost to the Arctic regions. Being, however, derivatives from warmer climates, their vitality and powers of variation were probably not great. They flourished luxuriantly and became considerable coal-producers, and their reign was probably of long duration, extending through the Triassic and Jurassic periods and into the Lower Cretaceous. In the north they met with a new and far more advanced and varied flora, originating there, and destined, in the Middle and Upper Cretaceous, to replace them throughout the whole Northern Hemisphere. This new and most important change was undoubtedly accompanied with climatal amelioration, giving a mean temperature of probably 55° Fahr. to regions within the Arctic Circle; and this, as we shall see, probably depended on geographical arrangements introducing the warm waters of the equatorial current into a vast land-locked basin in the interior of the American Continent, with corresponding though probably not so simple or easily-understood arrangements in the Eastern Continent as well.

Thus, when we ascend from the base of the Cretaceous, we find a remarkable and apparently sudden influx of angiospermous exogens of modern generic types. The aspect of suddenness is given not merely by the rapidity with which from a very few forms the new flora expands in richness and variety, but also by the simultaneous appearance, in the case of many genera, such as *Sassafras*, *Liriodendron*, *Magnolia*, *Quercus*, etc., of as many species in the Middle Cretaceous as the modern world can yet boast, and in some cases of a greater number. On the other hand, it is true that other genera, as *Populus*, *Betula*, etc., appear at first in fewer forms, and are more largely represented in the modern world. This difference is apparently not connected so much with the botanical rank of the several genera as with their degree of adaptation to the more equable climate of the earlier Cretaceous or to the more extreme climates that have succeeded. This climatal change has not only required the removal of some genera to southern habitats and the diminution of their species, but has required that they should be replaced in the north by new species of more hardy types. The southward movement of the whole flora in later Cretaceous and Tertiary times, and the introduction from behind of the modern species, is thus apparently connected with the gradual refrigeration which culminated in the Glacial period.

In Western Canada, in the Rocky Mountains, and in the Queen Charlotte Islands, as well as farther north in Alaska and Greenland, we have a Lower Cretaceous flora characterised by forms approaching those of the Jurassic. One of its characteristic species is a *Dioon*, allied to *D. edule* of Mexico, *D. Columbianus* and *D. borealis*, Dn. Along with this are species of *Zamites* and *Podozamites*, and primitive species of *Salisburia*, similar to those described by Heer from the Jurassic of Siberia. The lower beds of this (the Kootanie series) are not known to contain any angiosperms, but in beds a little higher (Intermediate and Mill Creek beds) these begin to occur. Newberry has found the same flora farther south in Montana, and it corresponds, in part at least, with the Potomac flora of Fontaine, which occurs over a wide area in the South-Eastern States of the American Union. The geographical distribution of this flora shows an extension of warm climate up to the territory of Alaska. With other geological facts, it also shows that the habitat of the Lower Cretaceous flora was around the margin of a continent not yet elevated into lofty mountain chains, and including to the south a mediterranean sea of warm water; while the conditions in the extreme north must have excluded anything representing the present snow-clad mass of Greenland. This alone is, in my judgment, sufficient to account for the climate of the period, whose warmth extended even to Greenland. I have noticed the nature and correlation of this flora in papers published in the *Transactions of the Royal Society of Canada* (1885, part iv., p. 1, and 1892, part iv., p. 79).

This is succeeded in the north of Canada, at least as far to the south as the latitude of 55°, by the Dunvegan series, holding a warm, temperate flora, containing species of *Magnolia*, *Laurus*, *Ficus*, and *Quercus*, along with such temperate forms as *Fagus* and *Betula*. It also contains Cycads and Sequoias (*Trans. Roy. Soc. Canada*, 1882, part iv., p. 20). It appears to be in the main parallel with the marine Niobrara farther south. This flora is probably continued along the Rocky Mountain region by that of the Mill Creek series, which, however, has more the aspect of that of the Dakota period. (*Op. cit.*, 1885, part iv., p. 11.) It is less rich in cycads and conifers, and has species of *Platanus*, *Macclintockia*, *Cinnamomum*, *Laurus*, *Magnolia*, and *Aralia*. The aggregate of the Dunvegan and Mill Creek series may thus be regarded as Middle Cretaceous or Cenomanian and Senonian, and corresponding in the main to the Atané of Greenland. It belongs to the northern and western sides of the same great Cretaceous mediterranean sea on whose shores the previous Kootanie flora had flourished.

East of the Rocky Mountains this is succeeded by prevalent marine conditions, with the local interposition of the Belly River series, which contains beds of coal, but so far a meagre flora, including *Sequoia Reichenbachii*, *Brasenia antiqua*, *Trapa borealis*, and species of *Acer* and *Populus*.

Passing across the mountains to the Pacific coast, we meet with the abundant and interesting flora of the Cretaceous Coal-measures of Vancouver Island, a truly Upper Cretaceous assemblage. It evinces a still warmer climate than those previously noted, or than the succeeding Laramie; but it is not improbable that already some difference existed in this respect between the Pacific coast and the interior region of the Continent. It probably coincides with the Patoot flora of Greenland.

Later than this, and in its floral character assimilated rather to the Eocene of other countries, we have the Laramie series proper, indicating a period in which the great interior plateau east of the Rocky Mountains had ceased to be an open sea, and had been reduced to the condition of swamps and lakes, the former holding a rich flora of temperate aspect, even as far north as Alaska and Greenland. The Laramie flora has been recognised locally on the west coast as well, but its greatest areas are in the interior plains, where it undoubtedly overlies the Fox Hill or Danien beds. It is, perhaps, most remarkable for its richness in coniferous trees, *Taxites*, *Sequoia*, *Thuia*, etc., and for the great development of the genus *Platanus*, as well as for its containing some ferns of modern species (*Onoclea sensibilis*, *Davallia tenuifolia*). For details of this flora the reader is referred to *Trans. Roy. Soc. Canada*, 1885, part iv., p. 16; 1886, part iv., p. 19; 1887, part iv., p. 31; 1889, part iv., p. 69.

The Miocene Tertiary is represented on the Canadian plains only by the gravels of the Cypress Hills, holding mammalian bones referred to the White River series; but on the Similkameen River and elsewhere in the interior of British Columbia there are beds holding an interesting insect fauna and a number of fossil plants. Among the latter are several swamp and aquatic species, *Equisetum*, *Azollophyllum*, etc., and conifers of the genera *Pinus*, *Taxodium*, *Glyptostrobus*, and *Salisburia*, along with species of *Myrica*, *Populus*, *Salix*, *Alnites*, *Accrites*, *Carpinus*, *Nelumbium*, etc. The climate evidenced by these plants is still temperate, but probably scarcely, if at all, warmer than that of the coast of British Columbia at present. (*Op. cit.*, 1890, part iv., p. 76.)

It would thus appear that, while we have no evidence of a tropical climate in Northern Canada in the Cretaceous or Cainozoic periods, the successive floras point to equable and warm temperate conditions extending very far northward, and gradually passing in time into those of the colder Miocene and Pliocene. We can also to some extent correlate these climatal conditions with the geographical features of the several periods and with the contemporary animal remains.

I may add that the validity of such deductions does not altogether depend on the accuracy of the reference of particular species to existing genera. In many cases there can be no doubt of this, as in the species of *Liriodendron*, *Sassafras*, *Platanus*, *Sequoia*, and *Salisburia*, and especially in the case of all those forms of which seed or fruit has been procured; but even where the naming may be inaccurate or where the number of species has been unduly multiplied, the deductions as to climate may hold good, though not perhaps to the extent of enabling us to fix a definite thermometrical mean temperature.

As to geological age, the primary requisite is that in some of the localities of fossil plants their position shall be fixed by stratigraphical evidence. This being done in a few cases, it is not difficult to assign to their approximate position intermediate or allied sub-floras. In Canada, though the collections of fossil plants have not been so large as would be desirable, we are fortunate in having the horizons of the leading floras accurately fixed by the officers of the Geological Survey, and the plants collected carefully referred to the beds to which they belong.

Thus, though the geographical conditions of the Mesozoic and Cainozoic are not of such a character as to enable us to refer sub-floras to their definite geological position throughout the whole Northern Hemisphere in the manner in which this can be done for the plants of the Lower, Middle, and Upper Carboniferous, nevertheless, a satisfactory approximation can be made, and I have no hesitation in affirming that it is possible to define with considerable accuracy the age of any collection of fossil plants from any part of our Cretaceous or Cainozoic districts.

Plants as evidence of geological age have the advantage of wide distribution over the surface of the land, and of long duration in any one place, and slowness of migration when obliged or enabled to spread to new localities. They are also so closely connected with the great movements of subsidence and elevation which mark the lapse of geological time, that they are very certain indices of these, whether they affect plant life directly by elevation and submergence, or indirectly by changing the climatal conditions.

As in the case of animal fossils, we have to allow for differences of station, for possible driftage and intermixture of species belonging to uplands and low levels, and varieties dependent on chances of deposition and preservation. We have also to consider that plants are more permanent and less changeable than the animal inhabitants of the land, so that they may not mark such small portions of time or such minute changes as may be indicated, for example, by mammalian remains.

On the whole there is very good reason to believe that the labours of Palæobotanists have, in the United States and Canada, succeeded in securing for fossil-plants an important place as guides in the determination of geological age. The knowledge we have acquired needs to be collected and arranged in such a manner as to make it more available than it can be when scattered, as at present, through a great number of reports and memoirs.

J. W. Dawson.

II.

Natural Science in Japan.

II.—Present (*continued from p. 111*).

THE Imperial Museum takes to itself the various functions which with us are distributed between the two sections of the British Museum and the Museum of Science and Art at South Kensington. That is to say, its collections are representative of the Natural History, Antiquities, Art—both ancient and modern, pure and applied,—Resources and technical Industries of the Mikado's Empire. It has, it is true, no immediate connection with the education of the country, since this is amply provided for in other directions and is, for the most part, subordinate to the Imperial University. At the same time, the officers of the Museum have other duties than those of merely conserving and cataloguing the collections committed to their charge. Thus, from the Handbook of the Imperial Museum (*Teikoku Haku-butsu-kwan Yo-ran*) we learn that the officials are instructed to look after the precious objects preserved in temples throughout the country; but perhaps this only refers to those of the state church, which is Shinto, and not to the other purely Buddhist temples. They are also sent out to collect objects, both in Japan and in foreign countries; so that specimens thus obtained are not only cheaper but more authentic than those which pass through the hands of a dealer, while the collector is enabled to obtain that knowledge about the surroundings of a specimen without which the most important collections often lose half their value. It is also considered to be part of a curator's duties to assist students in their investigation of the collections under his care, permitting them to make copies, drawings or photographs of specimens; at the same time he is himself expected to make a scientific study of the specimens and to publish his results. If these instructions, as given in the handbook, are adequately fulfilled, the curators have it in their power to utilise the Museum and their connection with it to far greater advantage than that which can be attained by more tape-trammelled curators nearer home; and we cannot doubt that this will be for the benefit of Science, of the Nation, and of the Museum itself.

The Museum is situated in a prettily arranged garden in Ueno Park. The building, which is two stories high, is of plain semimauresque architecture, with large windows, and appears well adapted for the purposes of exhibition. The offices of the staff are in a separate building at the back. The Natural History collections, with which we are chiefly concerned, are all on the ground floor. It is not of course to be expected that they should contain any specimens of exceptional interest, or be of any great size, since the collections of more scientific importance are at either the University or the Geological Survey office. A walk round the galleries is, however, by no means without interest to the visitor.

The Zoological specimens are arranged systematically and not geographically; still, as the bulk of the collection, at present, comes from Japan, one gets a very good idea of the local fauna. The labels are written in both Japanese and Roman characters, but beyond giving the name and locality they make no attempt to convey information; that is a development which will no doubt come in time. There are, however, a number of old French models of the digestive, respiratory, circulatory and nervous systems in various animals.

As will have been anticipated by those who remember the first part of this account, the arrangement of the Botanical gallery is far superior to that of the Zoological. First are given a series of specimens and models illustrating the different forms assumed by the various organs of a plant: the kinds of roots, kinds of stems, aërial and subterranean, the parts and arrangements of leaves. Then come models for the illustration of the natural classification of plants, and in the next case models to illustrate the Linnean classification. Models of flowers and fruits follow. A selected series of dried plants is exhibited: these are mounted in black frames, hung on screens, and each is accompanied by a coloured plate and an explanation of its position in the system. Thus one is presented with a synopsis of the vegetable kingdom that is both attractive, interesting and readily intelligible. Adjoining this admirable series are additional dried specimens, of local interest, in further illustration thereof. The genera of Japanese ferns are specially represented by a series of dried specimens, with coloured plates and explanations. There are also a collection of the insectivorous plants of Japan and some models of mushrooms. The catalogue of specimens exhibited in this gallery is by Mr. K. Saida, and if he is also responsible for its arrangement, I should like to offer him my congratulations on having interested one so ignorant of botany as I unfortunately am.

The Geological rooms contain nothing of particular interest, except, what seems a useful novelty, a case containing the instruments and reagents employed in mineralogical and petrographical research. The minerals are arranged in three distinct groups, the first illustrating their chemical composition according to the bases, the second according to the acids, and the third the crystalline form. There is a typical collection of rocks from different parts of the world, numbering about 500 examples. The fossils exhibited are mostly

European and largely supplemented by casts, but there are a few Quaternary mammalia of native origin.

Catalogues, printed in English and Japanese, are issued for these three departments, but they are nothing more than lists of names and localities. That to the geological collections is by Mr. M. Nishi, while the zoological catalogue is drawn up by Messrs. Ch. Ishikawa and T. Yuakawa.

The archæological collections of the Museum, though of considerable interest, must not now detain us; nor can one do more than mention the exhibition of native and foreign manufactures, designed to promote the industries of the country, or the various models of native and foreign engineering works. These, as well as the beautiful exhibits of pure and decorative art, are beyond our province. The curators of all departments seem to be doing their work with as much zeal as intelligence; but of course a foreigner is not skilled to judge of the merits of the Japanese labels. It was, by the way, curious that, when I visited the Museum, I could find no official with whom to converse to more than a very limited extent in any European language. In this respect the Museum officials contrasted with those at the University and the Geological Survey. I must not however omit to recognise the courtesy of the Director of the Museum, Mr. Kanaye Kubota, who gave me every information in his power.

We have now considered the chief government establishments connected with natural science in Japan. A few lines only need be devoted to the Learned Societies and minor institutions.

Of Societies the names are legion. As Professor Chamberlain says:—"The Japanese of our day have taken kindly to societies and associations of all sorts. They doubtless feel that their nation has to make up now for the long abstinence from such co-operative activity which was enforced during the Tokugawa *régime*, when it was penal for more than five persons to club together for any purpose." The Geographical Society, or Chigaku Kai, is a private society with about 30 members. The Anthropological Society numbers about 100, and publishes a bulletin which is in Japanese but contains illustrations showing that a vast amount of interesting matter is treated of in its pages. The office of the society is at No. 5, Roku-chome, Hongo, Tokio. The Botanical Society publishes in both Japanese and English. The Zoological, which has about 75 members, publishes in Japanese, but the diagnoses of new species are usually given in some language more intelligible to the world at large. Besides these, there are a Seismological, a Chemical, a Physico-Mathematical, a Geographical, a Philosophical, an Engineering and an Electrical Society, with others more or less connected with science, some of which also publish transactions. The members of these societies are few compared with those of societies with more practical objects. Thus, the Sanitary Society has a membership of over 6,000, the Educational Society over 4,000, while the Society for the Promotion of Commerce and Industry and the Agricultural Society are equally influential.

In addition to the publications of the scientific societies there is the *To-yo-gak-ge-zasshi*, which literally means the East Ocean Science Art Journal. This was started about 1880, is published at Tokio, and the yearly subscription is one yen, at present about two shillings and sixpence in our money. It is conducted chiefly by University people, and serves to relate the excursions of the students and other details of local interest. It also contains articles by the Professors, and reports of the monthly lectures which they deliver to the general public.

In describing the scientific course at the University, allusion has already been made to the science teaching in the public schools. In the Primary Schools, science is taught by means of object-lessons and talks. In the Middle Schools, which include boys from 14 to 18 years of age, science is taught in all its branches, and such a school is required to have a set of chemical and physical apparatus. Each Middle School has two or three masters who divide between them kindred branches of science. Science is compulsory in these and also in the Higher Middle Schools; but in his second year's attendance at the latter the student confines himself more to his own special subjects. These schools have better laboratories and more science masters, who are thus enabled to devote themselves to more special branches. All science teachers are either graduates of the University or licensed after examination by the Educational Department.

There is of course a large amount of scientific instruction given at the Engineering College in Tokio and the Agricultural Colleges in Tokio and Sapporo, of which the latter was the first founded. These, however, need not detain us now. One may also occasionally come across something of scientific value in the local museums, as at Osaka and Gifu; but their chief intention is to assist commerce and to promote the industries of the country. On the whole, the scientific movement in Japan is concentrated at the capital, and must be studied in connection with those institutions that I have endeavoured to describe in the preceding pages.

III.—FUTURE.

Let not this heading lead anyone to suppose that I am about to assume the prophet's mantle. Zadkiel and the Reverend Samuel Baxter may rest unrivalled. All I intend is to consider the facts already mentioned, as well as certain others that have not yet come within our view, and to suggest from them a few inferences as to the probable development of natural science in Japan, and the relations of that science to the world at large.

There is a tendency to underestimate the solid and original elements of the Japanese character, and to regard the Japanese themselves as a nation of mimics. It is pointed out that the art, the religion, the literature and the government of Japan have, at different times, been transplanted from foreign countries; and there are those who say that these various elements of national life have not greatly improved in the transplantation. At the present day we see the Japanese somewhat too rashly casting aside their ancient traditions and embracing the customs, constitutions and even the clothes of Europe with shamelessly open arms. Science comes with the rest, and we have noted the considerable pitch to which its cultivation is now carried. But, it is asked, will all this endure? When the foreign teachers have been dismissed and when the Japanese endeavour to teach themselves and to advance by their own efforts, will they not sink back into a state of semi-barbarism, from which their present veneer of western civilisation will gradually be worn away? And, what is after all of more importance to Japan, will the nation be able unaided to stand its ground against the plundering hordes of Europe? These sneering doubts come, it must be admitted, with rather a bad grace from a people so indebted to others as we ourselves are. England of the sixteenth century surely owed to Greek philosophy, Roman sagacity, Hebrew religion and Moorish science as much as ever Japan could place to the credit of China and Corea. But, apart from this very obvious analogy, there is no reason why the foregoing questions should be answered unfavourably to Japan. The Japanese are neither parrots nor monkeys. Compare their decorative art with that of China! In all qualities, except perhaps that of technique, it is admittedly superior. As for the Japanese and Chinese theatres, any comparison would be simply absurd; the former is as far above the latter as a "Haymarket" comedy is above a mediæval miracle-play. The fact that there was for two and a half centuries a period of comparative stagnation proves nothing: Europe has had its periods of stagnation too. Now that the incentive has come, there is no reason why we should not behold in Japan a Renaissance with effects as far-reaching as those which were seen in Europe when the re-discovery of the ancient world was followed by the finding of the new.

Such a conclusion will hardly be assented to by another class of objectors. There are people who find in the Japanese nothing but food for mild amusement, and a subject for the cheaper sorts of witticism. As a rule these are the people who see small merit in anything outside England, and it would be waste of time to discuss their opinions. But when we find a writer so in love with his subject as Sir Edwin Arnold uttering sentiments that differ from those of the minor scribblers only in the delicacy with which they are expressed, we feel obliged to give these opinions more careful consideration. Sir Edwin says of the Japanese, "They have the nature rather of birds or butterflies than of ordinary human beings. . . . They will not and cannot take life *au grand sérieux*." The exaggeration of these statements betrays the practised journalist. Did we not detect here the lurking desire for effect that vitiates professedly ephemeral writing, we should have to suppose that the ascription of a nature so superficial could be based only on superficial observation. Heaven forbid that light-heartedness and abundance of laughter should ever disqualify a people from paying a serious attention to the tasks of life, or make them any the less human beings! But in truth, if the Japanese do not take life so seriously as Sir Edwin Arnold thinks right, they at least take themselves seriously, perhaps a little too seriously, so that we older nations looking on at their solemn performances are sometimes reminded of children that play at being grown up. To compare the Japanese to children is, however, an injustice, and evinces a want of sympathetic insight. They have entered the lists with other nations, and they, if not the others, have the sense to see that the struggle is no child's play. The sincerity of their endeavours was shown only the other day by an instance not wholly foreign to our present purpose. At the Columbian Exhibition almost all the prizes for agricultural improvements were carried off by Canada, largely owing to the admirable system of instruction obtaining in that colony. No sooner did Japan hear of this than she appointed a commission to study on the spot the secret of the Canadian success. The precocity of this child should shame its critics.

No! Grant to the Japanese, by all means, the childlike qualities of sincerity, enthusiasm and imitative power; but recognise that these qualities are at all times admirable, and that in the present instance their value is not impaired by either levity or superficiality. On the contrary, as the description of only one small department of the interests of modern Japan should have shown, the open-eyed observer will note in this people an almost German thoroughness. So far as science is concerned, this may possibly have been, to some extent, derived from their German teachers; but it can hardly be denied that the quality is innate, and there can certainly be no doubt but that, left to themselves, the Japanese better the instruction.

Many, it is probable, will find in the Japanese somewhat too great an appreciation of practical ends, and will remind us gravely that man does not live by bread alone. In the present state of the nation's development the reproach is undoubtedly merited; but what nation that calls itself civilised does not merit it to an equal extent? To those, however, who have the smallest knowledge of Japanese history, to those acquainted (as who is not?) with the artistic skill, the traditional mysteries, the literary enthusiasm and the exquisite taste of old Japan, it will seem absurd to brand these children of the rising sun as devotees of a cold utilitarian creed. The truth is merely the trite one, that if the body be unsatisfied it avails not to satisfy the soul. Japan is struggling for her place among the nations, for her life itself; that once secured, we have no reason to doubt that she will return to her old allegiance, though perhaps in a modified form. The conditions of modern civilisation do not make for such art as was the soul and the saving of old Japan; but there are other subjects for intellectual activity, and among these one of the noblest and one that may well commend itself more and more to the Japanese in the days that are to come, is the search after knowledge for its own sake.

We may remove from the Japanese the reproach of utilitarianism, but they must retain that of materialism. To a certain extent, however, and certainly so far as it forms a philosophic system, this opposes no serious bar to scientific progress. It is when a man's materialism makes him nothing more than matter-of-fact, when it deprives him of the faculty of imagination, it is then that it impedes his intellectual activity. This is the failing one is said to meet with among the Japanese; and if the accusation be true, those that understand the true value of the imagination in scientific work will see under what disadvantage their students labour. There are many causes for this defect, partly, as we shall see, the language, partly the long period of stagnation already referred to, but chiefly the influence of the Chinese. To know the cause is however, to foresee the cure, and we may well expect that, under the influence of European education, the weakness will gradually disappear.

Another characteristic of the Japanese, upon which everyone is agreed, is their extreme handiness and neatness. How valuable this quality is in scientific work, every scientific worker is well aware.

One should not, perhaps, pass unnoticed here the love of monstrosities to which so much attention was directed in the first part of the present article. This, however, is too obviously a character common to all under-educated persons and nations for us to regard it as in any way a peculiarity of the Japanese. P. T. Barnum did not make his fortune in Japan. Consequently we do not find that the intelligent Japanese zoologists have devoted any abnormal proportion of their time to the study of teratology. In fact the sole instance that comes to mind, if indeed it be an instance, is Watase's paper on the double-tailed gold-fish.

Passing from characteristics such as the preceding, which may be noted by any intelligent traveller, we come to a graver charge, which has been brought against the Japanese by those who have had greater facilities for observation, and longer time for continued study. By many such writers it has been maintained that the Japanese are wanting in philosophic instinct and the kindred intellectual faculties. Kaempfer, for instance, says in his *History of Japan*,—"Now if we proceed to consider the Japanese, with regard to sciences and the embellishments of our mind, Philosophy perhaps will be found wanting. The Japanese indeed are not so far enemies to this Science, as to banish the Country those who cultivate it, but they think it an amusement proper for monasteries, where the monks leading an idle lazy life, have little else to trouble their heads about. However, this relates chiefly to the speculative part, for as to the moral part, they hold it in great esteem, as being of a higher and divine origin." In our own days, Mr. Walter Dening is said by Professor Chamberlain to write as follows,—"It is well known that one of the most marked characteristics of the Japanese mind is its lack of interest in metaphysical, psychological, and ethical controversy of all kinds. It is seldom you can get them to pay sufficient attention to such questions to admit of their understanding even their main outlines."

Comprehending now some of the tendencies and limitations of the Japanese character, we are better able to see what manner of work their scientific men are best fitted to do. It is clear that their genius leads them in the direction of accurate, detailed investigation; either minute dissections of animal and vegetable structure, careful observation of the habits of living beings, the appreciation of the slight differences so important in the problem of variation, precise chemical analyses and physical measurements, or the construction of elaborate apparatus for determining the slightest changes in surrounding conditions. In the exhaustive and microscopic questionings that the needs of modern science bid us put without cessation to ever-elusive nature, the new Japanese recruits will doubtless prove our most valuable allies.

Turning to the special branches of science with which we have here been dealing, we remember that the Japanese zoologists are privileged to live in a country where the fauna, both of land and sea, is remarkably abundant, while the extraordinary variety of the vegetation will ever render the self-same region a veritable Garden of Eden to the botanist. Both classes of workers may here exercise to the full the nomenclatorial propensities of the old Adam. Many of the native animals and plants have, it is true, been already described by European or American workers; thus Dunker has done the molluscs, Döderlein the sea-urchins, Pryer the butterflies, while besides the botanists previously named we may note Miquel, Maximowicz and Murray, specially instancing the beautiful work "Om Japans Laminariaceer" by Kjellman and Petersen. These and many other active workers have, however, by no means exhausted the treasures of Japan. The Museums already contain large collections of unnamed specimens, now being worked out by native students; while we may expect these collections to be considerably enriched when the northern part of the empire comes to be explored more thoroughly than has hitherto been possible. But it is not merely in systematic biology that we may still expect something new from Japan; this region has already yielded us forms of such far-reaching importance as the king-crab, the giant salamander and the glass-rope sponge, that we may continue to look eastwards for fresh light to fall on the problems of morphology. As for the geologists, it needs no prophet's tongue to foretell that, for many years to come they will furnish the world with observations of novelty and importance in the branch of their science that deals with volcanoes and earthquakes. Petrology also may be indebted to them; but we hardly dare hope that the greatly altered rocks of Japan will yield the solution of many palæontological enigmas.

There is then a fairly wide field in which the acknowledged powers of the Japanese men of science may well be employed, and their foreign colleagues will await its cultivation with a justifiable hope. One department of science exists, however, in which, if we may place any reliance on the opinions quoted above, the Japanese are not likely to make any conspicuous progress. The world, we may conclude, will never hail a great Japanese philosopher, nor will its line of advance be changed by any new principles emanating from Japan. This very bold conclusion may, however, be rendered invalid by changes similar to those which it has already been suggested will do away with other supposed mental deficiencies of the Japanese. A few such possible changes may now be discussed.

In considering the relations of Japanese science to that of the rest of the world, one of the most patent difficulties, which might almost prevent any relation at all, lies in the language of the country. At the outset there are two obstacles to mutual comprehension: the first is the great difference between the Japanese and European languages in respect of form and construction, the second is the very different mode of writing the two languages. The former obstacle affects the Japanese themselves more than it does the Europeans. There is so much in all European languages that it is almost impossible to express in Japanese; and even when some sort of translation has been effected, the different habits of thought will still render the result largely unintelligible. Thus we may note the absence of all those personal modes of expression and of that constant reference of all surroundings to the speaker as a centre which are of such universal occurrence in our own speaking and writing. Similar to this is the absence of personification of all inanimate and abstract objects. To quote from Professor Chamberlain's fascinating *Handbook of Colloquial Japanese* (p. 272), "Not only does Japanese idiom eschew all such fanciful anthropomorphic expressions as 'the hand of Time' . . . 'Nature's abhorrence of a vacuum,' etc.; but it goes so far as almost to prohibit the use of the name of any inanimate thing as the subject of a transitive verb. For instance, a Japanese will not say 'The rain delayed me,' thus appearing to attribute an action to those inanimate things the drops of rain; but he will turn the phrase intransitively." And again (p. 273), "Thus no language lends itself less to the imaginative and mythopœic faculty than does the Japanese. When, for instance, a European speaks of 'the strife between Religion and Science,' he very likely spells these names with a capital R and a capital S, and unconsciously slides into regarding them as being, in some sort, actual things, even individualities. . . . Such mythology (for mythology it is, albeit those who have been reared under the exclusive influence of European modes of expression may not recognise it as such) is utterly alien to the matter-of-fact Far-Eastern mind." There are also minor difficulties, such as the apparent want both of a passive voice and of a comparative, all which combine with the others to render the translation of European scientific works into Japanese a matter almost of impossibility. These difficulties are evaded rather than overcome by the necessity the Japanese find themselves under of learning almost all their science through the medium of some foreign language, usually English, and by the growing habit of introducing foreign phrases or at least foreign modes of expression into their own writings.

The second obstacle, that presented by the ideographic writing common to Japan and China, is one that chiefly affects the foreign readers of Japanese, although I am inclined to believe, from conversations with many native friends, that it also places a serious stumbling-block in the way of their own rising generation. It is quite clear that no foreigner, who does not intend to make the Japanese language his life-study, will ever attempt to learn two distinct forms of syllabary and some four thousand ideographs, even for the sake of reading the description of a new species of snail or the account of a novel method of cell-division. Unfortunately one can hardly doubt that the Japanese will not always write their scientific papers in English. Indeed at the present day there is much of value that makes its appearance in the native tongue; and as foreigners come to exert less and less influence in the education of the country the return to the Japanese language is likely to become more general. The prospect is somewhat appalling. Czech is a sufficient hindrance, and Russian daunts most workers: what shall we do when the floodgates of Japanese scientific literature are opened upon us? There is one hope left. The Japanese language does not in itself present insuperable difficulties, and if the Japanese would only consent to write it in the ordinary Roman alphabet, we should hardly have cause for grumbling. This solution of the problem has already presented itself to the Japanese, and in 1885 a society with this object, called the Romaji-Kai, was founded by Professor Toyama and others. Unfortunately the anti-European reaction, which set in in 1889, has made this society somewhat unpopular, and the Japanese students to whom I put the case had plenty of reasons to offer against the proposed change. This is not the place to discuss the question in full; but two facts seem to show that the old methods can hardly survive in the modern struggle for existence. One is that the sender of a telegram is obliged to use either Roman characters or the comparatively simple syllabary known as the Kata-kana. The other is that, even in inland towns such as

Kyoto and Gifu, many of the shopkeepers seem to find it an advantage to write their names up in Roman letters.

A greater hindrance to complete intercommunication of thought than that presented by language may by many be found in the great difference that we have already observed between our own and the Japanese modes of thought. This does not entirely consist in a different attitude of mind or a different temperament, but is to a large extent a result of antecedent conditions. It is hard for us to realise how largely all our Western religion, philosophy and science are the outcome of history, how intimately the present is bound up with the past. But in this past, the common heritage of all European nations, the Japanese have no portion. The allusions, the associations of ideas, the pregnant phrases, the postulated premises: all these inseparable factors of our thought have for the far East no shadow of a meaning. The inevitable to us is the impossible to them.

Of course as the world becomes more of a unit, and as the terms East and West come to have a merely relative significance, these obstacles will gradually disappear; meanwhile it is possible to suggest that they may after all be blessings in disguise. One cannot help seeing that, however much we Westerns gain by our imaginative and mythopœic powers, we are seriously handicapped by this irresistible tendency when we attempt to discuss things as they are. The gross anthropomorphism of all religions that we have at different ages affected finds its parallel in the realms of Science. The Japanese at least are not likely to deify Nature or to make such fetish of a phrase as we have done with "Natural Selection" and "Chemical Affinity." Again, the burden of the past is sometimes as great an incumbrance as ever delayed the progress of the pilgrim Christian. All men know how the introduction of the new scientific methods and the advance of the scientific spirit have perpetually had to struggle with the bonds of ancient belief and to fight to the death with the phantoms of superstition. The bitter feelings thus awakened, and the bigotry thus begotten on both sides, can hardly have advantaged truth or assisted the onward march of the world. Sadly and irresistibly have these events brought home to us the danger of putting new wine into old bottles. Here then is the opportunity of the Japanese, and it is one that they themselves fully recognise. Ignorant of the bonds and unpressed by the burden, they receive from us weapons forged in the fires of controversy and, at last after many a vain experiment, tempered to pierce the dense walls of matter which enshield the secret soul of truth.

F. A. Bather.

III.

Adaptation in Liverworts.

IT is well known among bryologists that the liverworts, unlike their relatives the mosses, are not stereotyped in form, but vary enormously, and in many different directions; they have in consequence been aptly called "one of Nature's experimental grounds." At the outset we have the two great groups of the foliose and thallose —or, according to a more recent and nearly corresponding division, the *acrogynous* and *anacrogynous* forms, with their strikingly different habits of structure and growth, though they are well connected by intermediate forms. Within these divisions, but especially in the acrogynous, there is still an extraordinary variety of form to be seen, and this group will be chiefly dealt with here.

The most important variations are connected with the collection and retention of moisture, as might be expected in plants presenting a small surface, and developing unicellular root-hairs only, which cannot penetrate the substratum to any considerable depth. Results of investigation in this department have been recently published, which show a remarkable power of complex adaptation in these lowly plants (1, 2).

The typical form of the acrogynous Jungermanniеæ is a thin, usually more or less prostrate, stem, bearing three rows of leaves, two lateral and one ventral. Those of the ventral row (amphigastria) are usually very much smaller than the others, and are often absent altogether; in the latter case the ventral segment of the three-sided apical cell forms stem tissue only, while the lateral segments produce each a row of leaves. The leaves are commonly bidentate or bilobed, and in the simpler forms, as in the common *Lophocolea bidentata*, the lobes lie in the same plane, so that there is no provision for retaining moisture other than the capillary action among the leaves and stem. Such forms commonly possess well-developed root hairs, sometimes in enormous numbers; while in a few species, *e.g.*, *Lepidozia reptans*, there are whip-like branches bearing only rudimentary leaves, but densely clothed with root hairs, which are apparently modified for this purpose.

Coming now to those forms which possess some kind of water-collecting apparatus, we find, as Goebel has shown, four chief classes, each with its own type of structure, whereby the same end is attained.

It must, however, be remembered that in the Muscineæ water is absorbed by the leaves, and in those which have a soft stem by the whole surface of the plant.

(1.) First, there are leaves which are simple in shape, but are cut up, and form a more or less spongiose mass. In *Ptilidium ciliare* and others the main part of the leaf is a cellular plate, but the border is divided into a large number of hair-like cell rows. In species of *Trichocolea*, however, there is scarcely any cellular plate at all, the leaf being cut down to its base, and resembling a densely-branched twig (Fig. 1). The effect of this is very well seen when the British species (*T. tomentella*) is gathered in damp weather, as it can then be wrung like a sponge.

The following types depend upon the alteration of the form of the leaf.

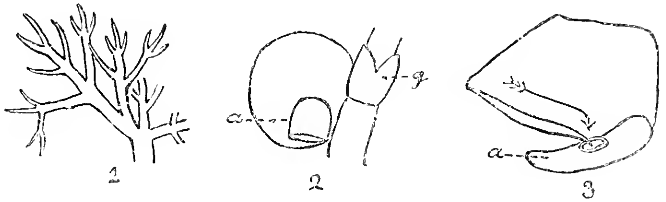

Fig 1. Part of leaf of *Trichocolea tomentella*.
Fig. 2. *Frullania dilatata* ; *a*. auricle or water sac—*g*. amphigastrium.
Fig. 3. Leaf of *Physiotium giganteum* ; *a*. auricle.

(2.) In species of *Lejeunia*, *Radula*, etc., the lower lobe of the bilobed leaf does not lie in the plane of the upper lobe, but is turned forward, so that the lobes are apposed. The advantage here lies in the increased capillary surface, while in some species a simple sac is produced by the depression of the base of the leaf.

(3.) In the British species of *Frullania* a considerable advance upon the foregoing is found in the bending and hollowing out of the lower lobe, which forms a cup-shaped sac, with a wide mouth opening posteriorly (Fig. 2). In a foreign species (*F. cornigera*) there are two sacs to each leaf, and the mouth is narrower than the basal part. It is interesting here to note that such sacs are not confined to the foliose forms, since in *Metgeria saccata*, one of the thallose Jungermannieæ, projections are developed at the edge of the thallus, which bend round and form sacs comparable with those of *Frullania*.

(4.) The last type presents a highly-organised water-sac, or auricle, with its mouth towards the middle or base, and protected by a valve. This sac, which is comparable in structure and development with the bladders of *Utricularia*, is found in species of *Colura* and *Physiotium*. In *Physiotium giganteum* (Fig. 3), a plant inhabiting the dry mountain regions of India and Ceylon, the sac is subulate, and has a circular mouth, bounded by a strong rim or collar, opening on the side next to the stem. Direct entrance is impossible, as the mouth is closed within by the depressed tissue of the circular area of the mouth, and entrance can only be effected by a passage downwards between the two flaps of the valve. One of these flaps is rigid, and exactly like the rest of the foliage in texture, but the other consists of thin-walled, empty, and dead cells; the latter forms the "clapper," and by its easy movement the opening and closing of the valve is effected. The shoots bend outward from the tree to which they are attached and grow vertically upward. The provision for the conduction of water into the auricle is remarkably perfect. "The upper lobe is well adapted, both by its shell-like form and its position on the upright stem, for catching and holding water, which, owing to its oblique position, will naturally flow toward the auricle. It is prevented from running off by the lower edge being strongly incurved, thus forming a channel in which the water may collect, and leading to the mouth of the auricle. The curved edge of the lobe is continued by a projection into the mouth of the auricle, the upper edge of which is raised to prevent the water escaping at the junction of the two members, while a depression below forms a channel which ensures the entrance of the water into the auricle" (2). How effective a water collector this plant is may be readily seen in the epiphytism it engenders, a variety of small plants and animals being commonly found in the sac, while a species of *Frullania* was in some cases so closely applied to the shoots as to be invisible except on close examination.

There is yet another means whereby water is collected and held, viz., the perianth or colesula. This is a more or less cylindrical sac, which develops around the archegonia, and after fertilisation elongates considerably, and encloses the developing sporogonium. As it stands vertically, and is in most cases much larger than is necessary to cover the young sporogonium, it will doubtless catch more or less water, which in those having a contracted mouth will be held with great tenacity. But in a number of species the colesulæ are mostly, and sometimes entirely, barren, the archegonia being in some cases entirely suppressed. These barren colesulæ are occasionally produced in immense numbers, as in *Physiotium acinosum*, where they form the main mass of the plant, the stem and leaves being small and comparatively insignificant; and that they function as water sacs is evident from the fact that water can be wrung from the fresh plant after weeks of rainless weather in a dry locality. There is, however, a disadvantage in this habit, as seeds are enabled to germinate in the vicinity of the liverwort, and the seedlings send their roots into the colesulæ and rob the plant. But the advantage to the "epiphyte" is very great, as the plantlets, which otherwise might not have germinated at all, have now become independent.

Another interesting point which has been recently brought to light is concerned in the moistening of the apex. The mucilaginous papillæ in the thallose forms, developed immediately behind the apical cell, are well known. It is now known that similar papillæ are commonly formed at the apex of the very young leaf in the foliose forms, and hang over the apical cell. This uses up the apex of the leaf, and the main part of this organ is subsequently formed by intercalary growth. The papillæ usually occur singly or in a pair on each leaf; but in *Physiotium giganteum* there are three to each upper lobe, which hang over the stem apex, so that the leaf in this state presents an appearance irresistibly recalling the jester's cap and bells.

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JESSE REEVES.

IV.

Thermo-metamorphism in the South-Eastern Highlands of Scotland.

IN the north-east of Forfarshire, there is a tract of moorland, much covered with peat and heather, that forms part of the singularly flat table-land of the south-eastern Highlands. It is drained by the North and South Esk, and in the craggy sides of their valleys may be seen exposures of the gneisses and schists of which the area is chiefly composed. Glen Clova, to the south-west, is especially well-known for its picturesque scenery. A detailed study of this area shows that there are several masses of intrusive rock, gneiss, and granite, which are probably connected underground, and that the highly crystalline character of the surrounding schists is the result, mainly, of thermo-metamorphism, or of alteration by heat rather than by pressure and mechanical movements. This conclusion is of some interest, as the special features may, after all, have no necessary connection with great antiquity, but be due to the depth in the earth's crust at which the metamorphism took place. It serves also to strengthen Dr. Barrois' views that regional metamorphism and contact metamorphism are much the same thing, differing not in *kind*, but in *degree*.[1]

The ordinary condition of the intrusive rock is that of a slightly foliated granite, with two micas: muscovite or white mica, and biotite or brown mica. Hence the rock may be termed a Muscovite-biotite Gneiss. Intruded among the schists are a number of pegmatites, or veins of coarse granite, the origin of which was uncertain; but they have now been traced to the parent mass of granite rock—the muscovite-biotite gneiss.

In considering the effect of the forcing of a granite magma, under enormous pressure, into the surrounding rocks, we have practically to deal with a process akin to that by which silver is extracted from lead. Just as the silver crystals are strained off from the lead at a certain temperature, so certain crystals are strained off from the granite-magma during the process of forcing it through every crack

[1] General results of paper "On an Intrusion of Muscovite-biotite Gneiss in the South-east Highlands of Scotland, and its accompanying Metamorphism." *Quart. Journ. Geol. Soc.*, vol. xlix., pp. 330-358, pls. xv., xvi., 1893.

and plane of weakness in the surrounding rocks. This results in leaving behind large masses of rock composed of what are known as the "earlier crystals of consolidation," while the residual liquid is forced upwards and outwards, finally consolidating as extremely coarsely crystalline veins and masses known as pegmatites, or "giant granite." A peculiarity of the present instance is the enormous distance to which these veins extend from the parent mass. Perhaps no case has before been clearly established in which pegmatites extend so far as a mile from the surface outcrop of the parent mass of any granite of post-Cambrian age; but in the area under consideration these veins extend as far as 40 miles from any exposure of the muscovite-biotite gneiss.

These pegmatites throw great light on the sequence of the rocks in this intensely-folded area. Obviously, if by a great normal fault, rocks which are penetrated by igneous veins are brought against rocks which these veins have failed to reach, the permeated rocks must be the lower of the two, and we are thus able to show that one group of rocks is higher or lower than another. A starting-point of this nature is invaluable in an area where it is difficult to say if any dip is true or reversed. It may be here noted that the characteristic feature of the pegmatites is the presence of large crystals of muscovite. The original magma consolidates normally as a true granite containing white and brown mica, but the pegmatites never contain large crystals of brown mica. This leads to the natural inference that the pegmatites bearing brown mica, such as may be seen at Cape Wrath, are the upward prolongations of a granitite magma, or one which contained brown mica only and not white mica, and which has been injected under precisely similar conditions to those of the south-eastern Highlands.

Most interesting is the development, over a vast area, of certain minerals, such as sillimanite, cyanite, and staurolite, which have already been described by many authors as the result of the intrusion of large igneous masses into sediments. The development of these minerals is found to be dependent on nearness to or distance from the main intrusion, and it may be further added that the crystalline condition of the entire region may be said to "rise or fall" away from the main intrusion, just as the pegmatites do or do not reach the surface. From these facts it may be inferred that the upward permeation of igneous (often gneissose) material must have taken place over a large part of the southern Highlands. In the ordinary post-Cambrian granites, the development of certain minerals occurs practically within cylindrical rings, one outside another, surrounding the inner cylinder of granite. Here, however, we have a new phenomenon to deal with. The thermo-metamorphism is dependent, not so much or so entirely on the distance away from the parent edge of the igneous mass, but rather upon the fact of the rocks being at a greater or less height above what we may conveniently term the "upper saturation limit" of igneous material. There is no reason to believe that a similar saturation is not going on now under volcanic areas. Nevertheless, the vast depth required for the rocks to have a sufficiently high temperature for the extremely slow cooling of the giant granites, points to an equally vast time to allow for denudation to expose them at the surface. This at once suggests the great antiquity of areas in which the phenomena referred to are seen. It is, however, well within possibility that, in special areas where denudation has acted powerfully for a long period, this phase of intrusion may be exposed, though it took place in post-Cambrian times; but the proofs of it should be placed beyond reasonable doubt.

GEORGE BARROW.

V.

The Museums of Public Schools.[1]

II.—ETON COLLEGE.

THE present Eton College Museum, which forms part of the block of buildings known as the Queen's Schools, was completed only a few years ago. Before that day there existed, on the present site of the Queen's Schools, a large round building (the Rotunda) and a number of small class-rooms known as the Old Mathematical Schools. After the completion of additional class-rooms for the mathematical work of the school, the Rotunda was used for various purposes until the year 1875, when it was, at the expense of several of the Science Masters, fitted up as a Museum.

At this period a set of British birds, stuffed in separate cases, together with a series of British butterflies, formed the nucleus of the zoological collection, while a large number of mineral specimens and fossils, got together by gift and purchase, formed the nucleus of the geological collection.

About the year 1888 the Rotunda and the Old Mathematical Schools were pulled down, and the present Queen's Schools were erected on the site. The Queen's Schools consist of a block of buildings on three sides of a quadrangle, the centre of which is occupied by a grass plot. The whole of the northern side is occupied by the new Lower Chapel, built by the subscriptions of old Etonians. On the south side is a large lecture-room and a physical laboratory, a large drawing-school, and several class-rooms. The western side of the block is not built upon, and the eastern is almost entirely occupied by the Museum, with a line of class-rooms on the ground floor beneath.

The eastern and southern sides of the quadrangle, with the exception of the Physical Laboratory and Lecture Room, the funds for which were provided by the Head Master, Dr. Edmund Warre, were built by the College out of their endowment.

The architect of the whole block of buildings was Sir Arthur Blomfield.

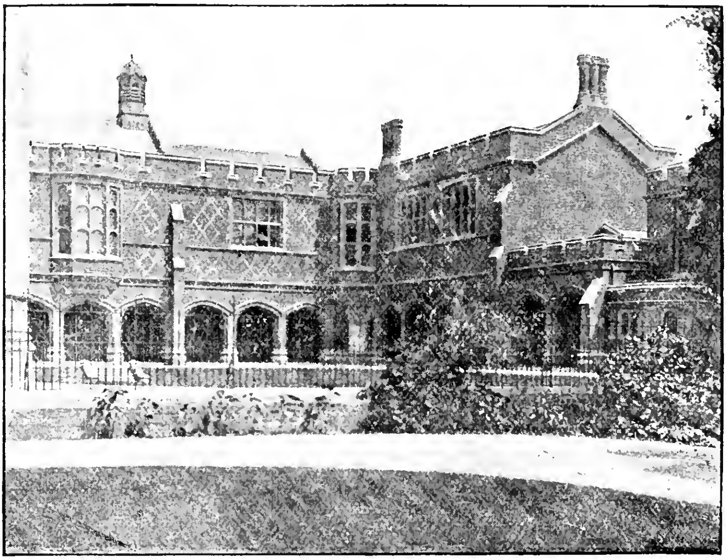
The Museum consists of a large room (87 ft. by 30 ft.) and a small

[1] The first of this series, on Charterhouse, appeared in this Journal for July, 1893.

adjunct. The principal room is very well lighted by a double row of upright skylights, which extend along the whole length, and by seven large windows.

The window at the northern end of the room is filled with stained glass, and was formerly in the old School Library, where it was put up by old Etonians during the head-mastership of Dr. Hawtrey. It is an heraldic window, containing the arms of Eton and of various personages and institutions connected with the school.

The northern end of the Museum, which is separated to a certain extent from the rest of the room by arches and pillars, forms a library, in which there is an excellent collection of books on Natural History; it is further furnished with tables and chairs for the purposes of reading and study.



THE ETON COLLEGE MUSEUM.

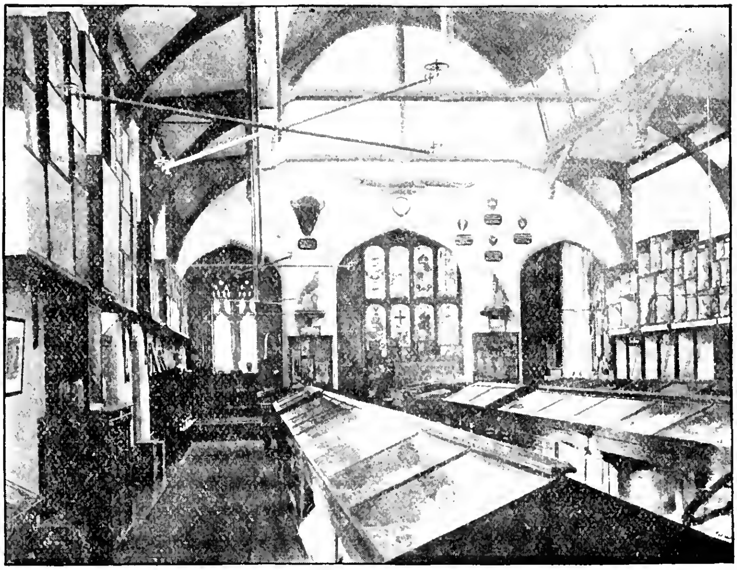
The books comprise text-books, books on the British fauna, natural history, travels, etc., etc., and include a complete collection of the Palæontographical Society's works, and of the scientific reports of the voyage of the "Challenger."

In the three years during which the Museum has been opened its contents have increased rapidly; but before giving an account of what the collections now consist of, it will be perhaps useful to give a sketch of what a museum of this sort should contain; in fact, of an ideal School Museum.

There are two very distinct and separate classes of boys to whom a School Museum will appeal: these may be called the Professional and the Amateur. Of these, the former, though considerably the smaller in numbers, will make much more use of the museum, while the Amateur class is much more numerous, especially in a Classical School like Eton.

The Professional class of boys are those who are taking up, as part of their school-work, some scientific subject, such as Biology or Geology. For the Biologists, a good typical series of well-named and well-labelled specimens, illustrating the structure and principal forms of the animal and vegetable kingdoms, is required. For the instruction of the Geologists, a good typical series of rocks, minerals, and fossils, arranged in stratigraphical order, is necessary. All the specimens can, of course, be removed when required to illustrate lectures on either subject.

For the Amateurs, by which name I designate those boys whose



INTERIOR OF THE ETON COLLEGE MUSEUM, LOOKING NORTH.

interest in Natural History has been aroused by making such collections as those of butterflies and birds' eggs, a different series of collections is required. For this class, what is mainly wanted is a set of specimens of the British fauna as complete as possible. Mammals, birds and their eggs, and insects are, of course, the groups in which the greatest amount of interest is shown, and it is especially to those groups that attention should be directed. Moreover, as many of the Eton boys come from very different parts of the British kingdom, it seems unwise to limit the faunal collections to the productions of the neighbourhood of Eton.

The local School Museum should, therefore, in my opinion, contain :—

1. Faunal collections limited to the British isles.
2. Small, well-chosen, typical collections to illustrate the forms of animal- and plant-life, together with typical collections of minerals and of fossils, stratigraphically arranged.

A brief account of the present contents of the Eton College Museum may now be given, to show how far it comes up to the ideal, and in what ways it is still deficient.

The north end of the Museum is occupied by three large mahogany table cases, containing a small but useful collection of Invertebrates. The dried specimens are arranged in the table-cases, the bottles containing preparations of the softer-bodied animals are placed on shelves between the two glass lids of the cases. Most of the contents of this collection have been purchased from time to time from the Naples or the Plymouth Zoological Stations.

The collection destined to illustrate the Vertebrate series is much less advanced; as yet it consists only of a few skeletons and preparations placed in a wall case.

With regard to the Faunal collections, the Mammals are not as yet very far advanced, but the Museum possesses a very good collection of stuffed birds, each species being mounted in a separate glass-fronted case. This collection is interesting historically, having been formed by Dr. Thackeray, the late Provost of King's College, Cambridge, who was a friend and correspondent of Yarrell. It is said to have been used by Yarrell while writing his celebrated "History of the British Birds"; indeed many of the well-known figures in that work seem to have been drawn from the birds now in the Museum.[2]

Provost Thackeray left his collection to the School, and it formed for a long time the nucleus of the Museum in the Rotunda above mentioned. Although it was made so many years ago, the specimens still remain in a very fair state of preservation, except for the fading of some of them. It is arranged along the walls on both sides of the room.

It has been lately proposed to add to the mounted series a collection of British birds "in skin," which will be much more useful for close examination and handling, and a beginning has already been made in this undertaking.

The collection of birds' eggs is arranged in glass-topped boxes and placed in drawers of a special cabinet presented by Mr. A. C. Benson, one of the Masters; the collection has increased a good deal during the last two years, but is still by no means perfect.

A very good series of British butterflies and moths, arranged in six cabinets, was presented many years ago to the school in memory

[2] *See*, for example, the Alpine Accentor, shot in the garden of King's College, Cambridge, on November, 1822, Yarrell's "History of British Birds," ed. 4, vol i., p. 296.

of Arthur Vernon Jones, an Eton boy, who himself collected the greater part of it.

The Geological collections are arranged in three long table-cases, extending two-thirds of the total length of the Museum. One of these is occupied by fossils arranged stratigraphically, another by a collection of rocks and minerals, and the third by a set of cases illustrating economic processes, such as the ores, varieties and uses of coal, sulphur, iron, tin, lead, and soda.

The collections in these cases have been received from various sources; a considerable number were given by Eton Masters—the late Mr. P. H. Carpenter, Mr. Hale, and the late Mr. Drew and others. A large number of the specimens, especially of the fossils, were purchased from Mr. J. R. Gregory, who also named and arranged most of those already in the Museum.

The Museum now possesses a very excellent collection of minerals, derived from three sources. (1) A collection in a cabinet presented by the Rev. S. A. Donaldson, an Eton Master; (2) a collection made by the late John Murray, of Albemarle Street, and recently presented in memory of him by his son, the present Mr. John Murray, also contained in a cabinet; and (3) a collection specially formed for the Eton Museum at the Natural History Museum at South Kensington.

There is one set of objects in the Museum which has a very close relationship to Eton, and in fact forms almost the only part of the Museum which has a distinctly local interest. This is a series of prehistoric implements of neolithic age, which has been obtained by Mr. Edward Hale from the men who dredge for gravel in the Thames. Besides many examples of the ordinary type of adze, the collection contains flint-chippings, arrow heads, bone-needles, and all the other characteristic remains of the neolithic people, including a remarkable dolichocephalic skull dredged up in the same way.

There is also a small collection of anthropological implements, of which the larger objects such as clubs, weapons, etc., etc., have been mounted on a large wooden shield. This collection was made by the late Sir John and Lady Franklin, and presented to the Museum by Mr. G. B. Austin Lefroy.

A great speciality has been made of photographs in the Eton Museum; a large collection of Gambier Bolton's well-known studies of animals, mounted and framed, with short descriptions and small maps of the geographical distribution, form a prominent object on the south wall of the Museum. We have also got three of Mr. Saville Kent's photographs of the Great Barrier Reef which were specially enlarged for museum purposes, and finally a considerable number of photographs of geological phenomena have been accumulated, all of which are mounted and framed, with descriptions appended and hung on the walls.

The Museum is open every day, except Saturday, between the hours of 12 and 2, and on whole-school days (*i.e.*, Monday, Tuesday, Wednesday, and Friday) between 4 and 5. Lately the experiment of opening on Sunday afternoons has been tried, and has succeeded admirably. A very large number of boys avail themselves of this opportunity every Sunday, but it must be confessed that the week-day attendance is rather meagre. Whether this can ever be remedied is a difficult question, the present Eton boy having very little leisure during the day. Besides the regular school hours, which, it must be confessed, are not too long, a large amount of time is taken up by the average boy in learning his lessons and also "extras" (*i.e.*, private tuition in extra subjects). When to this is added the time necessarily spent in games, there is very little leisure time left to the ordinary Eton boy for improving his mind, even if he wishes to do so.

The conception and carrying out of the Eton Museum has been almost entirely due to Dr. Warre, the present Head Master, who has always shown a most keen appreciation of the advantages and uses of a School Museum. In these ideas he has been ably seconded by the scientific members of the staff of masters: Mr. Hale and the late Messrs. P. H. Carpenter and J. Drew, who have all largely contributed out of their private means to the support of the Museum. The greater amount of the actual work of planning and setting in order the Museum as it now is, was, however, undertaken by Mr. A. Vaughan Jennings, who, after a year's hard work, had to resign the post of curator on account of ill-health.

W. L. Sclater.

VI

Instinct and Intelligence in Chicks and Ducklings.

IN my "Animal Life and Intelligence" I quoted some of Spalding's statements as to the intelligence of young birds. I then received a letter from my friend, Mr. T. Mann Jones, informing me of observations of his own which did not accord with those which I quoted, and expressing some scepticism as to the existence of what he termed "the philosopher's chick." I therefore determined to observe for myself, and the following paper contains some account of my observations, which should be compared with those of Douglas Spalding in *Macmillan's Magazine* for February, 1893, and those of Professor Eimer in his "Organic Evolution" (English Translation, p. 245). I desire to express my acknowledgments to Mr. Mann Jones for his suggestions and criticisms.

The eggs were incubated under the hen until about the third day before hatching, when they were transferred to an incubator. After hatching the young birds were left in the drawer of the incubator for from twelve to twenty hours. They were then kept under observation in a small pen surrounded with wire netting in my study. There was thus no influence of adult birds. I was their only foster-mother. I shall describe the observations under the head of the day of chick or duck life—first day, second day, and so on—dating from their removal from the incubator drawer.

FIRST DAY.—*Chicks.*—On opening the drawer of the incubator the newly-hatched birds are often seen to huddle together and to try and burrow under each other. Experiments on the co-ordination for pecking show that any small conspicuous object is struck at. The aim was seldom quite correct, the tendency being apparently to strike somewhat short. Moving the object a little with a long steel pin caused it more readily to catch their eye. It was generally seized at the third or fourth stroke, but a little awkwardly, and was not always successfully swallowed. Flies, from which a portion of their wings had been removed, were followed as they ran, and were seized at from about the seventh to the twelfth stroke. The chicks pecked persistently at their own and each other's toes and at the bright bead-like eyes of their yellow neighbours, also at excrement, shaking their heads and wiping their bills.

Ducklings.—The pecking co-ordination was imperfect. When a piece of white of egg was seized it was mumbled rapidly and shaken out of the bill unswallowed. Towards the close of the day they began to swallow what they seized, but the pecking co-ordination was not quite perfect. They were at first very unsteady on their legs (more so than the chicks) and tilted over backwards on to their tails. One scratched its head, but toppled over, the double co-ordination of standing on one leg and scratching its head was more than it could manage. They walked several times through the water placed in a shallow tin, but took no notice of it. I dipped the beak of one of them in the water; it then drank repeatedly, shovelling up the water with characteristic action. Presently the others imitated the action and drank freely. I dropped, at different times, two ducks into a tepid bath. They kicked vigorously and excitedly, dropping their excrement, but in a minute swam about with easy motion, pecking at marks on the sides of the bath.

SECOND DAY.—*Chicks.*—Several ran repeatedly through the water in a shallow tin, but took no notice of it. Then, after about an hour, one of them standing in the water pecked at its toes. It lifted its head and drank freely with characteristic action. Another subsequently pecked at a bubble near the brim and then drank. The stimulus of water in the bill at once led to the characteristic responsive action. Others came up and pecked at the troubled water; they too then drank. Later on one was running and toddled into the tin; it stopped at once and drank. Wet feet seemed to suggest drinking by association. I placed two winged flies before them. One chick seized a fly at the first stroke. Another followed the second fly and made three pecks at it, but the other chick rushed in and caught it at the first stroke. A large winged fly thrown among other chicks was approached by one bird which gave the danger note (a very characteristic sound). Subsequently the same chick followed it and caught it after several bad shots. They pecked about equally at four kinds of grain, millet, canary, groats, and pari; but swallowed more of the millet. They also pecked at and swallowed sand grains. I took one of the chicks and put it down near a young cat. The bird showed no signs of fear.

Ducklings.—Both ducks made at once for water in shallow tin, drank and squatted down in it. They ate keenly of white of egg, swallowing large morsels, the pecking co-ordination being nearly accurate. Both scratched their heads occasionally and toppled over. They preened the down, especially of the breast, in characteristic fashion; they also applied the bill to the base of the tail and rubbed the sides of their heads along the back in quite approved duck fashion. They stood up stretching out their necks and flapping their wings, sitting down on their tails from imperfect co-ordination. They showed much less accuracy of aim than the chicks in catching running flies. The abortive attempts were numerous.

They ate their own and chicks' excrement freely and showed little sign of disgust. (In South Africa young ostriches are often supplied with the droppings of the old birds, for medicinal purposes. So I was informed).

Third Day.—*Chicks.*—The chicks pecked excitedly at flies placed in an inverted tumbler, but failed to catch them on the wing when the insects were allowed to escape. They still peck at any small objects, especially bright ones, but show more discrimination in swallowing. They run to one's hand when one pecks on the ground with one's finger or a pencil, simulating the action of a hen. One can thus induce them to seize objects which they would otherwise leave untouched. They will always run to nestle in one's hands, poking their heads out between one's fingers prettily. To some chicks (Group A) I threw cinnabar caterpillars. They were seized but at once dropped, with some wiping of the bill. The caterpillars were uninjured, and were seldom touched again. They were removed and thrown in again towards the close of the day. Some chicks tried them once, but they were soon left. I could induce birds to pick them up by "pecking" with a pencil, but they were at once dropped.

Ducklings.—There was nothing special to note.

Fourth Day.—*Chicks.*—I threw to the chicks of group A some looper caterpillars and some green caterpillars from gooseberry bushes. They were approached with some suspicion. Presently one chick seized one and ran off, giving rise to a stern chase. Another stole it from the first and ate it. In a few minutes all the caterpillars were cleared off. Later in the day I gave them more of these edible caterpillars, which were eaten freely. Then some cinnabars. One chick ran, but checked itself, and without touching the cinnabar wiped its bill (association). Another seized one and dropped it at once. A third subsequently approached a cinnabar as it walked along, gave the danger note and ran off. Then I threw in more edible caterpillars, which again were eaten freely. The chicks thus discriminate by sight between the nice and the nasty caterpillars. To a second group (B) I threw cinnabars and small worms. Both were seized at first with equal appetence, but discrimination was soon established. The chicks began to scratch the ground (perhaps also the day before, but not markedly). Several of them pecked at the burning end of a cigarette two or three times, but some were stopped by a whiff of the smoke, and then shook their heads and wiped their bills. Subsequently, when the cigarette was out and cold, they came and looked at it ; and one, after eyeing it, wiped its bill on the ground. A large *Carabus* beetle, sprawling on its back, was an object of fear ; one chick at last pecked at it, uttering the danger note, and threw it on one side. After this none went near it.

Ducklings.—Experiments with cinnabar caterpillars, loopers, and worms gave similar results to those obtained with the chicks.

FIFTH DAY.—*Chicks.*—One of the birds, bolder than the rest, would eat large flies with relish. I threw in a bee. Most of the chicks were afraid, as they were of large flies. The bolder chick, however, snapped it up and ran off with it. Then he dropped it and shook his head, wiping his bill. Probably he tasted the poison and was not stung; in any case, he was quite lively and unconcerned in a few minutes; but he did not touch the bee again. The chicks preened their down early on this day. If they had done so before, I failed to note the fact. Later in the day I put beneath a tumbler a large fly and a small humble bee with a sting. Two of the chicks ran round the tumbler pecking at the insects. I let the bee escape. The bolder chick seized it, dashed it against the ground, and swallowed it without a wink. With another group of chicks I first gave bees, which were seized but soon let alone, and then *Eristalis.* They were left untouched. Their resemblance to the bees was protective. Later I gave *Eristalis* again, and induced one of the chicks to seize it by pecking at it with my pencil. He ran off with it, chased by others. It was taken from him and swallowed. The other *Eristalis* insects were left untouched, but one was subsequently eaten.

Ducklings.—I placed some frog tadpoles in their water. They were soon spied and eaten greedily. The vulgarity of the duckling as a feeder is painful to witness.

SIXTH DAY.—*Chicks.*—I gave them their tin without water. They stood in it and pecked, one lifting its head. They scratched at the bottom vigorously, and pecked again and again. On this day they frequently stood up, stretching out their necks and fluttering their wings. They may, however, have begun to do this earlier. Several of them pecked at a sleepy wasp, but soon let it alone. I made a number of experiments on this and the previous day with regard to their ability to catch flies on the wing, placing the insects under a tumbler. The birds pecked at them as seen through the glass. I then let them, one by one, escape. The chicks made a dash at them, but never succeeded in catching one, though they caught one or two as they crawled out and before they had taken flight. I tried also with tumblers covered with cards. I may add that up to thirteen days I have never yet once seen a fly captured on the wing by either a chick or a duckling, though I have often seen them struck at.

Ducklings.—Each morning, at nine o'clock, I had placed in their pen a large black tray, and on it a flat tin containing water. To this they eagerly ran, drinking and washing in it. On the sixth morning I gave them the tray and tin in the usual way, but without any water. They ran to it, scooped at the bottom, and made all the motions of the beak as if drinking. They squatted in it, dipping their heads and waggling their tails as usual. For some ten minutes they continued to wash in non-existent water (association). I then gave them water. I threw them a bee: one of them seized it and swallowed it. Possibly he was stung. He kept on scratching his beak—first on one side, then on the other, and seemed uneasy. He was all right again, however, in half-an-hour, but did not seem keen after a bee I offered him; nor would he take any notice of an *Eristalis*.

Seventh Day.—*Chicks* (Group A).—I threw in a number of bits of red-brown worsted, one to two inches long. They were seized with eagerness and eaten with avidity. I could not satisfy them with worsted worms, and desisted in the attempt lest the diet should produce unpleasant effects on their little gizzards. I left, however, one four-inch worsted worm, of which the chicks seemed afraid. Presently the bolder one seized it, ran off with it chased by the others, escaped from the pen, reached a secluded corner of my study, and with great efforts swallowed it to the last half-inch. The same chick pecked repeatedly at something near the corner of the turned-up newspaper which then formed the wall of my pen (I now use wire netting). This I found to be the number of the page. He then transferred his attention to the corner of the paper, which he could just reach. Seizing this he pulled at it, bending it down and thus forming a breach in the wall of my experimental poultry-yard, through which he escaped. I caught him and put him back near the same spot. He went at once to the corner, pulled it down, and escaped. I caught him and put him back on the other side of the pen. Presently he sauntered round to the corner, began pecking again, and escaped. I then pulled it up out of his reach. He pecked at it, but soon desisted. This is a good, simple example of the intelligent utilisation of a chance experience. Group A, including this chick, were near the close of their seventh day returned to the yard from which the eggs were obtained through the kindness of my friend, Mr. John Budgett. They were adopted by a broody hen, and were reported to seem afraid of her.

Very noticeable at this stage is the effect of any sudden noise—a sneeze, clapping one's hands, a sharp chord on the violin; or of suddenly pitching among the chicks a piece of screwed-up paper. They scatter and crouch, or sometimes simply crouch down where they are. The constant piping cheep-cheep ceases, and for a moment there is dead stillness, each bird silent and motionless. In a minute or so, up they get and resume their cheeping notes.

Ducklings.—I repeated the experiment with the dry tin. Again they ran to it, shovelling along the bottom with their beaks and squatting down in it. But they sooner gave up the attempt to find satisfaction in a dry bath.

Eighth Day.—*Chicks*.—On this day I noticed for the first time the chicks crouching down and making all the movements of sand-washing or dusting themselves in the way many birds affect. There was only a little sand strewn over the newspaper and not much good came of the operation. Still it was persisted in for a quarter of an hour at a time. I tried these too (Group B) with worsted worms. They seemed to give complete satisfaction, and there was many a stern chase after the fortunate possessor of an inch of worsted. I tried them again with cinnabar caterpillars, of which they took scarcely any notice. None were seized. I threw in a lump of sugar. The chicks stood round it, uttering the danger note. Then some ran at it, pecking rapidly and withdrawing in haste. They deal thus with moderate-sized suspicious-looking objects.

Ducklings.—On repeating again the experiment with the empty tin they soon left it, and did not squat down in it at all. But when I poured in water they ran to it at once.

Tenth Day.—*Chicks.*—I took two of the chicks to the yard from which the eggs were obtained, and opened the basket, in which I had carried them, about two yards from a hen which was clucking to her brood. They took no notice whatever of the sound. They were not in a frightened condition, for they jumped on my hand and ate grain off it, scratching at my fingers. I put them with a hen in a small fowl-house. They did not seem frightened, or, if at all, but little. To those that remained I took back a large humble-bee. One darted at it, giving it a sharp peck, and throwing it disabled to one side.

Ducklings.—One of the ducklings seized the disabled bee, and, after mumbling it for some time in the water, swallowed it.

Thirteenth Day.—I took the remaining chicks to the yard. A hen in a fowl-house was clucking eagerly to her young brood. The chicks were put down outside, out of sight of her. They took no notice whatever of the clucking sounds she made, but scratched about round me. They were then placed among her brood. She seemed inclined at first to drive them away, but afterwards looked more kindly on them. But they did not keep close to her like her own brood. I went over to see them next day. One was at some little distance from the hen. I leant down and held out my hand. The little thing ran to me and nestled in my palm.

The sounds emitted by the chicks are decidedly instinctive, and some of them are fairly differentiated. At least six may be distinguished. First the gentle piping, expressive of contentment. It is heard when one takes the little bird in one's hand. A further low note, a sort of double sound, seems to be associated with extreme pleasure, as when one strokes the chick's back and cuddles it. Very characteristic and distinct is the danger note—a sound difficult to describe,—perhaps somewhat as if a miniature policeman's rattle were sprung inside the chick's head. This is heard on the second or third day. If a large humble-bee or a black-beetle, or a big worm or lump of sugar, or in fact anything largish and strange be thrown to the chicks, the danger note is at once heard. Then there is the cheeping, piping sound, expressive, apparently, of wanting something. It generally ceases when one goes to them and throws some grain or even stands near them. My chicks were accustomed to my presence in the room, and generally were restless when I left them and made this sound. Then there is the sharp squeak when one seizes them against their inclination. Lastly, there is the shrill cry of distress when, for example, one of them is separated from the rest. I have very little doubt that all of these sounds have, or soon acquire, a suggestive value of emotional import for the other chicks. Certainly the danger note at once places others on the alert. But the suggestive value seems to be the result of association and the product of experience.

The foregoing observations I have presented much in the form, though with many omissions, in which they were noted down at the time; hence much crudity of expression. They appear to me to suggest—

(1.) That there are many truly inherited activities performed with considerable but not perfect exactitude in virtue of an innate automatism of structure.

(2.) That associations are formed rapidly and have a considerable amount of permanence.

(3.) That intelligent utilisation of experience is founded on the associations so formed; such associations being a matter of individual acquisition, and not of inheritance.

(4.) That there is no evidence of instinctive knowledge, even in a loose acceptation of this word. This follows from the non-inheritance of associations of impressions and ideas. *Co-ordination of activities* is thus apparently inherited, but *not correlation of impressions and ideas.*

(5.) That even the inherited co-ordinations are perfected and rendered more effective by intelligent guidance.

(6.) That imitation is an important factor in the early stages of mental development.

(7.) That the inherited activities on their first performance are not guided by consciousness, though they are probably accompanied by consciousness. The *rôle* of consciousness is that of control and guidance. Only on the first performance of an inherited activity is the chick a conscious automaton. In so far as the activity is subsequently modified and perfected by intelligence the agent exercises conscious control. If we then term it an automaton, we must admit that the automaton has a power of control over its actions in accordance with the conscious concomitants of certain cerebral changes. Into the physiological mechanism of control, as I conceive it, I cannot enter here.

C. LLOYD MORGAN.

SOME NEW BOOKS.

THE PSYCHOLOGICAL REVIEW. Vol. I., no. I, January, 1894. New York and London: Published bi-monthly by Macmillan & Co. Single numbers 75 cents. Annual subscription 4 dollars.

THIS new periodical makes an excellent start, including long contributions from Professor Ladd (his Presidential Address to the New York Meeting of the American Psychological Association), from Josiah Royce on "The Case of John Bunyan." Hugo Münsterberg sends the first of a series of studies from the Harvard Psychological Laboratory. Mr. Francis Galton has a note on "Arithmetic by Smell." Professor James discusses Wundt on "Feelings of Innervation" and the other articles and reviews are well up to the standard implied by the foregoing.

Professor Ladd's Presidential Address is very interesting. He discusses first the burning question of the relation of Laboratory work in physiological psychology to the general subject. He extends a generous welcome to the young science, but deprecates that ardour of its votaries which sees science in no other method. No doubt Professor Ladd holds rightly that scientific psychology must include not only laboratory work but introspection and "reflective study of that artistic delineation of soul-life in which the best novels, poems, and dramas are so wonderfully successful." But it is not good that all truths should be blazoned abroad and in those sciences that have a side open to the inexact and the amateur, it is specially necessary to distinguish between those who write about things and those who work at them. For this reason our sympathies are with those who insist on the laboratory and the methods of the laboratory. For similar reasons our sympathies are again with the experimental school in the endeavour to get at objective conclusions in psychology. No doubt the result of "series" of experiments and generalisations from statistics must be interpreted in terms of consciousness. But that, in a sense, is true of all science, and though the materials of psychology are peculiarly changing, evanescent, complex, personal, laboratory work has shown already that objective truths can be reached. There is no need to insist upon introspection: we all "introspect": perhaps we all must do it, but there is need to insist upon exact methods.

Professor Ladd's treatment of the relation between science and philosophy is very interesting. He traces the events leading to he relation of mutual contempt in which the two subjects stood twenty years ago, and although at the present day "reconciliations" are chiefly effected by "men of second-rate quality," he approves of the spirit. "For philosophy is but wild and mischievous speculation, unless it build itself upon the concrete and particular sciences; and science is but the unsatisfying husk of knowledge, is without rational self-consciousness and highest import and divinest interest, unless it intelligently lend itself to help, and to be helped by, philosophy."

P. C. M.

A Theory of Development and Heredity. By Henry B. Orr, Ph.D., Professor at the Tulane University of Louisiana. New York and London: Macmillan and Co., 1893. Price 6s.

At the present time all theories of Development and Heredity are classified naturally in accordance with the views of the writers about the inheritance of acquired characters. Professor Orr accepts the principle of such inheritance but he is somewhat cavalier in his treatment of the question. He compares one-celled animals with many-celled animals from the "physiological" point of view, and comes to the conclusion that there is no sure foundation for the assumption of a physiological difference between the great groups. In the one case the mass of protoplasm is continuous: in the other the protoplasm is intersected by cell-walls, running in all directions. "In the simpler forms of the metazoa each cell has a nucleus: in the more complex of the protozoa a single-celled animal may have several nuclei. Thus we see that the nucleus affords no basis for the assumption of such a profound distinction between the groups." Cell-walls (primarily, at least) are merely "an indispensable means of support." "None can maintain that the sluggish Hydra is a more highly-developed organism than the graceful Stentor or Paramœcium." In higher animals the complicated nerve-tracts place the organs in a more immediate connection with each other even than the protoplasm in the cells of Hydra. It is true, he admits, that metazoa differ from protozoa in that they have germ-cells. But these are merely part of the protoplasm which retains its original qualities, "only changing its nervous condition to a condition of greater complexity of co-ordinations." The germ-cells are, therefore, able to develop as did their forbears, with the addition of the "nervous" changes impressed on them by the forces of the environment. Professor Orr gives instances showing that the germ-cells are not isolated from the rest of the organism; instances like the effects on the body of castration; instances like changes of season determining the period of maturation. But hear the Professor:—

"Finally, since the germ-cells possess the potentiality of producing all the nervous and mental traits of the body from which they are derived, we cannot suppose them utterly disconnected from the nervous system and inaccessible to its influence. There seems to be a most profound and intricate connection between the two.

"We find, therefore, no essential difference between the development and reproduction of the protozoa and the same process among the metazoa. If inheritance of acquired characters be admitted for unicellular organisms (and I can see no other reasonable interpretation of the fact), then the same must be admitted for multicellular organisms."

Biology, according to the Professor, stands between the science of physics and psychology, and the laws of these cannot be neglected in biological research. The forces of growth and development must be regarded as transformations of the general sum of energy. Starting from this he builds up a theory that is epigenetic in the extremest form. It is the pressure of the outer world that moulds and forms the growing organism. Light and heat, vibrations and impacts, the chemical and physical nature of gases and food-substances, are the active forces at work, and by them protoplasm becomes organism. Some examples will show the extent to which Professor Orr attributes direct mechanical effect to the environment. The fauna of the Gulf Stream are *all* yellow because the seaweed in which the animals live is yellow, and living matter is capable of photographing colours: so also with the tawny animals of the desert. Nerves are formed because nervous molecular impulses seek the channels of least resistance: and by repeated passing through the same channels, cause a differentiation of the tissue. Cave animals are blind because the eyes of many generations "have never been stimulated to their full growth by light."

Psychology contributes to the theory, the laws of Association and Repetition. Professor Orr believes that the nervous system is merely a specialisation of the nervous activity of cell-protoplasm, and so cheerfully applies to all living matter considerations drawn from psychological observations on human beings. The simplicity of the theory consists in this: if you assume that outward forces are the "cause" of growth and development, and that molecular changes corresponding to memory of growth and development are transferred to the germ-cells, it is quite clear that under similar forces the germ-cells will be changed in the same way: only they will be changed more quickly, because they know what they are bound to do.

P. C. M.

INVESTIGATIONS ON MICROSCOPIC FOAMS AND ON PROTOPLASM; Experiments and Observations directed towards a Solution of the Question of the Physical Conditions of the Phenomena of Life. By O. Bütschli, Professor of Zoology in the University of Heidelberg. Authorised translation by E. A. Minchin, B.A. (Oxon.), Fellow of Merton College, Oxford. 8vo. London: Adam and Charles Black, 1894. Price 18s.

SOME time ago[1] in an account of the original German edition of Professor Bütschli's work, I was able to let readers of NATURAL SCIENCE know that an authorised translation by Mr. Minchin was in preparation. This has now appeared, and the publishers, the translator, and Mr. Minchin are to be congratulated. Only those who have had to grapple with the perplexing German of the original can appreciate how lucidly and how skilfully Mr. Minchin has interpreted his author. In *format* the book is an improvement on the stitched German quarto; the plates have lost nothing in the transference, and the convenience of the reader is consulted by the relegation to smaller type of some discursive controversial matter.

It is needless to describe at length a book which biologists have now no excuse for neglecting. Professor Bütschli, in the course of his well-known investigations on Protozoa, came to see that there are all gradations between scattered vacuoles and a completely alveolar or reticular structure. He was led in this way to interpret all reticular structure in protoplasm as honey-combed structure. Then, after patient effort, he succeeded in manufacturing microscopic foams that, under the microscope, presented the reticulate appearance of protoplasm. In this book he describes these foams minutely and compares them with protoplasm as seen in many organisms. But an unexpected marvel was the appearance of streaming movement and actual progression in his artificial foams. The discussion and physical explanation of these, and the suggestions these physical explanations give for the analogous processes in living material, form the most startling part of Professor Bütschli's contribution to science. These are all matters to be worked out with microscope and materials, rather than to be discussed and criticised in writing. Do not reason with a doubter, using vain words, but lead him to a laboratory and show him the foams streaming and moving.

P. C. M.

[1] NAT. SCIENCE, Jan., 1893, "Artificial Protoplasm," by P. Chalmers Mitchell.

'Mongst Mines and Miners; or Underground Scenes by Flashlight: a series of photographs with explanatory letterpress, illustrating methods of working in Cornish mines. By J. C. Burrows and William Thomas. 4to. Pp. 32, 27 photographs, and vertical plan of workings of the Dolcoath Mine. London: Simpkin, Marshall & Co., 1893. Price 21s.

This book is most interesting. Apart from its peculiar value as a faithful record of the method of working a mine, it gives the reader a good idea of the difficulties to be overcome in winning metals. Mr. Burrows has spent a twelvemonth in producing the twenty-seven excellent photographs contained in the book, and gives a lively picture of the patience necessary to enable one to become a successful photographer of underground mining scenery. The apparatus used was a Zeiss' Anastigmat lens, series iii. (Ross & Co.), and the artist enthusiastically terms it "a perfect gem." Of the many plates used, none equalled the Cadett lightning plates, which proved so satisfactory that in some cases every miner was taken in his working position with his light in its usual place. For illumination, limelights at their maximum intensity had to be employed simultaneously with powerful flash magnesium lamps and ribbons. For close subjects two triple-flash magnesium lamps were generally used, but in large areas more lamps were brought into requisition. The mines chosen for illustration in this work are the Dolcoath, Cook's Kitchen, East Pool, and Blue Hills. The photographs themselves, which are described by Mr. Thomas, include views of the man-engine at Cook's Kitchen and Dolcoath; the balance box and gig at Dolcoath; the 355 and 406 stopes at Cook's Kitchen; the 180 at East Pool; the 375 and the 412 at Dolcoath, and the 66 at Blue Hills; the 70 tram-road and the bridge, East Pool; engine shaft at Cook's Kitchen; the heave at Blue Hills; rock-drilling, milling, overhand and underhand stoping, and a group of miners at "croust," or afternoon meal.

The photographs are excellent, and most detailed; in those cases, too, where the men are holding candles the flame is seen to be perfectly distinctly outlined. We congratulate both artist and author on the results of their patient but enthusiastic labour.

The Oxford Museum. By Henry W. Acland, M.D., and John Ruskin, M.A. 8vo. Pp. xxxvi., 112, two plates, and folding plan. From original edition, 1859. With additions in 1893. London and Orpington: George Allen, 1893.

To all Oxford men, to all scientific men, to all artists, architects and craftsmen, to all who have any sympathy with either nature or art, this book comes fraught with stirring and pathetic interest. The book itself is professedly an address delivered by Sir Henry Acland, in 1858, to certain Architectural Societies, on the building of the Oxford Museum. But admirable though this address is, it is, we venture to think, in that which has grown around it, in the letters of Mr. Ruskin, in the notes and in Sir Henry's preface to the present edition, that the chief interest of the book will now be found. We have here a double story: the story of the revival of Gothic architecture, and the story of the progress of scientific education in an old university; and the two stories are bound together by the impressive personality of John Ruskin. How the Museum gradually came to be, and how it rose beneath the enthusiastic hands of an artistic band of Irish craftsmen, is a tale delightfully told in this volume. Then with wonderful delicacy and tact Sir Henry relates the causes that led to Mr. Ruskin's resignation of his professorship when Convocation voted

£500 a year for carrying on the work in Dr. Burdon Sanderson's Physiological Laboratories. Sir Henry regrets that no living plants or animals are kept in connection with the Museum. "Life in action, with the habits thereto pertaining, is a study as worthy as is the machinery which makes, preserves, and brings it to a close. It is a fault in most museums that only the mechanism of life and not its living actions are displayed."

What follows is of sufficient importance at the present juncture to quote in full. "These general thoughts may seem strange to those in Oxford who, from imperfect knowledge, desire to change the Museum into a so-called 'medical school.' They perhaps have not reflected on the loss that they will inflict on the Profession of Medicine if they succeed. Forty years ago it was hoped to add to the wide Philosophical, Historical, Theological life of the old University the means for similar study of the material Universe considered alike in its Unity and in its special parts. It was felt that this would harmonise with, and supply the missing link in the aims of the old education. The opportunities were to be open to all, for whatever walk in life destined. Adapt it only to one profession such as medicine, you rob all others of the larger opportunity, and—what is even worse—persuade future Oxford graduates that medicine has no relation to science as a whole; that it is a specialism, grounded on itself alone, and that the essence of its education is to prepare by schedules for passing examinations. No greater educational fallacy can exist. To give colour to it is a cruelty to all our youth. Our best students already feel this to be so. The foundation by them of the Robert Boyle Lecture is a proof. Wider views are held by the best thinkers, even for our elementary and Government schools. The conception is a relic of days of ignorance."

Like all works to which Mr. Ruskin's name is attached, this one is beautifully produced. One of the two exquisite plates represents the capital of a pillar in the central court of the Museum, while the other is a charming portrait of the two authors.

NOVITATES ZOOLOGICÆ: A Journal of Zoology. Edited by the Hon. Walter Rothschild, Ernst Hartert, and Dr. K. Jordan. Vol. i., no. 1. Imp. 8vo. Pp. 266 and three plates. Issued January 30, 1894, at the Zoological Museum, Tring.

THIS handsome publication, to which the yearly subscription is one guinea, has been started mainly for the purpose of describing new species, and, we presume, of thereby adding to the type-specimens in the Rothschild Museum. The species-mongering is, however, not to be done rashly, or at the mere caprice of writers; it is to be subject to certain principles which are laid down by the Editors in an introductory note. "The basis of truly scientific, systematic work is the knowledge of the species and their geographical distribution. Therefore we ought to distinguish between the different forms, even if their differences are very '*slight*,' provided they are *constant*. If very closely allied forms are connected by intermediate specimens (as is often the case in the countries where their areas meet or overlap), it is practically not advisable to admit them as distinct species, but they ought to be degraded to the rank of sub-species. Island forms, however slight may be their differences, will, in most cases, be more readily recognised as worthy of specific rank than similarly closely allied forms with a mainland distribution. The term 'variety,' especially among entomologists, has been indiscriminately used to denote an individual variation within a species as well as climatic or geographical races. We, therefore, to avoid all possible errors, have determined to discard the term variety altogether. To denote individual variations we shall employ the word aberration, and for geographical forms which cannot rank as full species, the term sub-species."

The present number contains communications from the three editors, from Dr. Forsyth Major and Mr. W. F. Kirby, which are written in Latin, German, or English. Nothing is said as to language, but we hope Mr. Rothschild's catholicity will not include Russian or Japanese. Two of the plates are beautiful specimens of the art of J. Smit and J. G. Keulemans.

THE CRINOIDEA OF GOTLAND. Part i. The Crinoidea Inadunata. By F. A. Bather. *Kongl. Svenska Vet. Akad. Handl.* Bd. xxv., no. 2. 4to. Stockholm: 1893.

THE Silurian beds of the Isle of Gotland have long been famous for the wealth of numbers and excellence of preservation of their fossils, ranging from the Upper Llandovery to the Upper Ludlow. Numerous monographs have appeared upon them from time to time, for they have yielded to the Swedish school of palæontology its most profitable material. The Crinoids have been elaborately figured in the great folio "Iconographia Crinoideorum" of Professor Angelin in 1878; and probably no one who has had occasion to use that work but has felt that it is not a fair specimen of Swedish science; the death of the author before its completion probably accounts for many of its errors. The unsatisfactory nature of Angelin's posthumous monograph has been the more regretted owing to the singular wealth and interest of the Gotland Crinoids. Students of Echinodermata will therefore welcome the first of a series of detailed memoirs on these fossils from the pen of Mr. F. A. Bather.

This first part deals only with the Inadunata, the Order in which all the brachials are free and the interradials do not take part in the composition of the dorsal cup except in the posterior interradius. The memoir consists of 200 pages, and 10 admirable plates, crowded with instructive and artistic figures by Mr. Liljevall. With the exception of a few introductory pages, which deal with the terminology, bibliography, and stratigraphical horizons, it consists entirely of a detailed account of the structure of the Crinoids, with discussions of the affinities and synonymy of the various species. The Inadunata in the fauna comprise thirty-nine species sufficiently well known to be described; these are referred to ten genera, and the imperfection of our knowledge of the Silurian Crinoids may be judged from the fact that these ten genera are referred to no less than seven or eight families. Of the species fifteen are new, and there is one new genus appropriately named *Gothocrinus*.

The present, however, is not a work to be judged by the number of species created; it is in its detailed dissections and figures, its precision of nomenclature, the care that has been taken in determining the morphological meaning of the different elements of the skeleton, and the patience with which the nomenclature and synonymy have been discussed, that its real merit lies. Forms such as *Pisocrinus* and *Calceocrinus*, that have been previously turned upside down, wrong side before, or inside out, to suit the varying explanations of their describers, are now finally explained, owing to the recognition of the anal tube. The curiously coiled *Herpetocrinus* is also now first satisfactorily worked out. One of the most remarkable innovations is the abandonment of the two suborders Larviformia and Fistulata, which have always seemed unsatisfactory on *à priori* grounds, and a return to a classification based on the presence or absence of infra-basals. The author admits that this may seem a retrograde step, but as in this mixed world advance does not always spell progress, it is, probably, none the worse for that.

In a brief notice such as this, one can do but scant justice to this important contribution to palæontological literature. It is unfortunate that it is impossible to get such a work published in England, and that this has had to see the light in a foreign capital. One's patriotism, however, has to get what salve it can from the recognition that this is not a sample of the rule-of-thumb palæontology which foreign workers seem generally to regard as the characteristic product of the English school. The "Crinoidea of Gotland" is worthy, by its conscientious thoroughness of detail, and its grasp of zoological principles, to rank among the best productions of modern palæontology.

THE FLORA OF THE ASSYRIAN MONUMENTS AND ITS OUTCOMES. By E. Bonavia, M.D. 8vo. Pp. xxvi., 215, with 98 figures in the text. Westminster: A. Constable & Co., 1894.

DR. BONAVIA's books are always worth reading. Even when he puts before us no new facts, he has a way of restating the old ones which is sometimes edifying, sometimes amusing. In the preface to this, his latest work, he has attempted "from the Assyrian real flora, to creep up to their sacred flora, and to interpret certain symbols found woven in with this." He may have succeeded also "in throwing some light on the derivation of other features affiliated to those symbols." He would also have us bear in mind that whenever it may appear that he is too positive in what he states, it is only a mode of diction, and simply means that in his "humble opinion it seems so and so." As regards the Flora of the Assyrian monuments in the British Museum and elsewhere, some plants are unmistakable, as for instance the date-palm, which frequently occurs, and no wonder, considering its immense importance as a food tree, and the reverence paid to it in consequence. The vine, pomegranate, and fig are also easily recognised. Some things looking much like bundles of asparagus are put down for bananas, and we certainly think the doctor makes out a very good case, showing from the geographical and botanical history of the plant that this fruit may well have been known to the Assyrians as an imported and rare article. This also explains why only the fruit and not the plant itself is traceable on the monuments. The pine tree which occurs on several bas-reliefs is identified with *Pinus Brutia*, a conifer, ranging nowadays from Syria to Afghanistan, and most likely to have been the one which was common in the hilly countries of Assyria. "A *young* pine tree, with its symmetrical, candelabrum-like branches . . . makes a very pretty and ornamental object, and such as would attract an artist's attention." The sculptors of those days were also acquainted with a lily, which is identified with the "Madonna Lily" (*Lilium candidum*). A plant with acute radical leaves, and long-stalked, composite flowers, has by the aid of the collection of drawings at the British Museum (Natural History) been run down to *Hieracium pannosum*, a native of the rocky regions of Greece, Taurus, Cilicia, South Armenia, etc. It certainly looks like a Composite, but he would be a bold man who would accept a specific determination made on such material and in such a very critical genus as *Hieracium*. Another thing, not unlike a sea-weed, "the identification of which appears to be hopeless," Dr. Bonavia suggests as not impossibly intended for the Baobab, a tree found in the Soudan and S.E. Africa, and introduced, perhaps, along with ivory and many other products, which must have come from the Soudan *viâ* the Red Sea.

Out of the study of the Flora arises the question of the origin of the so-called Sacred Trees, of which four or five different kinds are traceable on the monuments, viz., the date, vine, pomegranate, fir, and perhaps the oak. This leads us on to the cone-shaped object, "held in the hand of winged genii, and pointed either at a sacred tree or at the king's person, or at the entrance of a temple, palace, or town." In the other hand the genius invariably holds a bucket of some sort, and in the bucket the worthy doctor finds the key to the situation. After rejecting his own notion of the citron, and also Dr. Tylor's theory, that the cone is the male inflorescence of the date-palm, of which a further supply was contained in the bucket or basket, and that the pointing indicates fertilisation of the sacred tree, the author suggests an explanation to which he does "not see sufficient grounds for not adhering." It is that the bucket contains holy water and the cone-object represents a *cedar*-cone, used as a sprinkler. This will explain the pointing at the king's back hair and other objects besides the date-palm. As we are barely half through the book, we cannot stay to evolve a more satisfactory solution. In the next section the Lotus as a decorative object is discussed with a protest against viewing all ancient ornamentation through "lotus-spectacles." The "Anthemion," it is argued, originated in the sacred date-tree of the Assyrians. Apropos of "the Evil Eye" it is suggested that the Prince of Wales's feathers may have originated from a pair of horns (a protection against the aforesaid eye) and three date-palm leaves.

The last two sections of this very readable and well-produced work are entitled "The Trident" and "Some Notes on Cylinders."

THE GENUS MASDEVALLIA. Issued by the Marquess of Lothian, plates and descriptions by Miss Florence H. Woolward. Folio. Part v., containing ten species and varieties. London: Porter, 1893. Price £1 10s.

WE congratulate the authors of this admirable monograph on the completion of the fifth part of their undertaking, which must bring them about half-way through, as fifty species and varieties have now been figured and described. We are inclined to think the present the most interesting of any of the parts which has yet appeared. It certainly is so from a scientific point of view, as it contains a complete history of *Masdevallia uniflora*, the first Masdevallia made known to science, discovered more than a hundred years ago in the Peruvian Andes by the Spanish botanists Ruiz and Pavon, and named in honour of their fellow-countryman, Dr. Josepho Masdevall, a physician and a patron of botany. It was found only in one locality, of which a description is given by Ruiz in his manuscript diary preserved in the Botanical Department of the British Museum. Huassa-huassi, as it is called, was then a small village of about forty inhabitants, situated in the depths of a steep narrow ravine, on the banks of a mountain torrent of the same name; the slopes around were covered with brilliant flowering plants, among which orchids abounded, their bulbs crowding the entire surface of the driest and most rocky grounds while the air was filled with the fragrance of their strange and elegantly shaped flowers. In spite of this promising description Huassa-huassi has, so far as we know, never since been visited by any botanist, nor has *M. uniflora* again been gathered. The species has never been in cultivation, and until Miss Woolward made it a subject of study there was no specimen in the country. The graceful drawing of the plant which accompanies the text is taken from the better of two of Ruiz and Pavon's specimens preserved in the Museum at Madrid; a third, consisting of two leaves and a bud from the same collection, was given by the Director, Dr. Colmeiro, to Miss Woolward, and by her to the Botanical Department of the British Museum. The fourth, and the only other specimen known, is now in the Boissier Herbarium at Chambésy. It formed part of a valuable collection of dried plants belonging to Pavon, discovered after his death by Mons. Reuter, hidden away in a garret in Madrid. Reuter purchased the collection for the Boissier Herbarium, of which he was then curator, and the orchids were submitted for examination to the late Professor Reichenbach who redescribed *M. uniflora* in "Bonplandia" (1856). Besides the small specimen from Madrid, Miss Woolward has also given to the British Museum the original sketch of the larger Madrid specimen, and one of the plant in the Boissier Herbarium.

Part V. also contains plates and descriptions of two Brazilian species not hitherto figured, and quite unknown in Europe. They were found by Senhor Barbosa Rodriguez, Director of the Botanic Gardens at Rio Janeiro, to whom the authors are indebted for the originals of the plates and the information in the text.

Several other species are also figured for the first time, and the Part opens with a splendid double plate of the gorgeous *M. chimæra*.

ZITTEL'S HANDBOOK OF PALÆONTOLOGY.

THE recent appearance of the concluding fasciculus of Professor von Zittel's "Handbuch der Palæontologie," coupled with the circumstance that the Council of the Geological Society have, most worthily, just bestowed their highest honour—the Wollaston Medal—on its learned author, affords us a fit opportunity of congratulating both the Professor himself and his enterprising publishers on the conclusion of their labours. As we have from time to time noticed some of the fasciculi which have appeared since this Journal came into existence,[1] while the limits of our space entirely forbid any detailed notice of the earlier volumes, we must content ourselves on this occasion with offering our most unqualified congratulations on the completion of the work.

It has been frequently remarked that Science has had many martyrs, and in our day the chief of these are unquestionably the compilers. Compilation is, indeed, work which, owing to the vast flood of scientific literature now poured forth without any system of publication, and in a confusing Babel of tongues, becomes year by year more necessary and more difficult. If there are few men who are willing to abandon original research, with its bracing stimulus of effort and novelty, for the duller plodding work of preparing summaries, there are still fewer capable of accomplishing this in a satisfactory manner, more especially in such a difficult science as palæontology, where so much is uncertainty and speculation.

[1] *See* NATURAL SCIENCE for March and September, 1893.

Such a compiler must be master of many languages, for most States have their own Geological Surveys, and publish reports in their own dialects, however obscure these may be. He needs great patience and capacity for work to enable him to grapple with the enormous volume of literature, combined with considerable elasticity of mind to avoid treating foraminifera and mammoths alike; he requires literary ability for lucidity of exposition and accuracy of diagnosis; he must be thoroughly well versed in zoological methods of enquiry, and completely *au fait* with the rules of zoological nomenclature; while, above all, he must be a sound geologist, fully in sympathy with and conversant with the needs and work of his fellow-labourers in the field. If any of these qualities be lacking the chances are that he will do as much harm as good, and have thrown himself in vain under the Juggernaut car of periodical literature.

It is doubtful whether any other man could be found possessing these qualities in a higher degree than Karl von Zittel, the Professor of Palæontology in the University of Munich, a brilliant linguist, a masterly teacher, a field-geologist of wide experience in Europe, Africa, and America. Uniting the laborious patience of a North German with the imagination of a Bavarian, he possesses all the qualifications necessary for the compilation of a reliable summary of contemporary palæontology. For the last eighteen years he has been engaged upon the task which he has now brought to a conclusion.

The "Handbuch der Palæontologie" is divided into two parts or sections; the first, in four volumes, dealing with the animals, being by Professor von Zittel himself, while the latter, in one volume, describing the plants, was commenced by the late Professor Schimper of Strassburg, and concluded by Professor Schenk, of Leipsic. The part on the animals alone occupies four thick volumes, containing a total of no less than 3,364 pages, with upwards of 2,976 illustrations. The first part was issued in 1877, and the last at the close of 1893. Although a work which has necessarily been such a long period in progress has some portions standing in need of revision, it will be found to contain a complete and reliable summary of the state of our knowledge of extinct animal and vegetable life at the time when the several parts respectively made their appearance. The first volume contains the general introduction, the Protozoa, Cœlenterata, Echinodermata, Bryozoa, and Brachiopoda, the second describes the remaining groups of the Invertebrates, the third the Fishes, Amphibians, Reptiles, and Birds, while the fourth is devoted solely to the Mammals.

Not only is the work issued in the original German, but, with commendable promptitude, four volumes have already been translated into French by Dr. C. Barrois, with the aid of other specialists: these four volumes respectively made their appearance in 1883, 1887, and 1891, and only the one devoted to Mammals remains to complete the French issue. It cannot fail to be a matter of regret that there is no prospect of any English translation being presented to the public; and we fear that the remark of a late President of the Geological Society to the effect that "no English publisher at present would feel justified in undertaking" the task, is only too likely to prove true.

The description of each separate order commences with a general account of the anatomy, the structure of the skeleton, and a sketch of its distribution in time. The main part of the work consists of more or less detailed systematic description, the whole of such families as have fossil representatives being included; while short diagnoses are given of all genera of any palæontological importance. The work, therefore, is an almost complete synopsis of the whole range of palæontology.

The "Handbuch" is, however, by no means merely a compilation. Professor von Zittel has always shown himself far too conscientious a worker to be willing to be content to leave some of the groups he has had to treat in the state of hopeless chaos in which he found them. In nearly every group the author's acumen in interpreting the descriptions of others, or his researches on the very extensive collections at Munich, have considerably advanced the classification. Take, for example, the Sponges; before the author came to them in the preparation of his second "Lieferung," they were in absolute chaos, the descriptions being based almost entirely on points of such little scientific value, that it was totally impossible to make any satisfactory comparison of the fossil with the recent faunas. The author accordingly at once commenced a re-investigation of the group and devoted nearly two years to the eighty pages in which the Sponges are described; by the study of thin sections under the microscope the forms of the spicules were determined and our knowledge of the fossil sponges placed on a scientific basis. In other groups there was less room for such revolutionary changes; but there are few, if any, which Professor von Zittel has left where he found them. In the Echinoidea he founded the family Conoclypeidæ after a study of the internal structure of the peristome, and thus removed one stumbling-block from the path of echinologists. The classification of the Bryozoa was extremely advanced considering that it was prepared fourteen years ago, while many very sound advances were made in the complicated synonymy of this group.

In the Vertebrates, which, we believe we are right in saying, are not his speciality, the Professor has in the main followed the classifications of those who have made studies of the various groups. Even here, however, he at times strikes out a line of his own. Thus, as we have had occasion to mention in our previous notices, he divides the Mammals into the Placental and Eplacental groups, of which the latter includes both Monotremes and Marsupials; while in the Ungulates many modifications have been made (whether wisely or unwisely we do not care to discuss on this occasion) in the limits of family groups.

Perhaps the most valuable contribution which Professor von Zittel has made to this part of his subject is the masterly essay on the geological distribution and evolution of the Mammalia with which the last volume closes.[2] In the two preceding numbers of NATURAL SCIENCE certain remarks from the pen of an independent observer have been made in regard to the improbability of the extinct mammals of Patagonia being of lower Eocene age; and it is interesting to note how Professor von Zittel's observations support the view there taken. Thus, the Professor remarks how difficult it is to believe that mammals with such specialised dentition as those in question could by any possibility be correlated with those of the European lower or middle Eocene, and how much more closely they resemble in their grade of evolution those of the upper Eocene or Oligocene; more especially as they are accompanied by at least one

[2] Dr. G. J. Hinde translated this essay into English and published it in *Geol. Mag.*, Sept., Oct., and Nov., 1893.

existing genus.[3] If he had had the opportunity of knowing that the alleged commingling of Dinosaurian and Mammalian remains does not appear to be founded on facts the author's remarks might possibly have been still more decisive.

To proceed further in pointing out the merits of this unrivalled Compendium of Palæontological Science would, as we have said, far exceed the limits of our space, and we can, therefore, only conclude by stating that, in our opinion, Professor von Zittel and his two colleagues have succeeded in carrying out and completing their arduous task in a manner worthy of the highest admiration, and have produced a work of inestimable value not only to the palæontologist, but likewise to the zoologist generally.

An important paper on fossil vertebrates comes to us from France. In the *Annales des Sciences Naturelles* (*Zoologie*), Mr. Filhol describes remains from the Quercy Phosphorites, which he considers to be those of true Edentates. They include (1) a form, *Necromanis*, related to the Pangolins of the Oriental and Ethiopian regions, and with a skull approaching in some respects that of the South American genus *Myrmecophaga*; (2) *Palæorycteropus*, allied to *Orycteropus*, which is now found only in South Africa, though during the Pliocene period one species occurred in Samos and Persia; (3) *Necrodasypus*, related to the Neotropical Armadillos, and represented by a portion of a carapace said to resemble that of the Glyptodonts. These discoveries and determinations tend to show that the Edentates must have had a northern centre of distribution; consequently they are of great importance, if they are correct.

In the last number of the *Quarterly Journal* of the Geological Society (1 Feb., 1894), Dr. J. W. Evans gives an account of a recent journey through the Matto Grosso district of Brazil. The ground covered by the author, which was practically the region drained by the Upper Paraguay, consisted of an undulating tableland, rising in some places to 2,600 feet above sea-level. The formations exposed are referred to Quaternary, Cretaceous?, Trias?, Carboniferous?, Devonian, and pre-Devonian. The pre-Devonian beds consist of foliated and schistose rocks, highly-cleaved clay-slates, limestones, sandstones, and red argillaceous shales. The Devonian beds are sandstones, which extend over the greater part of the Chapada Plateau, from which they take the name; and are fossiliferous near Sant' Anna de Chapada, as shown in Dr. O. A. Derby's paper (*Arch. Mus. Nac. Rio de Janeiro*, vol. ix. (1890), p. 59). The Carboniferous age of other beds is inferred from the evidence of fossil ferns found at Miranda, the authority for which evidence is quoted by Dr. Evans. The Cretaceous contains vertebrate remains, as turtles and *Mosasaurus*, the nature of which decides Dr. Derby to regard them as Cretaceous rather than Triassic. A geological sketch-map accompanies the paper.

A few days before the publication of Dr. Evans' paper, appeared part 5 of volume xxviii. of the *Zeitschrift der Gesellschaft für Erdkunde zu Berlin*, containing the conclusion of Dr. Vogel's journey through the same district in 1887–88. This part of his paper consists mainly of topographical details, measurements of heights, and magnetic and meteorological observations taken during the journey. To this

[3] We may venture to point out (vol. iii., p. 738) that *Chlamydophorus*, and not *Chlamydotherium*, is an existing genus.

account is appended a paper by Dr. Ludwig v. Ammon on Devonian Fossils from Lagoinha in Matto Grosso. The specimens came from the Chapada Plateau, and consist of, among others, the trilobite *Phacops*, the gasteropod *Bellerophon* (*Bucanella*), a *Tentaculites* (*T. bellulus*, Hall), a fragment of a *Nucula*, and five Brachiopods. Of these Brachiopods one is said to be identical with *Discina baini*, Sharpe, and another with *Chonetes falklandica* (Morris & Sharpe) from the Falkland Islands, while a third is identified as *Leptocœlia flabellites* (Conrad), a North American species. Figures of these fossils are given, and Dr. Ammon notes that the beds containing them correspond to those of Ereré on the Amazonas, and to the Hamilton and Upper Helderberg series of the United States, a statement agreeing with one made by Dr. Derby in the paper referred to above.

In the last issue of the *Quart. Journ. Micr. Sci.* (vol. xxxv., pp. 407–432), Mr. E. S. Goodrich gives an exhaustive account of all the known remains of mammals from the well-known Stonesfield Slate of Oxfordshire. From having carefully "developed" several of the specimens, the author has not only succeeded in revealing the existence of teeth supposed to be missing, but has likewise determined in others the true arrangement of their cusps. Perhaps his most interesting result is to show that *Amphitherium* had true "tritubercular-sectorial" lower molars; that is to say, these teeth had three cusps arranged in a triangle anteriorly, followed by a keel, as in the modern opossums and bandicoots. This leads him to conclude that *Amphitherium* cannot be included in the same family with *Phascolotherium* and *Amphilestes*, in which the three cusps are linear. May we ask him if he would, on the same grounds, propose to separate the existing Thylacine from the Dasyuridæ, as the difference is nearly the same in the one case as in the other? We are glad to see that the author supports, in the main, the doctrine of "trituberculism," even going so far as to derive the primitive tritubercular molar from the multitubercular type—a derivation which we are by no means sure that we are inclined to support. He totally rejects, however, the view that the so-called triconodont type of molar (that is to say, the one in which the three cusps are ranged in a linear series) is the primitive type from which the tritubercular molar was evolved. On the contrary, he considers that the triconodont is the derivative from the tritubercular. He, however, propounds this view of the specialisation of the former type as if it were a new one, instead of dating from 1887. Thus in that year Mr. Lydekker (*Cat. Foss. Mamm. Brit. Mus.*, pt. v., p. 257) wrote of *Triconodon*, "it appears to be a highly specialised primitive form, of which the lower true molars come nearest to those of *Thylacinus*, and bear the same relationship to those of *Dasyurus* as is presented by the inferior carnassial tooth of *Ictilyon* to that of *Canis*." We will not take leave of this valuable piece of work without remarking how very refreshing it is to see palæontological investigation finding place in a journal popularly supposed to be given up to the section-cutter and embryologist. We hope that a new era is being entered upon in British Palæontology, and that this publication marks a closer alliance between students of the living and students of the extinct.

We are glad to hear that a fresh start has been made with the long-suspended and much-desired "Flora of Tropical Africa." The work was commenced by Professor Oliver, the late keeper of the

Kew Herbarium, more than five-and-twenty years ago, and three volumes were issued: vol. i. in 1868, vol. ii. in 1871, and vol. iii. in 1877. In the production of these volumes Professor Oliver had much assistance from other botanists; in fact, the last volume, which ends in the middle of the Gamopetalæ, is largely the work of Mr. Hiern. Since 1877 nothing has appeared, owing, says the *Kew Bulletin*, to the Herbarium staff being fully occupied in "keeping fresh accessions determined scientifically and incorporated," while "such extraneous aid as was available has been mostly absorbed in assisting Sir Joseph Hooker in his 'Flora of British India,' . . . and in other undertakings." Why so important a work as the "Flora of Tropical Africa" has had to await the pleasure of these other undertakings is not explained. Recent exploration and the development of commercial enterprise have at last suggested to the Government the desirability of pushing forward the work (in proof of which some three-year-old letters are quoted), a fresh start has been made, and vol. iv. is now "in active preparation." As German botanists are meanwhile rapidly describing all the novelties they can secure, it has been thought advisable to publish brief diagnoses of two new species in the *Bulletin* during the progress of the work, and the January and February numbers contain those of the orders Apocynaceæ, described by Dr. Stapf, and Gentianeæ, Boragineæ, Bignoniaceæ and Convolvulaceæ, by Mr. J. G. Baker, Professor Oliver's worthy successor.

OBITUARY.

SAMUEL WHITE BAKER.

Born June 8, 1821. Died January 20, 1894.

SAMUEL WHITE BAKER was born in London, and was the eldest son of Samuel Baker of Lypiatt, Gloucestershire. He was educated at a private school, and afterwards went to Germany, where he studied engineering. As early as 1845 Baker went to Ceylon, chiefly for the purpose of elephant hunting. The reader of his books, however, will find that he had already taken an interest in geography, and before he left the island (1854) he had founded an agricultural settlement at Novera Elia, which he had peopled with English emigrants, and stocked with cattle mainly at his own cost.

From 1855 he superintended the construction of the Danube and Black Sea railways, and in 1861 made his first exploration in Africa, taking with him his second wife, Florence Finnian von Sass, a Hungarian lady, who has since shared all her husband's labours and enterprises. His journey had for object mainly the determination of the sources of the Nile, but partly the relief of Speke and Grant, who had left Zanzibar in 1860 with the same intent. Diverting his course in search of sport, he explored the Abyssinian rivers, and learned Arabic. Reaching Khartoum, he proceeded in 1862 southward to Gondokoro, where he met Speke and Grant in February 1863. Fired by their accounts, Baker and his wife determined to push still further, and on March 14, 1864, they reached the east side of the Albert Nyanza, and though unable to prove the exit of the White Nile, he crossed the river on his return journey about sixty miles to the north of the lake. For this adventurous journey, and its brilliant results the Geographical Society awarded Baker a gold medal. He was further created M.A. of Cambridge, and received the honour of knighthood. The story of his wanderings will be found in "The Albert Nyanza," 1866, and "The Nile Tributaries," 1867.

After a year's rest in England Baker and his wife returned in 1867 to Egypt, having in view the extinction of the slave trade. In 1868, the Khedive took Baker into his council, and it was decided that he should go, with a strong force, and absolute and supreme authority "to suppress the slave trade, to introduce a system of regular commerce, to open to navigation the great lakes of the Equator, and to establish a chain of military stations and commercial depôts distant at intervals of three days' march throughout Central Africa, accepting Gondokoro as the basis of operations." But nature and the natives were against him, and from June, 1870, to April, 1871, the expedition suffered great hardships, and numbers died from malaria and other diseases. After reaching Gondokoro, the Bakers pushed on south, and towards the end of 1871 established a fortified camp on the Nile at Fatiko, from which he waged war unceasingly on the slave hunters, and for a time checked the trade. But so soon as he left the country the trade revived and the crusade was continued by Baker's successors. Baker and his wife returned to England in 1873, and told the story of their expedition in "Ismailïa" 1874.

Sir Samuel settled down for a while at Newton Abbot, but the old sportsman and traveller could not rest. He and his wife visited Cyprus in 1879, Syria, India, Japan, and America in later years.

His chief works, beside those referred to above, are:—"With Rifle and Hound in Ceylon," 1854; "Eight Years' Wanderings in Ceylon," 1855; "Cyprus as I saw it in 1879"; "Wild Beasts and their ways," 1890.

THE cost of African exploration has been exceptionally heavy during the past month. Mr. Ingham has been killed by an elephant owing to the jambing of his rifle on the Congo, where he had done much good work. M. Parmentier, who for several years had been one of the Belgian officials on the Upper Congo, and who added greatly to our knowledge of its geography, has died at Nice; on the very day of his death the news arrived that three missionaries in Equatorial Africa had fallen victims to the climate. The unhealthiness of this region has been impressed on the public mind by the difficulties it is placing in the settlement of Uganda. By Sir Gerald Portal's death, the malarial dysentery of the Sana has robbed the nation of a public servant of exceptional promise; Mr. Rennell Rodd, who took his place at Zanzibar, has been invalided home and cannot return to Africa. Captain Besant who had started to fill the vacancy left by the death of Sir Gerald Portal's elder brother in Uganda, has collapsed on the way, and has been brought back to the coast by Dr. Charters of the mission station at Kibwezi. The news, however, that the daring young American explorer, Mr. Astor Chanler, has succeeded in reaching Mombasa is the one bright spot on the page of disaster. He started in September, 1892, on an expedition to Fort Kenia and Lake Rudolph. His colleague, Lieutenant von Höhnel, was wounded by a rhinoceros in the thigh and had to be sent back. Shortly afterwards eighty porters who had been sent up as reinforcements with extra stores left him and returned to the coast, and this was followed by a still heavier blow as over one hundred of his original force deserted and left him in Daicho with only eighteen men.

ALEXANDER THEODOR VON MIDDENDORFF.

BORN 1815. DIED 28 JANUARY, 1894.

MIDDENDORFF was born at St. Petersburg; he studied medicine at Dorpat, where he received his doctor's degree in 1837. He completed his studies in Germany, and in 1839 was appointed

Professor at the Vladimir University, Kieff. The following year he undertook, with von Baer, a voyage in the Arctic Seas and Lapland. Charged shortly after by the Academy of Sciences of St. Petersburg, he explored Northern Siberia, and made, between 1842–1845, a difficult and perilous journey. The results of his work were given in "Voyage dans l'extrême nord et dans l'est de la Siberie" (St. Petersburg, 1848). He added to this work another dealing with the natural history and physical conditions of Russia in Asia. Returning to St. Petersburg in 1845, he became privy councillor, and was made secretary of the Academy of Sciences from 1855–57. In 1859 he was President of the Society of Economics but retired soon after, on account of ill-health to Livonia.

JUSTUS KARL HASSKARL.

HASSKARL, the botanist, died on January 5 at Cleve in the Rhine Province. He was formerly co-director of the botanic garden at Buitenzorg, Java, where he introduced the Cinchona and for some time actively superintended its cultivation. The *Münchener Allgemeine Zeitung* in announcing his death, remarks that he died in moderate circumstances, although he had been instrumental in conferring on his fellow countrymen so great a boon. He was also the author of numerous papers dealing with the Flora of India and the Malay Archipelago.

THE McGill University, Montreal, has lost a valuable benefactor in the person of Mr. Peter Redpath, who died last month at Chislehurst, Kent, at the age of 73. Until his retirement, Mr. Redpath followed the business of a sugar-refiner at Montreal. In 1880, he founded the Peter Redpath Museum, in the grounds of McGill University, the finest Natural History Museum in Canada; and last year he presented to the University a new spacious library, capable of holding 130,000 volumes.

WE are also informed of the death of Mr. Charles Otley Groom, who later assumed the style of His Most Serene Highness the Prince of Mantua and Montferrat. Mr. Groom left a large and valuable collection of Natural History specimens, and we understand that the cabinets of fossils and minerals have been purchased by Mr. R. F. Damon, of Weymouth.

THE following deaths are also announced: Sir Harry Verney, the Father of the Agricultural Society; General Sir C. P. Beauchamp Walker, Foreign Secretary to the Geographical Society; and Edmond Frémy, Director of the Museum of Natural History at Paris.

NEWS OF UNIVERSITIES, MUSEUMS, AND SOCIETIES.

Herr Holst, a German botanist, has been appointed to the German station at Kilima-njaro in East Tropical Africa.

Dr. W. Migula, docent in Botany and Bacteriology at the technical high-school at Karlsruhe, has been raised to the rank of Professor.

Professor Engler, the well-known director of the Berlin Botanic Garden, has been raised to the dignity of Geheim Regierungsrath.

Geheimrath Professor Pringsheim, another famous German botanist, has been appointed a Knight of the Order of Maximilian and an honorary member of the Petersburg Academy of Science.

Dr. W. Saposchnikoff becomes Professor of Botany at the University of Tomsk, in Siberia.

Dr. G. F. Stone has been appointed assistant Professor of Botany at the Massachusetts Agricultural College at Amherst.

Mr. Albert F. Woods has been appointed assistant Pathologist in the Section of Vegetable Pathology of the Department of Agriculture in Washington.

Mr. W. W. Clendenin, formerly an Assistant in the University of Missouri, has been appointed Professor of Geology and Botany at the University of Louisiana.

At the University of Cagliari, in Sardinia, Dr. Dominico Lovisato has been appointed Professor of Botany and Keeper of the Botanical Garden, while Dr. Francisco Sanfelice has been nominated Professor of Hygiene.

Dr. Giacomo Catterina has been made Assistant in Zoology and Comparative Anatomy at the Naples University.

Dr. Zacharias, late Professor-extraordinarius in Strassburg, whose recent paper on the cells of the Cyanophyceæ is of so much interest, has been appointed Director of the Botanical Gardens at Hamburg. Dr. Zacharias is a native of Hamburg, and has now returned after 17 years' service in the famous Strassburg school under De Bary and Graf zu Solms-Laubach.

Mr. E. Chapman, who has for many years been science tutor at Magdalen College, Oxford, is leaving Oxford at the end of the summer term. Mr. R. T. Günther has been appointed his successor.

The Linacre Professor of Comparative Anatomy in the University of Oxford, E. Ray Lankester, is republishing in one volume various studies made in the Morphological Laboratory since his election to the Professorship. We sincerely trust that the original place of publication and the original pagination of these papers will be fully quoted; otherwise the volume will please few people besides the Professor and his pupils. Professor Lankester has recently been removing a quantity of worthless stuffed specimens from the court of the Oxford Museum, with the intention of replacing them by decent specimens and anatomical preparations so arranged and labelled as to afford as much information as possible. This is only a continuation of many valuable improvements that the Linacre Professor has carried out during the last three years. When are similar improvements to be continued in the zoological galleries of our national museum?

There is now a Psycho-physical laboratory at Cambridge, and Dr. W. H. Rivers of St. John's College, is conducting practical work this term.

At Cambridge University an important proposal has been made by the Council of the Senate, to establish two new degrees, Bachelor of Science and Bachelor of Letters, which may be conferred upon graduates of any recognised University. The conditions suggested are—matriculation; residence for three terms, the prosecution of advanced study in Cambridge; an original dissertation on some subject, literary or scientific, coming under the cognisance of one of the Special Boards of Studies. This lead is pretty certain to be followed by Oxford, where similar ideas have been in the air for some time. The scheme, if confirmed, will prove of great advantage to the Universities themselves, and to the advanced students who will then be attracted thither.

The Library of the late Professor Milnes Marshall has been generously presented to Owens College, by his friends and executors. A committee has been appointed to establish some memorial of his work, and it is thought likely that some definite scheme for the keeping up of the library will be proposed.

The Professorship of Zoology at the Owens College, Manchester, vacant through the death of Professor Marshall, has now been advertised. The income is calculated to amount to £750 per annum, and consists of a fixed stipend of £300, a fee of £50 for services rendered to the Museum, and various capitation fees. The Professor is required to instruct in Biology (Physiological and Zoological portion) and Zoology, including Comparative Embryology; to take charge of the Laboratory; to conduct certain special classes for teachers; to give scientific aid in the arrangement of the Zoological part of the Museum; and to deliver annually a short course of museum lectures or public demonstrations. Further, as he becomes a member of the Senate, he has certain duties to discharge in the College and in the Victoria University. He has two demonstrators to assist him in his work. Applications must be made to the Registrar, not later than April 3.

Professor Alexander, who has succeeded Professor Adamson in the chair of Mental Philosophy at Owens College, Manchester, intends to offer opportunities for laboratory work in physiological psychology. Professor Alexander has been engaged in experimental work in Dr. Burdon Sanderson's laboratory at Oxford for a considerable time.

Edinburgh University is about to add to its possessions M'Ewan Hall, built at a cost of more than £50,000, for graduation and other ceremonies; University Hall, erected through the efforts of Professor Patrick Geddes, as a hall of residence for men students; Masson Hall, about to be erected as a hall of residence for women students; a field near Corstorphine, purchased for £9,000, and fitted out at a cost of

£3,000 more, for athletic sports; and a chair of Public Health, for endowing which the late Mr. A. L. Bruce has left £5,000.

THE Milroy Lecturer to the Royal College of Physicians this year was Dr. J. Berry Haycraft. His lectures on "Weismannism, Disease, and Race Progress" were given in the Examination Hall at the Savoy on February 15, 20, and 22.

AT the annual meeting of the Board of Regents of the Smithsonian Institution, the secretary presented his annual report with a few remarks upon the enlarged activities of the Institution, referring especially to the work in physical science and to the increased number of correspondents of the Institution, now numbering about 24,000, more than half of them being without the United States, and scattered over the whole globe.

THE Ohio Academy of Science is organising a Natural History Survey of the State. Professors Claypole, Kellerman, and Kellicott have been appointed directors, their duty being to enlist and organise volunteers, to direct them in the choice of fields, and to aid them in the prosecution of their labours. Each worker will, however, independently present his results to the Academy, and be himself responsible for them.

A FREE course of lectures on General Archæology, entitled "Man before History," has been delivered by Dr. Daniel G. Brinton, at the Lecture Hall of the Academy of Natural Sciences of Philadelphia, during the winter session. "The Aims and Methods of Archæology" formed the subject of the first lecture; those of the second, third, fourth and fifth respectively were Africa, Asia, Europe, and America in the semi-historic and pre-historic periods; that of the sixth and final lecture, to be given on March 8, "The Island World in the Semi-historic and Pre-historic Periods," including geographical distribution. The detailed results of this suggestive series will, we trust, be eventually published in the same form as Dr. Brinton's previous course on "Races and Peoples."

THE Biological Station at Plon, which was started about a year ago for the special investigation of Fresh-water Biology, seems to be doing well. In the second part of its *Forschungsberichte* (Berlin, 1894), Dr. Zacharias gives a map of the East-Holstein fresh-water areas in the Plon district. Dr. W. Ule contributes a sketch of the geology of the district, and Dr. Krause a sketch of the botany. Graf Castracane and Professor Brun describe the diatomaceæ of the Plöner See, and Dr. Zacharias figures and describes ten new infusoria.

WE understand that "The British Institute of Preventive Medicine," to which we referred in our February number of last year, has acquired land for the erection of buildings close to Chelsea Bridge, from the Duke of Westminster. The committee have received £120,000 to enable them to carry out their scheme.

THE Woodwardian Museum, Cambridge, has recently been enriched by a large collection of fossils, mostly Cretaceous, the gift of the Rev. Professor T. Wiltshire.

THE Royal Botanic Society (London) is appealing to Government for a grant towards the support of their gardens in Regent's Park. The Society has done good work in the past in affording help, in the form of living specimens, to botanical students in the medical, pharmaceutical, and veterinary schools of the metropolis. We can ill afford to lose such institutions as the Regent's Park Garden or the Apothecaries' Garden at Chelsea; at the same time, they should be made as available as possible for the use of the interested public. There has been no doubt a certain exclusiveness towards the public on the part of the Fellows of the Society now in question; and a Society which asks for public money and occupies a large space in a public park must afford simpler means of entrance to their domain than an order from a Fellow. A small fee for admission, following the example of their neighbours at the Zoological Gardens, would give people generally the opportunity they have a right to ask, and at the same time help to make up the £8,000 deficiency which the Fellows of the Society have now to meet.

The Scottish Geographical Society has appointed a committee, consisting of Dr. John Murray, Professor James Geikie, Dr. Buchan, and Mr. J. G. Bartholomew, together with delegates from other scientific societies, to take steps towards the promotion of Antarctic exploration, and the *Scottish Geographical Magazine* for February contains two communications on the subject. In the first Mr. William S. Bruce, naturalist to the s.s. "Balæna," gives a short account of previous explorations; in the second Dr. C. W. Donald describes the Dundee Whaling Expedition of the summer of 1892-3. A landing was effected on the beach in the north-west of the Erebus and Terror Gulf, and the authorities all agreed that a party could spend a comfortable winter in such a spot as this. Dr. Donald ascertained also that it would be comparatively easy to reach the surface of the ice-cap from many of the landing-places in sight, on Louis Philippe Land as well as on Joinville Island. The finding of a practicable wintering place from which the surface of the ice-sheet would be accessible is an important advance in our knowledge, for abrupt cliffs of rock or ice, bound most other parts of the Antarctic continent. There are numerous notes on the character of the ice, and some illustrations; but little could be added during an expedition of this sort to our knowledge of the fauna and flora of the parts visited, and the notes made naturally refer mainly to the whales and seals. Among the birds only one not aquatic, the common hooded crow, was seen. The plants were all mosses and seaweeds. Some fossils are mentioned as having been obtained from Seymour Island, but it is not stated what they are. We believe, however, that land or fresh-water species are still quite unknown from the Antarctic regions, either living or in a fossil state, except the few cryptogams found on different occasions. If the Scottish Geographical Society continue their efforts, we may expect before long to learn something more about this mysterious land, and may ascertain whether it ever supported a fauna and flora as peculiar as that of the similarly isolated continent of Australia.

Dr. Henry Woodward, F.R.S., is the new President of the Geological Society of London, Mr. Richard Lydekker becomes a Vice-President, and Dr. J. Walter Gregory forms the new blood in the Council. The election took place on February 16, when the retiring president, Mr. W. H. Hudleston, F.R.S., read his address "On some recent work of the Geological Society," being a continuation of the subject dealt with by him on the occasion of the last annual meeting. The fellows and their friends dined together at the Criterion the same evening. The more reasonable charge of half-a-guinea for dinner tickets, initiated by Dr. Woodward, resulted in a better and more representative attendance. Speeches were made by Sir Douglas Galton, Sir Charles Wilson, Sir W. Flower, Sir Archibald Geikie, Dr. Hinde, Dr. Hicks, Dr. Woodward, Lieutenant-General McMahon, Mr. J. E. Marr, and others.

Lieutenant-General C. A. McMahon was elected President of the Geologists' Association (London) at the Annual General Meeting held on February 2. The retiring President, Mr. Horace B. Woodward, read an address "On Geology in the Field and in the Study," which will be printed in the "Proceedings."

A few months ago Mr. James H. Veitch exhibited before the fellows of the Linnean Society a number of interesting objects collected during his recent travels in Japan. He has now presented his extensive and varied collection to the Museum of the Royal Gardens at Kew, and the January number of the *Kew Bulletin* supplies a few notes on some of the products, many of which are quite new to the Museum.

THE Eastbourne Natural History Society has issued its *Transactions* for the Session 1892-3. Among the various papers on subjects of such world-wide importance as are usually affected by our local societies, we note a list of the Marine Polyzoa of Eastbourne, by Dr. H. S. Gabbett, and some interesting notes by Mr. H. Michell-Whitley, the president, on recent archæological finds in the Eastbourne district. The Society numbers 62 members, including the Right Hon. T. H. Huxley.

THE Royal Zoological Society of Dublin has recently acquired by purchase a jaguar, a hairy tapir, a golden agouti, three tree ducks, two curassows, four crested quails, and two black parrots.

THE Geological Society of America held its sixth annual meeting at the end of December last, in Boston and Cambridge, Mass., under the Presidency of Sir J. W. Dawson. In his presidential address, Sir William discussed recent geological problems, especially those connected with pre-Cambrian rocks, mountain formation, the Glacial period, and the Deluge. Abstracts of many of the papers read will be found in the February number of *The American Geologist*. The next winter meeting is to be at Baltimore, when Professor T. C. Chamberlin will preside. We are informed that at the annual dinner "there was a continual flow of wit and good humour." This is probably to be accounted for by the fact that the remarks made by the fellows present were "brief."

AT the annual meeting of the Biological Society of Washington, the President, Professor C. V. Riley, entomologist of the U.S. Department of Agriculture, delivered an address on the Social Insects. "The instinctive and inevitable actions of insects are," he said, "associated with many others, which result from the possession of intelligence, of conscious reasoning, and reflective powers."

PARTICULARS of the sixth Geological Congress, which will be held at Zürich from August 20 to September 2, are to hand. The subscription will be twenty-five francs (£1), and should be sent to M. C. Escher-Hess, Bahnhofstrasse, Zürich. The Excursions are numerous and comprehensive, and for the convenience of our readers we append a brief list.

Those arranged before the session commences are as follow:—August 22 to 27, under the direction of M. Schardt—Geneva to Bellegarde; Châtillon-de-Michaille to Nantua; Charrix to Chesery; to Thoiry; to Gex; to Geneva (cost 50 frs.). August 23 to 27, under M. Jaccard—Portarlier to Vallorbes; to Yverdon; to Fleurier; to Neuchâtel; to Locle (cost 50 frs.). August 22 to 27, under M. Rollier—Porrentruy to Delemont (3 days in this district); to Saignelégier; to St. Imier; to Bienne (cost 60 frs.). August 22 to 26, under M Schmidt—Wiesenthal to Bâle (2 days); to Laufenberg; to Brugg; to Zürich (cost 60 frs.). August 24 to 28, under M. Mühlberg —Staffelegg to Olten; to Kirchzimmer; to Reigoldswil; to Aarau; to Zürich (cost 50 frs.).

Those arranged after the session:—September 3 to 13, under M. Heim—Zürich to Weissbad; Säntis; Amden; Obstalden; Linthal; Elm; Flims; Tenigerbad; Olivone; Bernardino; Lugano (cost 200 frs.). September 3 to 14, under M. Schmidt —Zürich to Schwytz; Wasen; Hospenthal; Ulrichen; Airolo; Fusio; Faido; Lugano (250 frs.). September 3 to 10, under M. Baltzer—Zürich to Innertkirchen; Gstellihorn; Guttannen; Hospice Grimsel; Hospenthal; Airolo; Lugano. September 3 to 15, under M. Schardt—Bulle to Albeuve; Rougemont; Châlet du Gros Jable; Ormont; Bex; Champéry; Sanlanfe; Tête-Noire; Champex; Bagnes Brigue; Domo d'Ossola; Lugano (150 frs.). Several other excursions have been arranged, but full particulars of each and every excursion can be obtained from M. le Prof. E. Renevier, Lausanne, or MM. Ruffieux et Ruchonnet, Agence Suisse de Voyages, Lausanne.

THE Oxford University Junior Scientific Club announce that they will hold a conversazione at the University Museum on May 22, and that Professor Macalister of Cambridge will deliver the third "Robert Boyle Lecture" on 4th or 8th May, his subject being "Some Morphological Lessons taught by Human Variations." At the meeting of the Club on February 16, papers were read by Mr. M. S. Pembrey, on "Histology of Organs after Extirpation of the Thyroid Gland"; and Mr. F. Druce, on "Some Characteristics of Cyclonic Storms."

A LARGE quantity of natural history material, which was exhibited at Chicago, has been purchased on behalf of the city of Philadelphia, and it is proposed to erect a fresh building for its accommodation, instead of incorporating it with collections already in existence.

THE Crystal Palace has fallen from its high estate, and is associated in the minds of most people with no other science than that of pyrotechny. Still, however, it does something for the cause of natural history, and we learn from the report of the directors of the company that £300 *per annum* is spent on the natural history department, while £800 goes to the attendants in the Aquarium, and as food for fishes.

THE HAECKEL CELEBRATION (Special Account).

ON the 16th of February Ernst Haeckel completed the sixtieth year of his life. On the 17th, the little town of Jena, in whose University Haeckel is Professor of Zoology, was thronged by a great crowd of his friends, pupils and admirers, among whom may be specially mentioned the Hertwigs (Oscar and Richard), Waldeyer, Arnold Lang and Hermann Credner, besides many well known professors of Jena itself. The chief ceremony of the day was the uncovering of the marble bust of the great scientific worker and writer, from the chisel of the eminent sculptor, Professor Kopf, of Rome. At noon the lecture-theatre of the Zoological Institute, in which the greater part of Haeckel's life-work has been carried on, was crammed from floor to ceiling, and Professor R. Hertwig, of Munich, the pupil, friend and colleague of Haeckel, was called upon to unveil the bust. In an admirably-worded speech he alluded to the main facts of Haeckel's life, and especially to his labours in the cause of science and scientific freedom; of these facts we give a short account below. The unveiling of the striking bust was the signal for a great outburst of applause, and when this had subsided, a deputation from some societies, the Medicinish-Naturwissenschaftliche Gesellschaft of Jena and the Geographische Gesellschaft of Thüringen, offered to Professor Haeckel their honorary membership. They were followed by a deputation from the students, who expressed in enthusiastic terms their admiration and respect for the Professor of Zoology. Professor Max Fürbringer of Jena followed with details concerning the subscription to the bust, informing us that there had been nearly 700 subscribers, who sent their tokens of appreciation from all parts of the world; he especially alluded to the gratifying fact that many subscriptions had come from France. As a consequence of this, the total amount exceeded the cost of the bust by at least £300, and this sum he had pleasure in placing in the hands of Professor Haeckel, for him to devote to such purpose as he might think best in the interests of science.

After the ceremony, and after Professor Haeckel had, not without emotion, acknowledged the honours showered upon him, the elect among the visitors adjourned to a banquet in the Hotel zum Bären, where covers were laid for about 120 of both sexes. The day concluded with that characteristic German institution, a "Commers," in which almost all the students of Jena seemed to be taking part. Cheers for the Professor, songs and speeches in his honour, mingled with the clinking of glasses, enlivened the old University till a late hour of the night.

Ernst Haeckel, the second son of Ober-regierungsrath Carl Haeckel, was born in Potsdam on February 16, 1834. He was early led to the study of nature, especially of Botany, an inclination nourished by his mother, who came of the old legal family of Sethe, and by his father, who himself took a keen interest in Geography, and numbered among his friends the geographer Ritter and the African traveller Barth. He went to school at Merseburg, whither his father had removed, and continued his studies in natural science. At his father's instance, however, he decided on medicine rather than pure science, as affording a surer means of livelihood; at the same time he hoped to travel as a ship's doctor, and so to see distant lands. At the age of eighteen, then, he began his medical studies in Berlin, but seems to have been mostly attracted by the lectures of the botanist, Alexander Braun. From the autumn of 1852 till Easter of 1854 he attended the anatomical lectures of Kölliker and Leydig in Würzburg, where he made friends with Gegenbaur and the present Berlin physician, Gerhardt. Returning to Berlin, he went to the lectures of Johannes Müller, which greatly influenced him and determined the future course of his life. In his enthusiasm he spent all his spare time in natural history excursions in the neighbourhood, holding entirely aloof from the beer-drinking entertainments of his fellow-students. Autumn of 1854 saw him with Johannes Müller in Heligoland, where he obtained his first impression of the sea and of the pelagic fauna, from which sprung his predilection for researches on the "plankton" or floating tribes of the sea. While at Berlin, Haeckel made friends with Max Schultze, Claparède, von Richthofen, von Martens and others who have since attained to eminence. At Easter, 1855, he returned to the then famous medical school of Würzburg, where, in the summer of the following year he became assistant to Virchow, in whose *Archiv* he published one of his first independent works,—"Ueber die Plexus chorioides." In the autumn of 1856, together with Müller and Kölliker he visited the sea-fisheries of Nice, where he made his first acquaintance with the Radiolaria, and discovered the movement of cells in the connective tissue of Tunicates. His medical studies in Berlin were then resumed, and in March, 1857, he took his degree of Doctor of Medicine, presenting before Ehrenberg his Thesis "On the Tissues of the Crayfish." A summer in Vienna was divided between medical work and excursions in company with the botanist Focke from Bremen and the zoologist Krabbe from Copenhagen. Although in the following winter he passed the State Medical examination in Berlin, yet, at the instance of Johannes Müller, he determined henceforward to devote himself to Zoology. Unfortunately, his intention of working under Müller was thwarted by the sudden death of the latter at Easter, 1858. In 1859 he went to Italy and again studied the pelagic fauna of the Mediterranean, collecting materials for his Monograph on the Radiolaria, which appeared in 1862. At the suggestion of Gegenbaur, in 1861, he settled in Jena, where he was soon elected Professor of Zoology. In this quiet little town, amid beautiful and natural surroundings, he has stayed ever since, resisting pressing invitations to go to the larger Universities of Würzburg, Bonn, Vienna, and Strassburg.

A change now came. After a year and a half of happy married life, his wife, who was his cousin, Anna Sethe, died, and Haeckel drowned his sorrow in the most intense work. Darwin's "Origin of Species," which had appeared a few years before, had made a great impression on him. This he had already acknowledged in his Radiolarian monograph, and now he set about his important work "Generelle Morphologie," which appeared in 1866, and was the first book to view the animal kingdom in its entirety from the standpoint of the dual doctrine of descent and natural selection. This work completed, Haeckel went on a holiday to the Canary Islands, of which we have an account in his "Besteigung des Pic von Teneriffa.' On his return through London he met Huxley, Lyell, and Darwin himself.

In 1868 appeared another book inspired by Darwinism, his "Natürliche Schöpfungsgeschichte," which in 1889 had reached its eighth edition, and been translated into twelve languages, including Malay and Japanese. This result was not, however, attained without gaining for the author many enemies, and converting several warm admirers into hot opponents. From these general works he turned again to monographs on particular groups, the Development of Siphonophora (1869), Studies on Monera and other Protista (1870), Monograph of the Calcareous Sponges (1872). The material for the latter work had been collected on excursions to Norway and Dalmatia, and in it is first found the Gastræa Theory, subsequently elaborated by him; according to which all many-celled animals are derived from and pass through in their development a primitive sac-like form, the Gastrula. In 1874 was published his "Anthropogenie," a popular exposition of the evolution of animals leading up to man. About this time Haeckel travelled a good deal; in 1873 to the Red Sea in 1875 to Corsica, and in 1877 to Corfu. In 1876 appeared his important paper on the Perigenesis of the Plastidule. In 1877 he delivered his address before the gathering of Naturalists in Munich, on the modern theory of development in its relation to general science. This produced a reply from Virchow which Haeckel answered in his pamphlet "Free Knowledge and Free Teaching," where he adopted as his motto, "Impavidi progrediamus." In 1881 appeared his Monograph of the Medusæ, and this was followed by a journey to Ceylon, which gave rise to his charming "Indische Reise-briefe." After this Haeckel came into closer connection with English scientific men, by the publication of his magnificent 'Challenger" Reports on the Medusæ (1881); on the Radiolaria (1887); on the Siphonophora (1888), and on the Horny Sponges of the Deep Sea (1889). In 1890 he visited Algiers and Tunis, and in this year was published his "Plankton-Studien," which summed up his pelagic researches and stated his views as to the distribution of marine life in opposition to the views of Hensen and others. A continuation of these researches was made in 1892, around the Hebrides, in company with John Murray of the "Challenger," and in 1893, in the neighbourhood of Messina. Last year also he published his "Monism as a Link between Religion and Science."

It would be impossible here to enumerate the many eminent scientists who have been pupils of Haeckel, and who have raised the fame of the University of Jena. By his own fame, too, the University has been enriched, as in the case of the endowment of a Professorship and a travelling studentship by Dr. Paul von Ritter, and the bequest of the Countess Bose. Indeed his lucid and flowing style, his orderly and philosophic grasp of facts, have attracted many to his works who would otherwise have been repelled by their detail and technicality. In the broader aspects of his scientific work he has been as it were the complement of Darwin in the direction of Morphology and Embryology, somewhat as Herbert Spencer has been in Psychology and Sociology. His works are adorned by drawings from his own pencil, for he is an excellent draughtsman and water-colourist. Although sixty years of age, he has the strength, energy, and freshness of a much younger man, having been in earlier days a noted gymnast. In 1867 he took as his second wife the daughter of the anatomist Huschke, by whom he has one son and two daughters. Haeckel has never plunged far into the troublous sea of politics, but has reserved his energies for fighting his own battles, and they have not been few, and for advancing the standard of science, which he has done to no small extent.

In connection with the P.N.E.U., the A.W.P.L. have arranged two courses of lectures on natural history and geology, which are being given at the British Museum (Natural History). The first course, on the Domesticated Animal, from which men were excluded, was delivered by Miss Goodrich Freer on Saturday afternoons during February. The place chosen for the lecture was that very popular gallery of the Geological Department of the British Museum in which the fossil Ammonites are exhibited.

The next course will be given by Miss Whitley on the mornings of March 2, 9, 14, and 16. The subject is Field Work in relation to Practical Geology, and the lecture hall is to be the adjoining public gallery of the same department (Members meet near the Mastodon). After one hour's talking, the lecturer will give demonstrations in the Museum, which, it is well known, contains a large number of exhibits relating to practical geology (or, are we confusing it with the other establishment at Jermyn Street?); anyway there are some fine blocks of fossiliferous stone on which the members can practise field work.

CORRESPONDENCE.

Scientific Volapük.

The following, written nearly seventy-five years ago by Thomas Jefferson, one of the signers of the Declaration of American Independence, and sometime President of the United States, seems rather to the point now that new words are so much to the front:—"I am a friend to *neology*. It is the only way to give to a language copiousness and euphony. Without it we should still be held to the vocabulary of Alfred or of Ulphilas, and held to their state of science also, for I am sure they had no words which could have conveyed the ideas of oxigen, cotyledons, zoophytes, magnetism, electricity, hyaline, and thousands of others expressing ideas not then existing, nor of possible communication in the state of their language. . . . . Dictionaries are but the depositaries of words already legitimated by usage. Society is the workshop in which new ones are elaborated. When an individual uses a new word, if ill formed, it is rejected in society; if well formed, adopted, and after due time laid up in the depositary of dictionaries. And if, in this process of sound neologisation, our trans-Atlantic brethren shall not choose to accompany us, we may furnish, after the Ionians, a second example of a colonial dialect improving on its primitive." — ("Correspondence of Thomas Jefferson," vol. iv., pp. 339, 340. Monticello, Aug. 15, 1820. Letter to John Adams.)

Nearly three-quarters of a century afterwards *our* American brethren still hold the lead. But words must not be condemned because they are new. Some of the new words, like "topotype" in your list, supply a decided want. New words again, are certainly preferable to old ones distorted. It must be easier for a beginner to learn a new word than to remember that "period" and "age" in a geological paper each mean very different things, according to whether they are in inverted commas or not, and in some cases they occur in the same page, each with their different meanings. "Age" has been strongly condemned by a President of the Geological Society in his address (W. T. Blanford, 1889, p. 37).

Another advantage of new words is that they often emphasise a distinction which is apt to be otherwise overlooked. It ought to be impossible for a warm discussion to arise betwen consentients, as I have seen, over a remark—"the older shells of —— are more plicate"; because one took "older" in a geological sense, another as referring to the age of the individual, a third to the age of the race. It is a climax of absurdity that the "older" shells geologically are the "younger" biologically. It suggests that geological strata should be called "earlier" and "later," never "older" and "younger"; but, again, "earlier" and "later" are used in an "evolutionary" (!) sense, and they are not necessarily equal to "primitive" and "more specialised."

S. S. Buckman.

Climatic Conditions and Life.

With reference to the remarks made on p. 89, no. 24, of Natural Science (Feb., 1893), regarding a suggestion of mine as to former climatic conditions—

I.—May I be permitted to point out that so far as I know there is no *limit* to the extent of the areas over which these phenomena (fumaroles or hot-springs) might be manifested.

A whole continent might, in former times, have been covered with them and the character of its vegetation and animal life determined by them—though it was set itself in a frozen sea. Such an extreme case is, I think, a possibility.

In India where we have flows of trap or lava, altogether covering an area of 200,000 square miles, we learn to look at such questions from a somewhat liberal scale of measurement.

II.—Chemical deposits are by no means invariably formed by hot springs. And even in those cases where they are formed they are not always of so stable a character as to leave permanent traces.

Still it may be the case that beds of limestone occurring in association with such fossils as I have referred to may really have been derived from the calcareous deposits (travertine) of hot springs.

III.—It is scarcely needful to add that fossil localities often occupy very narrow and restricted areas.

Science and Art Museum, Dublin, V. Ball.
February 12, 1894.

The Geological Society's Journal.

In the "News of Universities," Nat. Sci., vol. iii., p. 470, reference is made to the printing of the date of issue of scientific publications side by side with the signatures. Allow me to point out that the editor of the *Quarterly Journal of the Geological Society* has this year initiated an improvement even on this, the date of issue being printed at the top of every open two pages, half on each side of the fold. C. D. S.

Cephalaspis in the Caithness Flags.

In reference to the recent announcement of the discovery of the "typically Lower Devonian genus *Cephalaspis*" near Thurso (Nat. Sci., vol, iii., p. 255), it should be remembered that this fish occurs in the Upper Devonian of Scaumenac Bay, Canada (see *Geol. Mag.*, 1890, p. 15). We must not, therefore, be surprised to find it in the allied fauna of "Lake Orcady."

Junagadh, Kathiawad, India. J. W. Evans.

TO CORRESPONDENTS.

Rev. S. Barber.—We are obliged for your communication. Meteorology does not especially concern us; but you will find a mention of the storm of July 8, 1893, on p. 395 of our third volume.

Recorder.—The investments of the Geological Society of London for the past four years are:—£420 (1890); £506 (1891); £528 (1892); £502 (1893). The total value of the invested funds is, according to the latest balance-sheet of the Society, £10,729 11s.

All communications for the Editor *to be addressed to the* Editorial Offices, 5 John Street, Bedford Row, London, W.C.

All communications for the Publishers *to be addressed to* Macmillan and Co., 29 *Bedford Street, Strand, London, W.C.*

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NOTES AND COMMENTS.

Independence in Scientific Journalism.

MR. ROBERT LOUIS STEVENSON, in his delightful "Letter to a Young Gentleman who proposes to embrace the Career of Art," insists that it is "far more necessary that a man should support his family than that he should attain to—or preserve—distinction in the arts." So also in journalism, it is the first business of a journal to prove the utility of its existence by paying its way. The splendid memoirs of endowed institutions are necessary and honourable, the periodical caprices of the wealthy are amiable follies, but neither are journalism. On either side the path of a scientific journal are many pitfalls. Mere popularity may be lucrative but is a descent from science, mere technical science for the most part requires external financing. But there are pitfalls more perilous because less apparent. Suppose the necessary condition of a journal be attained—that it can pay its way—the next thing is for it to take a strong, fearless, independent line on all questions affecting its subject-matter. It must distribute praise and blame; it must criticise freely where criticism may lead to improvement; it must attempt in every way to serve the best interest of science. For these purposes, especially in matters of blame, the most competent and complete information is necessary.

Now, in England the number of those who are competent to deal efficiently with all matters concerning the advancement of science is strictly limited. Necessarily, most of them are connected with the Universities, great societies, and institutions of this country—connected, in fact, with precisely those social mechanisms the working of which must be passed in review. Natural Science, therefore, believes that in the best interests of science and of individuals a certain part of its columns must be open to anonymous criticism. It is the editorial business to distinguish between anonymity and irresponsibility. In many matters this distinction does not exist: fortunately, in scientific matters the degree of reasonableness of any criticisms is patent to all whom they concern. We shall continue to welcome all comment that is useful, and to publish it in whatever way seems most useful. We are concerned with science and not with individuals; it is our business to distinguish between merely personal criticism and criticism for the advantage of science. So far as we succeed in this we are confident of securing the approbation of all workers: if ever we fail, or seem to fail, we shall receive gladly advice and correction.

NEW JOURNALS.

THE stream of new periodicals is this month increased in volume by two dealing with Natural Science. The first of these is not strictly a new journal, though practically it is so. *Science Gossip* is reappearing under "entirely new management," and seemingly with somewhat different aims. The present month has also witnessed the birth of *Science Progress*, a "monthly review of current scientific investigation." It is conducted by Mr. H. C. Burdett, of Stock Exchange and hospital fame, and it may be purchased for half-a-crown. Mr. Burdett is assisted by Professor Farmer, who is editor-in-chief, and a number of other gentlemen, who form an editorial committee. He has also secured as "contributors to the earlier numbers" Professors Burdon Sanderson, Dunstan, Ray Lankester, and others. The committee states that "in no case will the articles be of a popular character, although it is intended that they shall be intelligible to persons possessing an ordinary scientific training." The first number contains 104 pages, distributed among seven articles, dealing with "Physical Science and its Connections," "The New Theory of Solutions," "Insular Floras," "Fossil Plants," "Bacterial Poisons," "Vertebrate Morphology," "Chemical Physiology." These appear to be excellent *résumés* of current research, and cover a wide field.

MEMORIAL VOLUMES.

THE multiplication of periodicals not directly containing the results of individual research leads us to the consideration of a type of publication which is both interesting and annoying. Journals, popular or otherwise, which do not affect to contain actually new work, have a notable and valuable place in the hierarchy of scientific literature. But the publication of actual research concerns very practically all those who are engaged on research. The confusion of tongues and the laudable enthusiasm of governments and institutions already render patience a necessary equipment of the Zoologist or Palæontologist. With care, access to many libraries, and perusal of Records, it is nearly possible for him to keep abreast with what appears in the ordinary publications. But there have of late been published a good many volumes, we cannot call them books, of a strangely composite nature, their subjects merely united by the desire to do honour to some teacher or school, or to glorify some particular professor. As instances we may mention the Macleay Memorial volume (Natural Science, vol. iv., p. 141), the volume just issued by the Linacre Professor of Comparative Anatomy (Natural Science, vol. iv., p. 232), and the Wilder Quarter-Century Book, which latter is a collection of papers dedicated to Professor Burt Green Wilder, at the close of his twenty-fifth year of service in Cornell University, by some of his former students. In some cases the papers contained in the volume have been previously published; in others they appear to be something that the authors wished to get out at the moment and for which they have availed themselves of the excellent opportunity presented under a laudable appearance of hero-worship. But in all cases the connection between the papers is of the slenderest. Now it is not our wish to detract from the honour that should be paid to great men, nor to do anything but praise the papers themselves; but we do submit that this mode of publication is one of the very worst that could possibly be devised, and is by consequence no excellent way of showing admiration. Take the case when the matter is new. The volume is probably too expensive for any but rich libraries or institutions to buy; it therefore does not readily fall in the way of the ordinary student; it is cumbrous and not easily broken up, so that one cannot buy the part that one wants; and, in fact, it combines all the disadvantages of a serial with none of its advantages. It would be more to the advantage of readers, and therefore of writers, that these papers should be issued through some of the ordinary channels of publication, and thus find their way readily into the hands of those who take an interest in the various subjects. When the matter is merely republished, of course, these objections do not apply to so great an extent. But another danger presents itself; namely, that the original pagination is often ignored and even the first place of publication not quoted. Whether this is done from ignorance or vanity the result is to cause much vexation and unnecessary labour to all who have to refer to these volumes, and it is probable that the language used about the person the volume is supposed to honour will not always be of a benedictory nature. Hence we wish to suggest that some other means, more consonant with the needs of workers, should be found for doing honour to those who are thought to require it.

A New Lemur.

Turning from the consideration of publications to the consideration of their contents, we must call attention to a new form of Lemur, named by Dr. Forsyth Major *Megaladapis*, recently (*Phil. Trans.*, 1894) described by him from a marsh at Amboulisatra in Madagascar. The animal appears from its skull—the only part known—to have been a giant among Lemurs; it had in all probability the bulk of four cats. The size, however, did not indicate anything but a comparatively low position among Lemurs.

It seems that this genus does not bring us anywhere near to the ancestral Lemuroid. Dr. Forsyth Major is of opinion that it was a highly-specialised type, mainly by reason of its tritubercular molars and its small brain. The tritubercular molar has been held by Osborn and by others to be the mark of the primitive Mammalia; but the author of the paper before us thinks differently. In Madagascar this kind of molar occurs in the Viverridæ (Carnivora), Centetidæ (Insectivora), and Lemuridæ. This of itself points to convergence, for the most bigoted adherent of "trituberculism" would hardly insist upon a very close resemblance between these three families. Moreover, each of these three families shows members in which the reduction of the cusps has gone further. The genera in which this occurs show other evidence of degeneration. It is an interesting question whether this ancient and extinct Lemur was contemporaneous with man, as was possible in the case of the Æpyornis found associated with it. The skull examined by Forsyth Major was scratched, as are the bones of the bird, but whether this scratching is due to a sharp-pointed instrument of human manufacture or to the teeth of a carnivorous neighbour appears to be uncertain.

Carboniferous Insects.

We learn from a letter in the *American Journal of Science* (February, 1894), written by Dr. Samuel H. Scudder from Paris, that we may shortly expect Mr. C. Brongniart's work on the fossil insects of the Commentry coal. Glimpses of this extremely rich fauna have from time to time been given to the student, and considerable interest naturally attaches to the complete record. The fact that mining at Commentry is carried on in the open air offers the most favourable opportunity for recognising and preserving the fossils. Dr. Scudder writes: "I have had the opportunity of seeing not only a considerable part of the collection, but also the illustrations prepared by M. Brongniart himself from the choicest specimens; illustrations made with a care and exactitude which leave nothing to be revised. . . . Leaving the cockroaches out of account, to which M. Brongniart will give his attention later, the number of these illustrations, their variety, the extraordinary character of the insects themselves and their rare perfection, leave not the least room for doubt that when his work appears, our knowledge of palæozoic insects will have been increased three- or four-fold at a single stroke, and an entirely new point of departure for the future opened. No former contribution in this field can in any way compare with it, nor even all former contributions taken together. Besides it will offer such a striking series of strange forms as cannot fail to awaken the attention of the least incurious. One may not enter into details, but mention may simply be made of one species, regarded by M. Brongniart as one of the forerunners of the dragon-flies, in which the wings have an expanse of considerably more than two feet (or about 70 centimetres), and of which several specimens are preserved. It is a veritable giant among insects."

Pedigree Wheat.

A well-known artist, on being asked by an amateur how he mixed his colours, replied that he mixed them with brains. Fortunately for the languishing pursuit of agriculture, there is some prospect of a larger admixture of brains than was necessary when farm produce was protected by duties on importations. The live-stock of England has become famous all over the world because of careful selection by breeders. As Mr. Rendle shows, in his article on the Cross-fertilisation of Food Plants in this issue of Natural Science, as much may be done for food plants as has been done for domesticated animals. Unfortunately, many plants, like fruit trees and potatoes, have been propagated so entirely from cuttings that the necessity of growing from seeds has been lost sight of. But it seems a general law of the organic world that sexual reproduction, securing as it does the advantages of cross-fertilisation and the admixture of strains, is necessary, at least occasionally, to secure the best and hardiest offspring. But in all breeding from seeds careful selection is absolutely necessary. The most expensive tillage, the most lavish manuring, and the blandest of seasons are as naught compared with the selection of seeds from the best plants, and the skilful choice of plants for cross-fertilisation. Animals and plants are born differently, and by careful attention to these natural variations almost anything can be done in a few generations. England is a country well adapted by its range of climate and of natural conditions, and by the high state of cultivation of its soil, for experimental seed-growing, and there is no reason why the pedigree wheats of England should not command the markets of the world just as the pedigree horses of England are sought far and near. The range of our land is not wide enough to yield the enormous crops of Russia, America, and Canada, but we might well provide the best seeds for these larger areas. For this change of industry scientific knowledge is requisite. The councils of many English counties are providing agricultural scholarships to be held at scientific institutions. We hope that the councils will see that their scholars are chosen from among those likely to engage in the practice of agriculture, and that they receive their technical training at institutions where scientific knowledge is combined with enlightened practice. There is still a future for England, but it is a future depending more on the brains of her sons than on the natural fertility of her soil.

An Ammonite Problem Solved.

It is a well-known fact that the various species of Ammonites have a very wide distribution over the earth's surface, and that they succeed one another in the rocks in the same order though in regions far apart. This fact, though extremely important, is in itself not particularly remarkable, since there are other groups of animals whose species have a similarly wide extension in space and a narrow limit in time. The truly remarkable thing is that the same species often occurs in rocks of a very different character, being found in limestones, clays, or sandstones. This may be expressed by saying that the lithological sequence bears no relation to the faunal sequence; and the apparent conclusion is that the evolution of Ammonites was in no way affected by the environment. Taking their stand on some such facts as these, some have even gone so far as to suppose that the rise and fall of any genetic series was an independent phenomenon, comparable to the life of an individual. This may be, but is it so certain that the facts of Ammonite distribution have any bearing on the question?

This question has recently been discussed by Dr. Johannes Walther in the second volume of his "Einleitung in die Geologie als historische Wissenschaft," a volume which deals with the mode of life of marine animals, especially such as are of geological importance. Without offering any opinion as to the zoological affinities of the Ammonites, Dr. Walther points out that their shells, which are practically the only portion with which the geologist has to deal, are paralleled by the shells of only two genera among recent Cephalopods, namely, *Nautilus* and *Spirula*, which, though differing in every feature of morphological import, yet resemble one another as well as the Ammonites in the possession of a coiled, chambered shell. Now the living *Nautilus* and *Spirula* both live at the bottom of the sea and are very restricted in their distribution; yet their dead shells are found over an enormous area. "In the mangrove swamps of Java, on the sandy shores of Ramesveram, among the volcanic ashes of the Canaries, and on the coral-reefs of the tropical zone; everywhere are the shells of *Spirula* found scattered. No coastal deposit in the whole of the Indo-Pacific province is free from *Nautilus*." In these respects *Nautilus* and *Spirula* differ from all other living Cephalopods, even from the female Argonauta, whose shell, though outwardly similar, is devoid of chambers; and just in these respects do they resemble the extinct Ammonites.

Dr. Walther comes, therefore, to the following conclusions: The distribution of Cephalopod shells provided with air chambers bears no relation to the habits of the living animal. The richness of a deposit in chambered Cephalopod shells does not depend on the distribution or habits of the living animal. The form of a chambered Cephalopod-shell allows us to frame no safe conclusion as to the organisation of the animal. The distribution of chambered Cephalopod-shells bears no relation to the changing character of the containing rock or to the depth of the sea in which it was deposited. Applying these conclusions to the particular case of the Ammonites, we see that their shells may safely be taken as zonal indices, since they mark truly contemporary divisions of the earth's crust wheresoever they occur; while, since their distribution must have taken place after the death of the animals, they afford us no evidence as to the environing conditions that may or may not have governed their evolution.

Molluscan Mimics.

Our ignorance as to the mode of life of extinct mollusca often lands us in great difficulties, and problems continually occur of which the solution can never be more than guessed at, although, could we have but a glimpse of the once living animals, our questions might receive an obvious and immediate answer. The curious resemblances between species of totally different genera, may be explained in more than one way, perhaps by action of similar environment, perhaps in obedience to dimly-perceived laws of growth; but it is not often that we apply to them the explanation afforded by the biological phenomenon known as "Mimicry," not at least when we are dealing with fossils. A paper recently read by Mr. A. H. Cooke before the Cambridge Philosophical Society seems to show that we might occasionally do worse than venture this answer to the riddle. He reminded us that the shells of *Strombus mauritianus* and *S. luhuanus* differed from those of all other *Strombi* in their close resemblance to the shell of *Conus*, a genus with which they were known to live. He pointed out that *Strombus* was a vegetable-eater, with small weak teeth, while *Conus* was a flesh-eater, with large barbed teeth, provided with a poison bag and duct. *Conus*, then, would naturally be avoided by predatory fish, and any resemblance to so dangerous a genus would be of great advantage to *Strombus*. In the case of extinct mollusca, a similar explanation might occasionally be possible, but, of course, only when the species in question occur in the same locality and bed.

Chaos in Science Teaching in London.

Some time ago (Natural Science, vol. iii., p. 297), in referring a second time to the clever anonymous pamphlet on the Organisation of Science, we urged that the existence of competitive journals and rival societies secured freedom and prevented novel views being suppressed, merely on account of their unorthodoxy. To a certain extent the competition and rivalry among teaching bodies in London secures flexibility and range in science teaching, and the present chaos of institutions, which has come about by natural growth, has its good side. On the other hand, much money and time is wasted by unnecessary multiplication of teaching plant; there is no coördination by which various institutions can as a right utilise each other's advantages. The great libraries, museums, and teaching institutions, are totally unconnected with each other; only by private courtesy or as members of the general public can those working at one institution gain access to another.

From the point of view of a student the case is still harder. He must throw in his lot with one definite institution, and though his education is at least as expensive, his opportunities, considered all round, compare most unfavourably with the opportunities in the great provincial towns, and at the Universities of Scotland and Ireland. In the case of medical students the disadvantages of present arrangements are peculiarly great. The foremost men in different branches of the profession are scattered among the hospitals, and a student at one must be content with mediocre lectures on many of his subjects, although a few streets off the foremost authorities in Europe may be discoursing on them. Moreover, two students at different institutions pursue nearly the same course, and at the end of their career receive the one, an University degree, the other, a mere qualification.

Report of the Gresham University Commissioners.

We hope that the report of this second Commission will prove a great step towards the removal of some of these anomalies. We do not propose to discuss it in a controversial spirit, but to note its main provisions.

The Commissioners recommend first that there should be one University in London; that its teaching functions should be confined to the metropolis, but that it should continue to be an examining body for students presenting themselves from all parts of the British Empire. To prevent a repetition of the old delays, it is recommended that the necessary modifications of the existing University should be made by legislation, and not by charter, as that would entail the action of the present University itself.

In the matter of examinations for degrees, the Commissioners propose that the certificates of institutions other than the University shall be accepted in lieu of the first examination for degrees, but that the final examinations for degrees shall be the same for internal and external candidates. This they propose, having in mind the necessity of the same standard for the same degree; but as in the reconstituted University the teachers will be a very large body with very great powers, they believe that the present unsatisfactory system, by which teaching is wholly subservient to examinations, will be remedied.

The University is to include six faculties—arts, science, medicine, law, theology, and music. The faculty of science is to include pure science and applied science under different boards of study. The latter is to include engineering, architecture, agriculture, and other subjects of technology.

A University Board is to encourage University extension, and if it be satisfied that any portion of its work is of equal educational value, is to accept it as a portion of the University course.

University College, King's College, the Royal College of Science, the Medical Schools of the Great Hospitals, the London School of Medicine for Women, the City and Guilds of London Institute, and Bedford College are to be among the Schools of the University, and their teachers, when individually approved by the University, are to be members of its faculties.

Great additional facilities for research are to be provided, and these, though not definitely associated with the teaching institutions, are to be open to all teachers of the University.

A senate consisting of a Chancellor and sixty-five other members, of which eighteen will be elected by the faculties, is to be the supreme governing body of the University. Then in order of authority follow an academic council elected by the faculties; the faculties, consisting of teachers appointed by, or recognised by, the Universities; the boards of studies; and convocation.

The Commission finally recommend that a statutory commission be appointed with power (subject to the approval of Parliament) to carry out and give conclusive authority to the recommendations of the report.

We must welcome this report as a solid, fair, and practicable attempt to evolve out of the chaos of London institutions an University worthy of the metropolis.

The New Biological Syllabus of the Conjoint Board.

The medical schools of London form one of the most important sets of institutions affected by the Gresham University. For some time, biological teaching at them was in abeyance, save at those large enough to have a fair annual number of students going up for a London degree. Three years ago, the Conjoint Board of the Royal Colleges of Physicians and Surgeons, the Board which gives their qualification to the largest number of medical students in England, wisely instituted an elementary course of Biology, as part of the necessary curriculum. The first schedule was cumbrous and peculiar. It included elementary botany, the differences between plants and animals, a number of types of parasitic worms, the characters of the vertebrates, the difference between Man and the Mammalia generally. The syllabus was neither educational, easy to teach, nor harmonious with the existing courses of biology. A revised syllabus of a much better kind has been issued recently. The theoretical work is associated with a definite series of types, which serve to illustrate the main features of ascending grades of structure. It can be taught along with the course for the London "preliminary scientific," although in certain respects the London syllabus is more advanced.

But a great deal has to be done to prevent waste of energy in the teaching of science at the London schools. The new university will have, as one of its most difficult tasks, the concentration of teaching in a smaller number of institutions without prejudice to the independence and friendly rivalry of the various hospitals. We suggest that the solution will be found on lines similar to the combined lecture-courses in successful operation among groups of colleges at Oxford and Cambridge.

Science Teaching at Secondary Schools—The New Commission.

Those who are accustomed to teach at medical schools, or at colleges and universities, must be struck with the lamentable ignorance and want of method of the ordinary pupils from secondary schools. At some of the larger public schools science teaching is admirably conducted, and those at least who give themselves up to the modern and scientific sides are well prepared for advanced science teaching or for the technical training of the medical schools; but in scientific training the majority of endowed and intermediate schools are no whit better than, as Sir Philip Magnus pointed out in 1876, they were at the time of the Commission of that year. Some students have a scrappy acquaintance with elementary facts, but they are ignorant of the methods of studying nature, and they are totally untrained in observation and incapable of describing on paper the simplest object set before them. In this respect, as in many others, endowed and secondary schools stand in marked contrast to the public elementary schools of this country. Anyone who has the slightest acquaintance with pupils from the two classes must have been impressed by this. Now that the movement in favour of technical instruction has become an actual force, the distinction between the education of the lower classes and the education of the upper and middle classes will become still more greatly in favour of the lower classes. Most of the County Councils of England are now offering higher scholarships for various purposes which will enable a greater number of elementary scholars to reach the higher scientific professions; and, unless great improvements are made rapidly in secondary and endowed schools, not only will the path of the most promising children from the largest section of the community pass by these institutions, but, in the competition of life, pupils of the higher schools will be beaten hopelessly. Boys from elementary schools will pass by scholarships direct to technical institutions, and from these by higher scholarships to the universities, medical schools, and engineering institutes. Going by these routes, they will not be subjected to that tone and leisurely culture which is the boast of endowed schools; but none the less will they succeed in the battle of life, and the total result to the community will be, taking for granted the pretensions of the endowed schools, an absence of culture and refinement from many of the most useful and successful members of the higher professions. If for these reasons only, we welcome the new Commission on Secondary Education. But although it contains many good names, it is specially weak on the side of the natural sciences. Science is represented on it by Mrs. Bryant, D.Sc., Dr. R. Wormell, Sir Henry Roscoe. We should like to have seen some representatives of the scientific teaching of Agriculture, of Medicine; some representatives of pure sciences like Biology and Geology.

Lord Playfair on University Extension.

Addressing students connected with the London Society for the Extension of University Teaching (on March 10), Lord Playfair paid a wise and eloquent tribute to the activity and utility of University extension. He regarded the hostile evidence given before the Royal Commission on the University of London as having arisen from a misunderstanding of the origin and purposes of extension. Up to the last quarter of the eighteenth century the working classes were separated by an impassable barrier from the learned class, for these spoke in a language the others could not understand. For about two thousand years Latin was the learned tongue, and for about two centuries Greek was raised as a second wall of separation between the learned and the people. University extension was an attempt to extend the higher knowledge to the people who are unable to attend courses during the day. Its main purpose was not to educate the masses, but to permeate them with the desire for intellectual improvement, and to show them methods by which they could attain this desire.

So far as extension limits itself to these great objects it must receive the approval of fair-minded people. But extension covers a multitude of sins, although it is only fair to say that the London Association is less a sinner than either Oxford or Cambridge. In the vast population of London it is possible to get together audiences who will prefer the competent expert to the mere lecturer. But in the provinces it is not so, and the lecturers of the Oxford and Cambridge centres are for the most part successful and popular in the inverse ratio of their special knowledge of their subjects. With this in itself we have no quarrel. An evangelist of the Gospel requires no Hebrew or even Greek. A lecturer whose business is to arouse the people, not to educate them, need be no profound thinker or learned scholar. But, at least on its present lines, the University Extension system is unadapted to the teaching of those who are themselves to teach, and against its pretensions to recognition from Government, or from bodies granting degrees, an emphatic protest must be made. For, unfortunately, on every side we hear it urged by the official representatives of the movement that a great educational work among teachers is being done. Teachers, like others, need stimulation and awakening, but stimulation and awakening are quite other than professional education. The theatrical methods of the public lecturer are the worst example for the trainers of youth. The London Association has some courses specially adapted for teachers: the Cambridge sequences are useful for teachers occasionally: the Oxford courses are least useful. Courses adapted to the mixed audiences of the provinces have no *direct* educational value, and should carry with them no certificates of any value as part of the professional training of teachers. The best training for these must come from those associated with the actual acquisition of new knowledge rather than with the popularising of the results of new knowledge. The advantage of knowledge to the community is not that it is interesting, but that it is useful: useful in the objective sense, that it is the means by which the forces of nature are bound to the service of man: useful in the subjective sense, that it is the means by which the human mind is deepened and widened. The adult population of the community who have found their places in the ranks of workers have earned a right to be interested and brightened, and the great task of humanising their leisure is the task of the University Extension. But children have to find their useful place in the world, and it is above all things necessary that their teachers should be taught by those who actually have to do with fresh acquisitions and fresh applications of knowledge.

Summer Meetings and the Training of Teachers.

On the other hand, University Extension Associations have arranged, in connection with their summer meetings, courses of the highest value for teachers. In the dog-days the great laboratories stand for the most part idle: no teaching is going on, and the devotees of research are taking holiday. At Oxford, at Cambridge, and at Edinburgh, practical courses for teachers, sometimes in connection with County Councils, sometimes not, have been arranged. These courses, where most successful, have been limited in sphere. An amount of ground that can be covered in four hours' practical work, preceded by an hour's demonstration-lecture each day for three weeks, gives teachers accustomed to mere book-work an insight altogether new into the meaning of scientific work. The afternoons can be occupied by excursions either purely for pleasure or bearing on geology, natural history, and agriculture.

We think that much might be done in this respect in London. We have here many laboratories that stand idle for considerable times during summer; there is no difficulty in getting competent teachers of practical work, and in the elementary schools of London and of the neighbouring districts there are hundreds of masters and mistresses who would rejoice to make use of any opportunities provided them. We commend this suggestion to the London Association and to the Technical Instruction Committee of the London County Council.

Closely connected in purpose with University Extension Associations are two bodies which, so far as we know, did not put forward a claim to be considered in connection with the all-embracing Gresham University.

The P.N.E.U.

A NOTE in our last number (p. 238) has, we regret to find, mystified several of our readers, who thought we were starting an Agony Column, and who have been racking their brains to discover the hidden meaning of P.N.E.U. and A.W.P.L. We hasten to dispel their deplorable ignorance.

The P.N.E.U., we beg to inform them, stands for the Parents' National Educational Union, an association intended to educate parents how to educate their children. Parentship is not, we believe, a necessary qualification for membership; still, many of the members appear to be parents, and are presumably married. Remembering, however, an old saying, we are not surprised to see that many of the lecturers on other people's children have not, apparently, entered either of those blissful states. We ourselves have lately pointed out how much education our educators need (NATURAL SCIENCE, vol. iv., p. 81), and from what we have learned of the work of this association, we are inclined to welcome its endeavours. We understand that there are agencies of the Union in various towns of England, but the leading branch appears to be that of Belgravia, which has for its honorary secretary the Lady Isabel Margesson. This is no impertinent patronising philanthropy that forces its way into the homes of the poor with a tract in one hand and a scented handkerchief in the other; on the contrary, it attacks our great under-educated classes themselves in the gilded ignorance of their own drawing-rooms. Possibly even these parents will resent the intrusion, and ring for the footman to show the P.N.E.U. downstairs; for these parents bring their children up by second-hand. First the nurses (of various denominations), then the governess, then the schoolmaster; these are all, as Professor J. R. Seeley has called them, "professional parents," usurping all the more important functions of both father and mother. They do their best, let us admit; but under this system true education, as opposed to mere instruction, languishes, parents fall into disrepute, sons go to the devil, and daughters revolt. The Parents' Union would remedy this. "It strives," to quote its own leaflet, "to show parents that they cannot, by money payments, divest themselves of their responsibilities. It endeavours to supply them with knowledge and training for their task, to impress on them the absolute necessity for giving careful thought and study to the subject of education, and to show them that without wisdom and knowledge parental love will be maimed, and unable to rise to its true perfection."

The Union uses many means to attain this admirable end. A few parents in any district take counsel together, and associating themselves with those who can assist in the study of child-nature and training, discuss and invite lectures on various problems and difficulties that present themselves. Libraries are started, training lessons are given, natural history clubs are formed. Many other agencies will arise as time goes on.

The educational advantages to be gained from the study of natural history are recognised by the parents who belong to the Union; who also recognise that children will not, as a rule, become keen about natural history, unless their parents and teachers themselves show an interest in it. But the poor parents were not taught how to study natural science in their youth, and now they do not know how to set about learning or how to be enthusiasts in an unfamiliar subject. Fearful of being found out, the poor papas and dear mammas of the Belgravia branch started a Natural History Club not quite a year ago. This Club is distinctly practical in its working, and those who join are required to do some field-work every summer. An Exhibition of the collections made during the first summer was held some time ago, and was very favourably reported on by Mr. E. Sykes, the Secretary of the Malacological Society. The Club also sold to its members a very suggestive Handbook, drawn up by the Lady Isabel Margesson and Miss Vintner. Encouraged by their success, they propose to issue shortly a more extensive Handbook, to which chapters are contributed by some dozen writers well-known in their own lines. This work will be published by Messrs. George Philip & Son, 32 Fleet Street, and should prove useful to others than the benighted parent.

The A.W.P.L.

These letters stand for the Association of Women Pioneer Lecturers. The objects of this Association beautifully combine egoism and altruism. First, it endeavours to open up a new field of work for women and to organise women. Secondly, this work is the extension of science and culture to places and people of all classes not reached by the University Extension lecturers, and the pioneering the way for those lecturers. A representative of Natural Science, who attended the annual meeting of the Association at University Hall, Gordon Square, on March 7, gathered the following information. The Association was founded by Miss Edith Bradley about a year and a half ago, and as it has not yet succeeded in paying its way, is kept going largely by the exertions of that lady. A woman who wishes to be a Pioneer Lecturer is required to prepare a syllabus of ten lectures and then to deliver one of them as a test lecture. Great attention is paid to proper delivery, and those who do not come up to the standard have to attend elocution classes. The lecturer is also desired to "cultivate a graceful deportment and to appear in a suitable and becoming costume." The staff of lecturers at present numbers twenty-four, of whom eleven are University women that have obtained honours. The number is increasing, but unfortunately the supply already appears to exceed the demand. If only 300 kind people would subscribe a guinea for three years, they would be allowed to attend *all* the lectures and the Association would be greatly benefited. But would the subscribers?

Our readers will be interested to hear that no less than nine ladies are anxious to pioneer them through the difficult paths of science, teaching them science—moral and otherwise, physiology with or without hygiene; in fact, everything from primitive man to all the duties of housekeeper and mother. Some of these scientific ladies have names not unknown to us; but we confess we should tremble to place ourselves in the hands of one who would lecture us from Greek literature, through the Poetry of the Century (Browning, of course, to be treated as an *extra*), down to the Vertebrated Mammal. Clearly "you pays your money and you takes your choice"; or you don't do either. The science lectures do not seem to have been very popular; at certain lectures given at South Kensington the average attendance was as follows: Geology, six; Animals, six; Botany, ten. The lectures in connection with the P.N.E.U., to which we alluded in our last number, were, however, better attended, and it is intended to follow them up with a course of lectures on Zoology for children.

We wish the A.W.P.L. all success; but we must point out one very serious omission from their lecture list. They give no instruction in the elements of humour. But possibly they think example is better than precept.

Science at the Free Libraries.

A remarkable suggestion which bears upon the instruction of the masses is made by Mr. John T. Carrington in the excellent first number of *Science Gossip*. As a result of a recent tour through the metropolitan libraries, he points out striking deficiencies in them. Illustrated books on popular natural history are to be found in many, but these, for the most part, are out of date and of no educational value. In most cases the income of the library goes in the purchase of fiction, or in general expenses, and the librarian depends on donations for the science section of his catalogue, and must accept whatever comes to hand. He makes the valuable suggestion, that some competent authority should invite the councils of the various learned societies to draw up and revise periodically a list of text-books and authorities dealing with their especial subjects. Although we consider this suggestion most valuable, we do not think it practicable. Members of the councils of learned bodies are not, we fear, likely, as such, to give the necessary advice periodically and satisfactorily. For one thing, most of them are not specially familiar with text-books. Proper advice could be attained more easily by appeal to the teachers of different subjects at the various scientific institutions of London. But Mr. Carrington has made out so excellent a case for the establishment of some kind of guidance, that we hope he will succeed, through the medium of *Science Gossip*, in arousing the necessary attention of authorities.

The Darwin Memorial.

Last month we commented on the praiseworthy efforts of Shrewsbury to do honour to Charles Darwin, perhaps the greatest name associated with that beautiful city. Apparently dogmatic folly is still raising its bray against science. A correspondent writes to us:—

"A prophet has lifted up his voice against the iniquity of the people of Shrewsbury in venturing to propose a memorial to Darwin in his native town. A sign has been sent from heaven, and the spire of St. Mary's Church has been blown down. The righteous then are punished for the sins of the ungodly. The punishment would have been more *ad rem* had it fallen on the Shrewsbury Museum or the mayor's house; but 'the wind bloweth where it listeth.' It is not for wicked people like ourselves to deny the logic of the Reverend N. Poyntz, but he seems to have a marvellous short memory. Are we not right in saying that about a year ago some stones of this same spire fell down, a fact which might have suggested even to the vicar the advisability of initiating some repairs? Really the supposition most charitable to the common sense, if not to the ingenuousness, of Mr. Poyntz is that, knowing himself to be in the wrong, he endeavours to distract attention by casting the blame on those who could have had least to do with this regrettable disaster."

I.

Plateau Man in Kent.

THE further back we push our studies of man, the plainer it becomes that a more comprehensive and at the same time more simple definition of the word "anthropology" must be allowed than is sometimes given. Anthropology is not a science of structure and function simply, but of man as an object of natural history, so that man's ontology and phylogeny must be studied like that of any other animal. Unfortunately, we are so prejudiced by preconceived ideas as to his dropping from the clouds in a highly civilised state, that anything claiming more than a very limited amount of development for him is ill-received. Anthropology has thus been but grudgingly allowed to embrace even Palæolithic man; and all sorts of theories have been invented, in the face of hard facts, to minimise the number of centuries that have passed since Palæolithic times. We have still with us the venerable champion of Palæolithic man—Professor Prestwich, who almost single-handed fought for our progenitors in the valley of the Somme. Since those days, however, this science has made remarkable strides: not only has it made its strongholds impregnable, but it has found it necessary in many parts to extend the dominion of the genus *Homo* away into the geologic past to a degree that was previously undreamed of. Nor has this been done at the expense of the State or by official observers. Month by month, year by year, a body of workers has been plodding along in various parts, gaining here a little and there a little, to which a new importance has occasionally been given by the more detailed work of the Geological Survey. In our own Thames area we have had workers like General Pitt Rivers, Messrs. Spurrell, Worthington Smith, Allen Brown, Greenhill, and Shrubsole, to whose names may be added the less known but none the less deserving one of H. Lewis. Then we have had collectors and philosophers in wider fields, such as Sir John Evans, Sir John Lubbock, and several others. During this time it has been conceded that a division might be made in the science, under the head of Prehistoric Anthropology or Prehistoric Archæology. So long as the study is confined to Neolithic, or even later Palæolithic man, these terms might be allowed to stand; for, so long as our discoveries are confined to river-drifts some hundred feet above present water-levels, it is just possible that no great changes in the surface have taken place, such as we should require any great amount of geological knowledge to understand. But recent discoveries show that the science does not begin with the archæologist, but with the geologist and the palæontologist: when we come to deposits upon existing watersheds, or others which bear no relation to them, or yet others 400 or 500 feet above these, it is obvious that the subject has entered the domain of Geology. For the principal of these latter discoveries, especially in Kent, we are indebted to the undaunted energy of Benjamin Harrison, a tradesman in the little village of Ightham, between Maidstone and Sevenoaks.

It is now over thirty years since this indefatigable observer began making a collection. From time to time the echoes of the great thought-movements of the day reached this sequestered little village, but they were to Harrison as handbills dropped from a balloon; he was entirely shut out from the scientific world. His struggles and his perseverance; his fighting against want of encouragement and sleepless nights; his early risings and tramps to some spot four or five miles away, so as to be there at sunrise, and to hunt before opening his shop: all these are matters to be read with a relish only when the hero is no more. But, however Harrison's labours might have suffered from want of sympathy, they were soon rewarded by interesting finds. The house of his ancestors happened to stand in the old Valley of the Shode; relics of Palæolithic man found not far from his own shop soon whetted his appetite, and stimulated his researches. He carefully searched almost every inch of the adjoining country in the Holmesdale Valley, adding, as he went along, not only to his finds, but bit by bit to his store of knowledge, until he had managed to pull himself abreast of many of the scientific opinions of the day. Then he chanced to come upon a very beautiful palæolith (Fig. 1), some 70 ft. above the bed of the Shode, which set his mind at work in another direction, and one in which it must be conceded he received but little encouragement for a long time. From the first Harrison had kept a strict account of his finds, numbered them, sketched them into books, marked the position of their occurrence on the 6-inch map of the district, and made notes upon them as they presented themselves to his mind. As he contemplated the skilful work of this weapon, the question suggested itself—"Is it possible that this represents man's first essays at flint working? If so, what a dexterous creature he must have been born; in fact, he must have dropped from the clouds nearly perfect. But is it likely? Is it at all probable that man's evolution began with so highly-worked a flint weapon?" To which his reason answered: "No! If, then, this is not one of the first, where must I look for his earlier attempts, but to the more unwasted conditions, to the gravel patches lying above the present watersheds?" Nor were his labours in these places in vain, for he soon found a number of implements, which, in point of workmanship, were inferior to the majority of those of the valley, and, therefore,—from an evolutionist's point of view—might be considered to be older. There was one thing, however, that hardly fell in with his expectations, and that was, that in the valley there were implements of a type identical with those on the hills. But when he came to compare these two groups, he found that those of the hills were fresh and somewhat sharp, while those of the same type in the valley were, without exception, more or less water-worn. Here, then, was the explanation. The implements of this character found in the valleys were derived from the hills; and this idea also explained the existence in the valleys of several other things, such as erratics foreign to the locality, and types of implements still rougher than those of the Hill-men.

But now the physical features of the country perplexed him. He had evidently got to something older than the oldest existing vestige on the Counterscarp; and the question was, where to look for the earlier home of man, in a period before the genesis of this last physical feature, and when the land-surface was probably 700 feet higher than at present. This surface, said he, must have been continuous with the chalk plateau; and upon the elevated ground of the latter, in its most unwasted parts, we must look to find the earliest traces of man in our district. Then commenced an inch-by-inch survey of the whole plateau for a distance of eight or ten miles; and here his labours were rewarded by considerable finds, at first, perhaps, a little disappointing. He soon discovered that here were to be found some implements exactly similar to the later palæoliths of the Holmesdale valley. His ruder forms were also represented, especially in the deep valleys which cut into the plateau, while the "old brown" deeply-stained flints occasionally found in the valley below were now found in great profusion all over the surface, especially in some places where the land was higher and had been curiously less denuded. Unfortunately, however, not a single section was to be seen upon the whole of the interesting area. Careful searching of the surface, of slight excavations for mangold trenches, of holes for trees and posts, and the deepenings of dew-ponds, and here and there of a well-section, not only showed the existence of the "old brown" flints, quartzites, cherts, and other erratics, but revealed the remarkable fact that the former had been picked up and worked perhaps on one edge, used, sharp edges being abraded in the using, then thrown down again; and further that all this had taken place before the flint entered into the remarkable deposit which so altered the surface of the stone, and changed its colour to that characteristic dark brown.

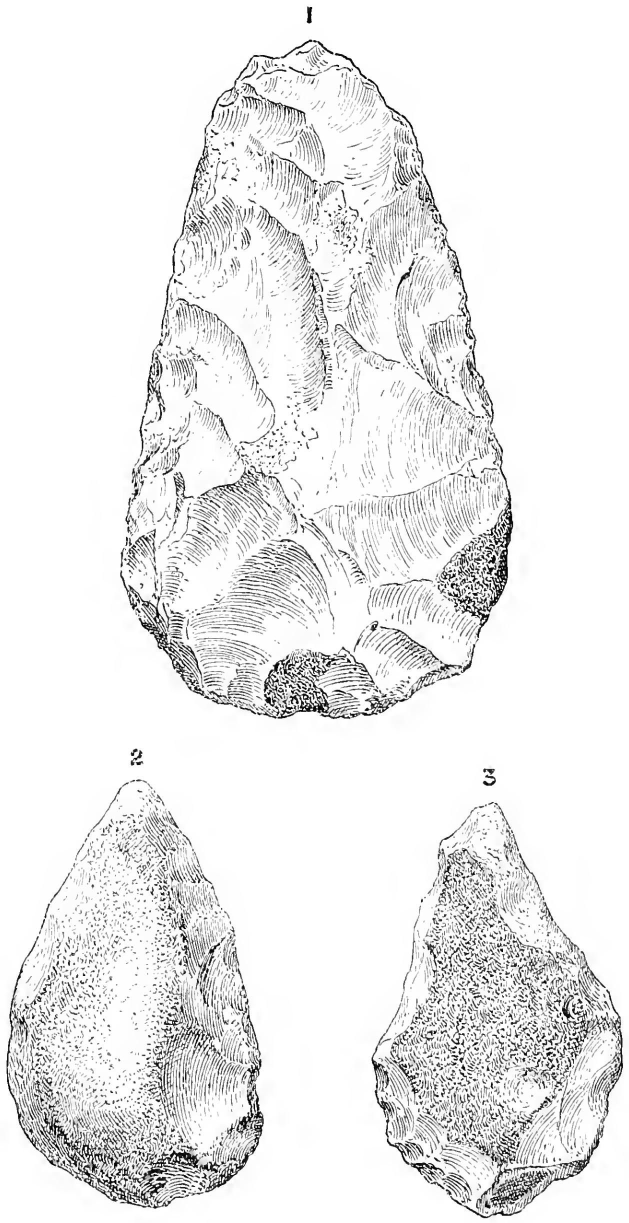
Here Harrison was sure he had evidence of an earlier form of culture or even of intelligence. The tools were *used* tools rather than *shaped implements*. But from the want of sections and invisibility of beds in juxtaposition it is at present impossible to state positively the exact age of the deposit in which these tools received their colouring. Sometimes they are Eocene pebble flints split by frost, and worked from one side only, at others they are nearly whole flints picked up promiscuously, the working appearing always on the opposite side to a good hand grip. There are no oval hammer-stones such as were used in Palæolithic times, and consequently bulbs of percussion on flakes are very rare. Frequently the flints are striated exactly like some of those in the glacial beds of East Anglia. From these rude used flints numerous groups of implements diverge towards the well-known types of the Palæolithic and Neolithic ages. Just as our palæontologists saw the progenitors of our present ungulates in very dissimilar Eocene forms before the connecting links were discovered, so Harrison saw in his early finds the prototypes of later implements. For years he sought to make his finds known to the scientific world, but his converts were few. However, as time went by, spurred on by his own assurance and the incredulity of others, he increased his collection amazingly. He also distinguished groups of different forms, some of which were most curious. Form, however, was nothing to Plateau man; two objects alone presented themselves to his intelligence, a hand-grip, and a usable edge. Nor was he as yet the victim of one-handedness, left-handed forms being almost or quite as numerous as right. In all his early workings he worked from *one* side of the flint, which he did sometimes with one hand and sometimes with the other, as is evinced by the reversed workings.

While collecting this material Harrison was brought into contact with many well-known scientific men. On one occasion he was introduced to a celebrated archæologist bearing a name classic in geology, who, as Harrison began to speak of Palæolithic man, blurted out in his characteristic way, "Of no interest; prove nothing; in fact prehistoric archæology is played out; my old friend Boucher de Perthes proved all that could be proved." Rather disheartening this, but perhaps better than the action of another set of critics, who, while admitting some of the better finished weapons when shown separately, assumed a position of open hostility to the subject both in season and out of season. Among the various scientists who encouraged him mention might be made of Messrs. Montgomery Bell, F. C. J. Spurrell, and Grant Allen, Dr. A. R. Wallace, and Dr. James Geikie.

In the meantime Harrison had been continually in touch with Professor Prestwich for several years; and as soon as the Professor's leisure would allow he traversed the whole or principal parts of the scene of Harrison's discoveries under his guidance, and from time to time studied these new evidences of a greater antiquity of man. To those who know Professor Prestwich's conservative tendencies and his predisposition to close in the period during which man has been on earth, it will at once be clear how strong must have been the evidence for him to turn round and become the champion of the cause. We well remember the eventful evenings at the Geological Society and the Anthropological Institute on the occasions of the reading of the

Professor's papers on this subject, when the old adage "history repeats itself" was once more verified; for assuredly the Somme finds were never scouted with such contempt as were the poor plateau tools. It is, perhaps, only right to say that we were among the majority. We remember well the impression made upon us by a specimen, which the Professor afterwards figured (*Quart. Journ. Geol. Soc.*, vol. xlvii., pl. viii., fig. 4); but even from this we admit we were obliged to withhold our assent, and we should think none the less of any who did the same in the absence of seeing a series of these things. Fig. 3 shows this to be simply a naturally broken piece of flint with the bark on one side, the right top edge being also a natural break, while any of the flakes struck from the other part are such as might, under exceptional circumstances, be produced in the vicissitudes of gravel making. But, upon closer examination, we notice that the whole of the left edge is worked from the flat side, and that it was formed by some score of blows. Moreover, we see that the resulting edge, till it reaches the butt, lies all in the same plane, and is at a constant angle to the flat side, which implies that every blow must have been administered at the same angle to the surface struck. Anyone who has had a few years' practice in the working of flint would readily admit that this flint was held in the right hand and the blows administered with the left. Further, when we come to the butt, we find that a slight twist exists in the flint, and, accommodating it to the grip of the hand, changes the angle at which the blows were received; consequently the rest of the flakes came off at a lower angle. Now arises the question of mathematical probabilities and the possibilities of "Nature" working in this manner. Could natural forces have administered all these blows on one side, at each time in the right place, when the whole surface of the flint was exposed, and on each occasion at the right angle although there were 180 degrees to choose from? Could natural forces have maintained the blows at a constant angle from the point of the implement till the butt was reached, and then have maintained them at another angle all round the butt? Would all the blows have been struck from the flat side, except when a prominence occurred, and have then been struck from the other side? Finally, would they have attacked the projecting ridge on the top right edge, with the result of turning out a usable implement, however rough? The improbability of such a coincidence of natural blows is so extreme, that though we may regard the shape of this stone as three-parts the work of Nature, we are obliged to ascribe the remaining part to the agency of man.

That Nature suggested this outline to man, or, in other words, that man discovered it nearly or quite at hand, we have not the slightest doubt. In Fig. 2 we have an example with even less work, but when placed with the others, its position in the series is evident. We have but little faith as a rule in illustrations of these rude forms; the specimens must be *seen*, and the physical properties of flint, the laws



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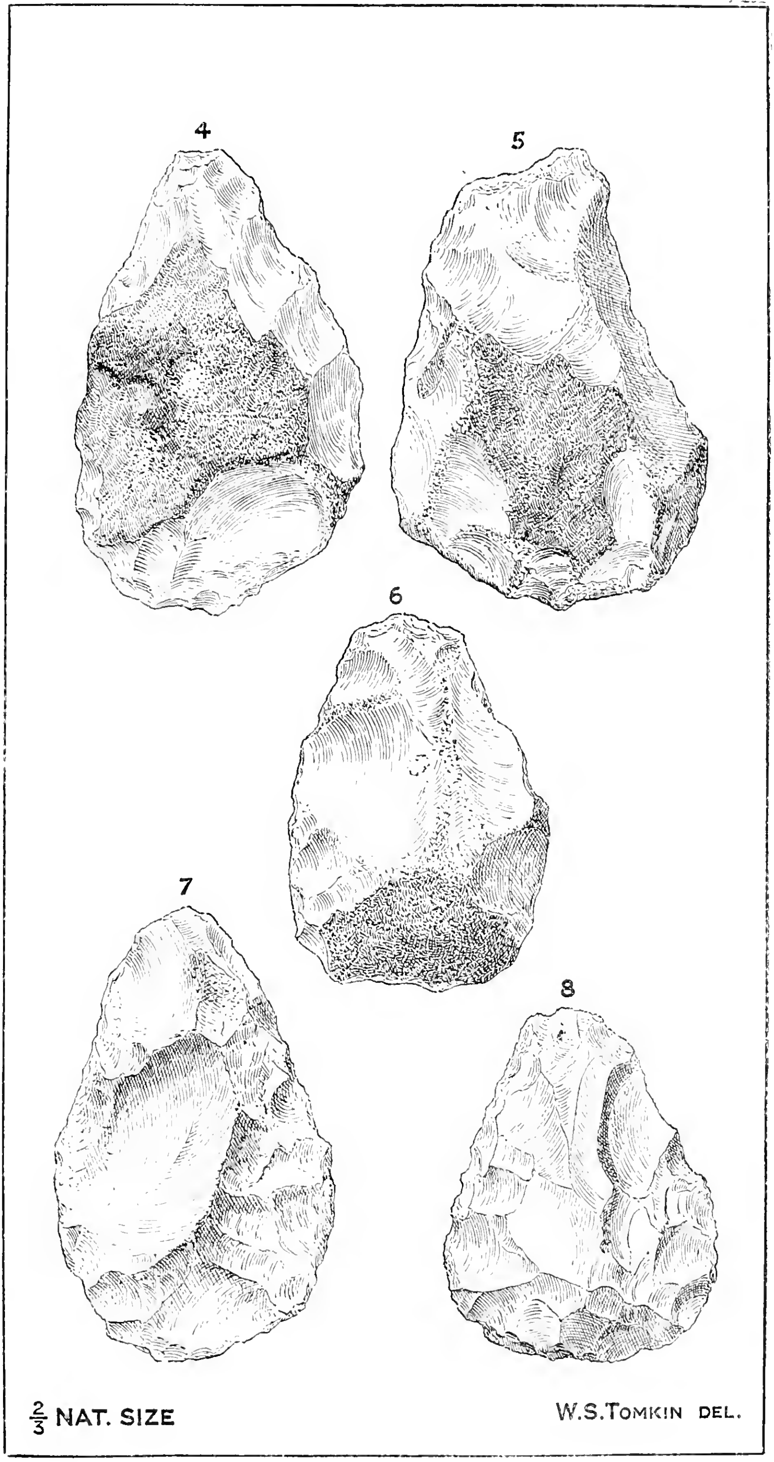
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of force, and the vicissitudes of gravel making, thoroughly understood. In this tool a half pebble is again employed, and from the flat side the whole of the right edge is worked, being struck at a very low angle and made to correspond with the opposite edge. And here again, as in the preceding, the flakes from the point to the commencement of the butt are in the same plane, or at the same angle; and with the change of grip to operate upon the butt, the angle becomes correspondingly changed. A few flakes removed from the left edge, extending about half of its entire length, complete the bilateral symmetry. In Fig. 4 we have got a step further, or, judging by the specimens before us, several steps. Nature, however, still claims the greater part of the work. The large flake from the base is due to the action of frost, but antedates the work on the edge, so that it is practically worked on one side for seven-eighths of the edge, the blows being delivered in different zones and at different angles. On the other side Nature claims a greater share, about one-quarter of the surface being occupied by the natural bark, and about another third by frost-bite; but in this we are introduced to workings on both sides of the edges, which mark a decided advance upon the early workings from one side only. Fig. 5 shows a still further advance; a great deal of the natural bark is still left, but there are decided attempts towards a thickening of the butt, and a tapering from above and below towards the point. Unfortunately, the ancient artisan found he had got too much material to finish with ease and did not quite understand the angle at which flint breaks; but he had the right idea in his head, and probably was far more successful than in this case before he gave up implement making. In Fig. 6 we have a greater advance; the bark is still retained for the base, but the latter is well thickened. Most of the blows, however, were delivered from one side, giving rise to a plano-convexity. This is about the quality of skill achieved by the Hill-men. Fig. 7 marks a still further advance, being chipped all over, and is only one of many specimens which are found in the hill group and occasionally in the valleys.

In selecting from Harrison's collection a half-dozen specimens to illustrate the whole evolution of a type, we are aware of the great gaps that exist between each specimen figured, and of this we are more conscious from the large number of specimens presenting those intermediate characteristics now before us. We cannot expect to prove the evolution, but merely to show the relation of one form to the other. Study of the specimens, however, shows clearly enough that we have here an unbroken sequence of development. In some cases, such as hollow scrapers and bone-splitters, quality of work and condition of material alone separate the Plateau from the Neolithic forms. There are numerous other extensive groups into which the Plateau tools can be divided, in which the archæan character is only surpassed by their constancy of form and recurring numbers. What the uses of some of these tools could have been is as great a mystery as would have been a fossil boomerang had its use died out with Palæolithic man.

Coming now to the reality of Plateau man, the question, to our mind, is a very simple one. It matters not to us whether many of the cherished treasures of Benjamin Harrison are the work of Nature. We are certain that very many hundreds of them are not. Even if of the 2,625 collected, the odd five can be shown to be the work of man, and their stratigraphical position established, then Plateau man becomes a real being, to whom the modern world was first introduced by the Ightham shopkeeper. At the time of Professor Prestwich's paper the horizon of these implements was not susceptible of exact definition ; since then a number of important finds have been made and facts discovered which will go a very long way to settle the question of age. But we dare not enter upon this question now, although we hope to do so shortly, and to prove Plateau man to have been Pliocene.

There is also another great work which Harrison has accomplished at the suggestion of Professor Prestwich since the papers of the latter on this subject. At the date of these papers, the Hill-men were not clearly defined, and implements found at certain heights were associated with them. This group of implements was first noticed by Mr. F. C. J. Spurrell, and he called them the Cave Group ("Palæolithic Implements found in Kent," *Archæologia Cantiana*, 1883). But, so far as we remember, Mr. Allen Brown was the only one to notice that they were of far more modern facies than those of the Hill-men. These have since been proved to have been the work of the Rock-shelter men, and for the purpose of making the necessary excavations the British Association have made grants of money to Mr. Harrison. Anyone who visits this spot will admire the skill displayed in his mode of procedure. Since the occupation of these shelters, the configuration of the country has been so altered that the ground just in front of them, which one would naturally expect to prove fruitful, was not worth working ; but, seeing an unwasted ridge about two hundred yards off, Harrison successfully excavated it, obtaining some fifty implements and six hundred flakes. On this ground, and round about the shelters, he had found remains for many years. The implements of this period constitute a distinct group in which the work is of the highest quality ever reached before Neolithic times, indeed the skill displayed in one of the specimens is so great that, when first submitted to Professor Prestwich, despite its shape and altered surface, he was doubtful as to its claim to be called Palæolithic. Many years ago a superb weapon was found in a garden near Sevenoaks Station, beautifully polished all over, which in outline was exactly similar to one of Harrison's finds drawn out half as long again. One of Harrison's specimens, of the Rock-shelter group, was illustrated by Mr. Spurrell (*loc. cit.*). Especial reference may be made to this, as it helps to bridge the gap between Palæolithic and Neolithic implements. It has usually been considered characteristic of Palæolithic implements that they were used on the point as thrusting tools, and that the broad cutting edge was an essentially Neolithic feature. But in this implement there is a soft spot near the point, and through this a hole has been somewhat irregularly drilled. A point intended for use would hardly have been so weakened; the hole, however, might have served to fasten the flint into a haft of some kind, thus leaving the broad end for a cutting edge, as in Neolithic weapons.

These indefatigable labours of Harrison have thus established the existence in the neighbourhood of five distinct stone periods, although not necessarily separated by a great hiatus, each characterised by special groups of implements. They are as follows:—(*a*) The usual neoliths on the surface; (*b*) The superior late palæoliths of the Rock-shelter or Cave-men; (*c*) The ordinary river drift types of existing valleys and watersheds; (*d*) The Hill group, above existing watersheds; and (*e*) The Plateau group which antedate the present structure of the Weald. Of course, it is only natural to expect to find the implements of all the later periods in various positions in the valleys of the plateau. One thing, however, of extreme importance remains, and that is, that there are large tracts of plateau drift from which all traces of deposits of Palæolithic age have been entirely removed, if indeed they ever existed on them; and in these patches the old Plateau forms are found, to the total exclusion of the Palæolithic types, although the most diligent search has been made for the latter, both by Mr. Harrison and other workers. This disposes of the weightiest argument against the separation of the two races, namely, the idea that the old rude Plateau specimens were the rough work of Palæolithic man dropped upon the surface. It is greatly to be regretted that the necessary funds are not forthcoming to carry out a thorough system of excavations upon the plateau, and to trace the relations of this drift to the undoubted Pliocene beds of the neighbourhood, which we are quite sure would confirm Mr. Harrison's discoveries.

W. J. Lewis Abbott.

II.

Characters in Biology.

IN a recent controversy as to the Factors of Organic Evolution, as well as in other biological writings, many difficulties have been raised, and many phenomena have remained inexplicable, because of fallacious reasoning that occupied itself with terms which have been inaccurately defined, and which mean much less than they are taken to mean. There are several prominent instances of this fallacy, notably in connection with the words *adaptation*, *purposeful* or *zweckmässig*, *variation*, *acquired*, and others; but by far the most remarkable case of the uncritical use of an ill-defined term may be observed in most of the speculative writings where the word *character* is prominent, and the same is true of the German *Eigenschaft*, or *Merkmal*. The frequent term *hereditary tendency*, used as it is in a sense not greatly differing from the word *character*, is also a great source of confusion, and needs the same examination as does the latter.

"*Character*" appears on every other page of our biological works, and is a term we could not well do without. It has always had so obvious a meaning, and is now from long use so familiar to the ear, that it is difficult always to keep in mind what the limitations of the term should be. This character is, or is not, inherited; that other tends to vary: these are plain and intelligible phrases, and are apparently incapable of introducing serious error when used in the study of organisms. But as a matter of fact the term is extremely wide; it may, indeed, include almost anything, yet it is often used as if it had a definite meaning, or answered to real distinctions of parts or relations of the organism, or as if a *character* could justly be regarded as a unit in the study of heredity. The characters of an organism may be new or atavistic or neither; acquired or congenital; individual, specific, or generic; quantitative or qualitative; of a part, of an organ, of a function, or of a relation; or even the negation of any of these; and, yet, utterly incoördinate as they are in kind and amount, utterly arbitrary and changing as are their limitations, they are constantly regarded as units, not only rightly, to the observer, but wrongly, to the organism; are talked of as being present or absent, or as varying in one way or another without affecting the rest of the body, and as only occasionally being connected with one another so as to show a relation of interdependence. Even where the idea is not so definitely formulated as in de Vries' chapter on "the mutual independence of the hereditary characters," we are constantly met with the assumption that the aspects of the organism, or of its parts, looked at from a hundred different points of view, and selected for consideration in a rich variety of ways, have a special significance as units for the study of inheritance, being treated of as independent of one another in heredity and variation, and often, for that reason chiefly, being regarded as represented in the germ by independent and special material vehicles. A dog, for instance, according to the view of that writer, inherits some of his characters from his mother, some from his father. Some come from a remote ancestor, and others are quite new. One of the parents may have had more to do with him than the other, for in the list of characters it may be that there are ten from the father and only seven from the mother. In most cases the characters are not the mean between those of his parents, they do not even vary all in one direction. There is no obvious interdependence between them. They are, therefore, according to de Vries, to be referred to different material foundations in the germ, derived from various ancestors, which *Anlagen* may vary independently of one another, each working out the character it represents. There are material vehicles for each of his characters, as, among others, for the length of his legs, for his swiftness, for his bark, for his love of sugar and his fear of snakes, as well as for the absence of all that he is not. All these are hereditary characters, varying to all outward seeming independently of one another, and all due to the ultimate *Anlagen*. Now, while few go so far in isolating characters as de Vries does, yet their independence of one another and their unity in themselves is so generally accepted that it is worth while studying what is the principle on which phenomena are grouped together and called a character, thereafter to be treated of as unit, and on what principle they are grouped to form two or more characters, varying independently or in correlation with one another.

The term may, in the first place, be used generally, of the whole creature as individual, with or without any special reference as of size, colour, habit, etc.; and this is generally Weismann's use of the term. Here there is no artificial division of the organism into parts that have no answering physiological divisions. In agreement with this point of view, Weismann's determining foundations in the germ answer each of them to the complete character of one individual ancestor, which is impressed on the whole of the new organism by the little piece of matter in charge of that character and by the little pieces derived from it, whereas those of de Vries answer each of them to one artificially limited character of many ancestors, which aspect of the new organism they look after, neglecting the rest of the body. As Weismann often, however, uses the term character in its narrower sense, he is led into the common fallacies at times. Indeed, an animal is generally thought of and observed in some special direction, with the result that some appearances soon eclipse the others and come to be regarded as the characters *par excellence* of the form. Anything particularly striking to the eye or fancy at once assumes undue importance and becomes marked off as a unit. And still more often, those characters which are of the highest definitive significance, and consequently, as a rule, of the lowest physiological importance, those which are most "characteristic," take a more prominent position in our minds than others, quite rightly for some purposes, but wrongly for the study of inheritance. For thus one aspect of the organism comes to stand for all.

But, as a rule, characters are quite freely regarded as separate from one another and as independent of the rest of the organism, and are formed arbitrarily and used singly in the observation of the facts of inheritance. The animal is made up of, or at least capable of definite analysis into, separate incoördinate individual appearances, the presence or absence of which, in various proportion, determines its specific and individual relations. And in marking off characters from one another, one principle is always present, though loosely adhered to; that is—that those appearances which usually vary without any obvious accompanying change in the other relations of the organism, are included in one term. Thus a patch of colour is one character, being present or absent from animals otherwise not different. Any relation of paired parts is always called one character, not two, because such always bear a fixed relation to one another. An instinct or habit is a character, being for us irreducible to its complex causes. But any phenomenon for which we can find a cause, or even a distant causal relation in another, is grouped with the latter as one character. Wherever our knowledge of physiological relations between parts breaks down, there we too readily assume a breach in organic relations, calling all that lies between such breaches a unit that varies independently. So, to modern biology, a seeming independence in quantity or quality of one or many structures or functions or both, from the rest of the organism, together with a real and obvious causal relation between the former, are enough to give them the status of a unit for heredity, having a set of little determining demon particles all to themselves. And yet we are asked how it is that characters can vary independently of one another; and ingenious theories are built to account for so strange a fact and to fit an apparent union on to this disunion. Why, but for the very simple reason that just those phenomena which, to superficial observation, range themselves in independent groups are chosen for the dignity of being styled separate characters. Why A = B, is a question that needs little discussion if higher up the page you have defined A solely on the ground of that equation. If this be not the principle of definition of a character, why consider the length of right and left legs not two relations but one? If they ever differed seriously in length they would be distinguished as two. Now, if this is really the principle on which characters are to be defined, it is superfluous to ask whence the independence in variations. That independence rests on ignorance of causes, and is restricted, step by step, with the growth of physiology. Were all the relations of function of the parts of an organism known, it is simply inconceivable that the quantity or quality of any part you like could be regarded as without effect on the rest, or as having come to the condition in question without the co-operation of the rest. And even if such a hiatus in the relations of parts were thinkable, we have ample evidence that it does not occur, in the cases of obscure correlation of phenomena of various kinds in various parts apparently unconnected with one another in any special manner. In every living thing the islands of connected changes which rise here and there above our sea of ignorance are united on a common bed, perhaps not so deep down as is usually taken for granted.

This false isolation of characters in the adult, and with regard to inheritance and variation, is the chief cause of the assumption of demon particles; and in this connection it may be said that in the expression *latent characters*, which are carried through one generation or sex to appear in another, whether in cases of dimorphism, polymorphism, or atavism, we have a metaphor that often causes error, though it would be pedantic to object to the convenient phrase. The character simply does not exist in the intermediate generation, and no carriers need be invented for it. To say that an appearance is latent is to say that it is not. Though there were waves yesterday and will be waves to-morrow, we do not think of saying when the sea is calm that they are now latent in the sea; we simply say that there are no waves, though we know that when the conditions arise they will appear. A character is simply the appearance caused by the reactions of circumstance and the mass of cells derived from the germ, and in the absence of certain conditions certain characters do not appear. This has been well shown in respect to one class of characters by the valuable essay of Geddes and Thomson. The action of circumstance must come into our account of the rise of alternative structures and functions somewhere; it is surely more reasonable to regard it as directly answerable for the changes in question, and not simply indirectly as awakening the demon carriers of one set of structures which thereafter supersede the demons of the alternative set which now become latent. For thus we have the support of experiment, and substitute a physiological account for what is at best only a bad formal one. One might as well say that men have within them the carriers or determinants of a latent black eye, which are called into action by a blow, as that the difference in form and function of the sexes is due to the action of alternative sets of "determinant vehicles of hereditary characters" one of which triumphs over the other. If one alternative form differs from the other in one respect, it differs in all; it is against all physiological and pathological experience to think of, say, the sexual characters as independent structures and functions superimposed on a common neutral basis.

If characters are not regarded as varying independently of one another, or as being present in some mystical way in the forms which "transmit" them without "showing" them; if they are not looked at as being any definite unities for the organism, but are recognised as arbitrarily-defined groups of phenomena; if, in short, we make it clear to ourselves that they are only appearances of the individual, which cannot with justice be divided into parts in the consideration of heredity, and which if it varies in one respect varies in its whole constitution, then the result for our theories of heredity is obvious. The questions become at once more complex and more simple. More complex because, being deprived of our false units, we have to leave tabulating characters, and have to go to school to physiology that we may trace the many aspects of the individual to the functional peculiarity of the germ, the many differences to the one, just as the above-mentioned authors have done for the complex phenomena of sex; and because a character ceases for us to be transmitted or carried latent as such by the demon particles, and has instead to be referred in its rise to the reactions of every part with every other and with the world. They become more simple, because we shall cease to be hampered by the difference in the habits of authors as to the way in which they form characters, or by the difficulty of reducing positive and negative relations of quantity and quality, utterly incoördinate and incomparable as they are, to a common formal expression; and most of all because we shall cease to be confronted with the question as to how the demon particles do their strange work.

Surely it is an unprecedented thing that men going about to explain the shapes of animals and plants should leave on one side what are clearly the causes of these shapes, namely, the processes of development which lie to their hand in physiology and embryology, and should rest content with an antique and fantastic scheme of growth which makes all intermediate processes of no value; so that all the changes known as inheritance and variation can be studied in relation to only two moments in the whole of life, namely, the adult, as pure *morphe*, and the germ, fixed and stained. And since this has been to so great an extent our method, it is not surprising that Natural Selection is loaded with more than it can bear, or that the expression which the great principle of use-inheritance receives is artificial and exaggerated.

GEORGE SANDEMAN.

III.

The Cross-Fertilisation of Food-Plants.

SUCH a Society as the Royal Agricultural, which boasts the motto, "Practice with Science," could not better carry out its principles than by encouraging experiments in the cross-fertilisation of food-plants. Darwin, we know, put forward conclusive evidence in favour of cross-fertilisation as a general rule for the production of the strongest and most fertile offspring, and insisted on the advantage or necessity in all cases of an occasional cross. These are points which scientists universally accept; yet so great is the gulf still between practice and science, that the vegetative method is to-day often the only one used in the propagation of our most necessary crops; *i.e.*, this year's plants are produced, not from the seed, but from cuttings or some detached portion of last year's plants.

The potato plant, for instance, has been taken from a light soil in the cool, dry, even climate of the mountains of Chili and grown for years in all soils in the warm, damp, changeable climate of the British Isles, and, to make matters worse, instead of starting again and again with new individuals produced from seed, the life of single individuals has been indefinitely protracted by purely vegetative reproduction. Part of an older plant, namely the tuber, has been divided up into new plants, and this process has been repeated till, under the artificial conditions of growth and multiplication, the plant has lost all stamina. What wonder, then, that the last fifty years tells a tale of continued struggle between the weakened plant and disease? It is to cross-fertilisation that we are now looking for help in the fight with the fungoid and other pests which have done, and are doing, so much damage. During the last few years Messrs. Sutton have raised seedlings by crossing a variety of the common potato, *Solanum tuberosum*, with another species, *Solanum Maglia*, or, as it is sometimes called, Darwin's potato; and, though it is too early for definite statement, we may hope that in a few years some of the seedlings will prove the precursors of varieties yielding crops good in themselves and also less liable to disease. Not only is there the strengthening influence of the new blood introduced by the cross, but the advantageous fact that *Solanum Maglia* is a native of a damper, warmer climate, more like our own than is that to which the common potato is indigenous.

The recent discovery of seedling sugar-canes may exercise an important influence on the prosperity of our West Indian colonies. As with the potato so with the sugar-cane, vegetative propagation has been exclusively followed: new individuals have been produced, not from seeds, but from cuttings of the joints of older plants. Indeed, so long has the sugar-cane been cultivated that, like the wheat, its native country is to-day a matter of dispute, and it is a question if it is now ever found in the wild state. In consequence, perhaps, of the many centuries of cultivation, the plant has almost lost the habit of producing seeds, and we may search the "arrows," as the long, feathery flower-heads are called, and find not a single fertile flower. It is obvious, that if the ovary has become permanently sterile, or the pollen lost the power of fertilisation, the benefits of cross-fertilisation in the form of invigorated offspring or new varieties, are precluded. Until about three years ago there was a very general opinion, and one, too, of long standing, that the sugar-cane did not seed. In 1889, however, as the result of observations in Java, Dr. Benecke published a description and drawings of the ripe fruit and the germination of the seed; while, almost at the same time, Messrs. Harrison and Bovell, working at the Botanical Station at Barbados, proved that some varieties on the island also produced seed. From them seedling plants were raised, while some seed sent to England was successfully germinated at Kew, and also by Messrs. Veitch at Chelsea. Fertile flowers on the "arrow" are few and far between, and the size is very small; but in spite of these difficulties the discovery opens up the prospect of seminal reproduction, and the advantages of cross-fertilisation.

The object of the cross-breeder is to secure in one variety the valuable characteristics of two or more; to get, in fact, the largest possible crop of the best quality, and ripening at the proper season. In no case is this of more importance than with wheat and other cereals, the cultivation of which in Great Britain is now at so great a discount. In 1839, according to a statement in the *Journal of the Royal Agricultural Society*, the annual growth of wheat in England and Wales was estimated at 12,350,000 qrs., worth, at 50s. per qr., nearly 31 million pounds sterling. Fifty years later, in the same journal, we read: "The present annual growth in the United Kingdom does not exceed 9 million quarters." As the crop is still held to be indispensable in the corn-growing districts, the introduction of improved varieties for the sake of adding to the yield is of great importance. An account by Mr. Carruthers of some experiments on the cross-fertilisation of cereals, published in the latest volume of the same journal, is consequently of great interest, and no apology need be made for a brief re-description in NATURAL SCIENCE.

In the great majority of grasses the male and female organs, stamens and pistil, are contained in the same flower, not surrounded by an attractive corolla of petals but more or less enclosed in brownish scales called glumes, the number of which varies in different genera. Each flower is solitary, or more often several are crowded together forming a spikelet, while the spikelets may be arranged closely forming the so-called "spike" as in wheat and barley, or loosely as in the "panicle" of the oat.

In each flower the stamens and pistil are generally ripe at the same time and thus self-fertilisation is favoured. The barley is an extreme case, as here the fertilising pollen escapes from the stamen and falls on the moist receptive stigma of the pistil before the flower opens and while the ear is still within the sheath. When the stigmas are finally pushed out beyond the scales of the flower they are dead, and cross-fertilisation is therefore precluded. In the wheat the anthers are already burst and some of the pollen-grains discharged and adhering to the divisions of the ripe, feathery stigma before the flower naturally opens, showing that self-fertilisation is at any rate possible. The flower opens for a short time, about a minute, the opening being effected through the pressure of the stamens, stigmas, and the two small scales, or lodicules, supposed by some to represent the petals; the filaments pushing the anthers before them extend to three or four times their former length, and the feathery stigmas spread to the air. The pendulous anthers are shaken by the least breath of air and rapidly emptied of their remaining pollen-grains, so that the transference of pollen from one plant to the stigmas of the flowers of another is also rendered possible. Observations in the field show, however, that self-fertilisation is the rule, for in experimental grounds where different varieties of wheat are grown in close proximity in parallel rows, no accidental cross-fertilisation due to wind-carried pollen-grains has been noticed.

Artificial cross-fertilisation of wheat or barley is a delicate operation. The parts of the flower are small, and the slender stamens must be removed before the pollen is ripe, while the stigmas must be protected from the access of pollen from outside. The application of the selected pollen to the feathery stigma is best accomplished by applying the ripe grains direct from the anthers to the stigma by gently moving them over its surface. Moreover, this has all to be done in the open field on a flower supported on a long, slender, and easily-moved straw.

The offspring obtained by cross-breeding vary in fertility with the closeness of affinity between the two parents. By fertilisation with pollen from the flower of a similar plant of the same species, or even of a plant with characters distinct and permanent enough to be recognised as a variety, though still of the same species, we obtain offspring producing fertile seeds from generation to generation. When the pollen applied is taken from an allied species of the same genus, perfect seeds can generally be obtained, but the hybrid plant of the next generation is almost always sterile, though the vegetative organs, such as leaf and stem, are often finer. In the case of widely-separated species of a genus the difficulties are greater, and the chances of procuring fertile offspring less; while hybrids between distinct genera are rare. Out of four hundred experiments in fertilisation of plants of the four different genera—wheat, rye, barley, and oats, with pollen from each other, in only two cases were seeds produced. The two seeds, hybrids between rye and wheat, germinated and produced plants intermediate between the parents, but the pollen did not ripen, and consequently the flowers set no seed.

In the case of plants which are not cultivated for the sake of their seed, but merely for the flower as by the nurseryman, or for some portion of the vegetative structure like the sugar-cane or the potato, the absence of seed is no disadvantage, while the increased vigour of the vegetative organs may be an advantage. It is obvious, however, that with cereals we must keep well within the limits which will ensure production of seed; attempts to produce improved forms must be limited to the crossing of individuals of a single species, including its varieties. Since they have been so long under culture and have given rise to so many cultivated varieties, it is not only hard to determine which variety most nearly represents the primitive form, but also with how many species we are dealing. The following seven types of wheat are easily distinguished:—

1. *Triticum monococcum*, L., with one grain in each spikelet, and the innermost scale (or pale) dividing into two when ripe.

2. *T. Spelta*, L. (spelt), with a loose four-sided ear, and grains which do not fall out in threshing.

3. *T. dicoccum*, Schrank, with dense two-sided ears, and grains as in the spelt.

4. *T. vulgare*, Vill., with compact ears, and grains falling when threshed.

5. *T. turgidum*, L., with dense four-sided ears, and short, thick, blunt grains, which fall out in the threshing.

6. *T. durum*, Desf., with dense long-awned ears, and long, narrow, very hard, and flinty grains, which fall when threshed.

7. *T. polonicum*, L., with long compressed ears, long papery glumes, and long narrow grains.

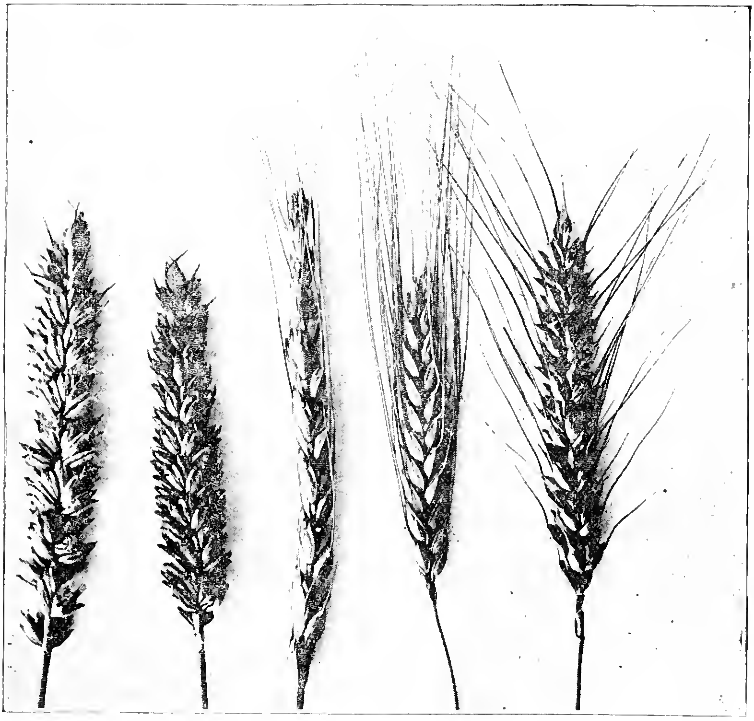
Botanists hold different opinions as to the number of species comprised by these seven types. Blomeyer unites them under one, *T. sativum*, L., while Hackel, the greatest living authority on grasses, thinks *T. monococcum* must be separated as a distinct species. The second view is supported by the fact that fertile hybrids have not been obtained between *T. monococcum* and any of the varieties of *T. sativum*. Hackel considers *T. polonicum* as a species which has, perhaps, arisen under cultivation. Our illustrious countryman Bentham recognised three species, *T. monococcum*, *T. Spelta*, and *T. sativum*, the last being represented by several varieties. Hence, if we wish to obtain improved varieties by means of cross-fertilisation, *T. monococcum* must be tabooed, while *T. polonicum* had also better be avoided.

The ideal wheat for cultivation in Britain should give plenty of straw of good quality, and strong enough to carry the ear till ripe without being laid, should tiller—*i.e.*, produce new shoots from the base—freely and ripen early, yielding a good weight of fine well-filled seeds. "In selecting parents it should be remembered that the male appears to exercise a special influence on the seed, while the female affects the character of the vegetative parts of the plant." In the *Royal Agricultural Society's Journal* for 1889, Mr. Henry Evershed gave an account of experiments on the cross-fertilisation of wheat carried out by Messrs. Carter; the cross-bred seedlings yielded a variety of forms, and careful selection was required to fix permanently the best of these. In his recent paper, Mr. Carruthers describes some results of experiments in cross-breeding, extending over thirty years, made by Messrs. R. & J. Garton, at Newton-le-Willows, Lancashire. These gentlemen have collected numerous varieties from which to select suitable parents, not only from Britain, but from all parts of the world. Parents have been chosen both from the established varieties with which they began and also from the improved ones obtained in the course of their experiments. Whenever a good point in quality or quantity of straw or grain was detected, an endeavour was made to maintain or increase it by using the plant in turn as a parent. Thus the varieties with which they are now working are the products of many previous crosses, and may be termed composite crosses. A serious difficulty exists in the increased tendency to variation with the increase in the number of parents, and careful selection of desirable forms and their continued cultivation is necessary, with persistent elimination of sports and defective plants, before a fixed variety can be established.

Our first figure represents a few of the parents of the new varieties raised by Messrs. Garton. Hardcastle and Mainstay are in general cultivation. The spelt was used in the hope of getting a form which would inherit a seed so enclosed in the glumes as not to fall out during harvesting, while the flinty seeds of the Hard wheat and the abundant cropping of the Grey wheat offered qualities which might be combined with advantage. After several years' crossing, a selection was made of the most hopeful varieties, and these have been under careful cultivation for three years. The second figure represents eleven of these composite crosses grown in 1893, "all of which are the progeny of a selected plant of the harvest of 1890." The remarkable tendency to sport is well shown; it results from the great diversity of ancestors represented in the direct parent, the 1890 plant, and gives some idea of the difficulty experienced in getting a pure and fixed variety. An examination of the individual figures and comparison with the figures in our first illustration will show the effect of the different original parents.

Thus the first figure recalls both Hardcastle and Mainstay, but the ear has more spikelets, each of which contains an increased number of larger grains. The spelt comes out very strongly in Nos. 3, 4, and 5; the last approaches it most nearly, but has larger spikelets more compactly arranged on the main axis. Nos. 3 and 4 contain characters derived from the commonly cultivated varieties. No. 6 is somewhat similar, but branched. In this case the axis of the spikelets, after producing two normal seeds, has, instead of bearing two or three additional flowers as usual, become extraordinarily lengthened, forming a secondary axis which in turn bears smaller spikelets. A similar

FIG. 1.—SOME OF THE VARIETIES USED AS PARENTS.

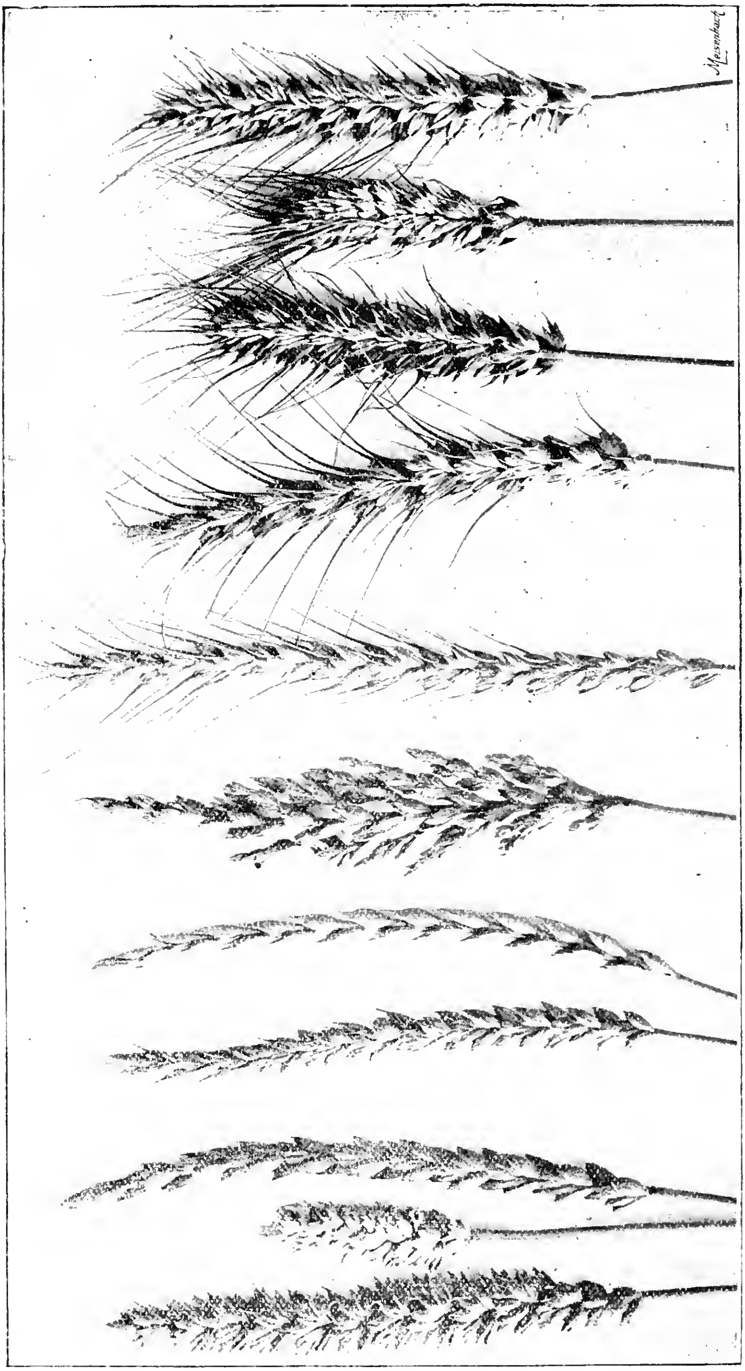


Hardcastle. Mainstay. Spelt. (*T. spelta.*) Hard Wheat. (*T. durum.*) Grey Wheat. (*T. turgidum.*)

Reduced One-half Natural Size.

monstrosity in the Grey wheat has produced the branched variety known as Mummy wheat (*T. decompositum, L.*) In No. 7 the spelt is again in evidence, though influenced by a bearded form. In Nos. 8 and 9 is seen the effect of the Grey wheat, as also in No. 11, which is, however, nearer the selected Bearded wheat.

The different forms of cultivated barleys are probably all varieties of a single species. The spikelets are borne in groups of threes on the opposite sides of the axis, but as a rule only the centre one of each group is perfect and produces seed. The ear is thus two-rowed



1. 2 3. 4. 5. 6. 7. 8. 9. 10. 11.

FIG. 2.—COMPOSITE CROSSES, PROGENY OF THE SAME PARENTS IN THE THIRD YEAR OF CULTIVATION.—*Reduced to Two-fifths Natural Size.*

1. 2. 3. 4.

1.—Bere (Parent). 2 and 3.—Crosses (Progeny). 4.—Two-Rowed Barley (Parent).

FIG. 3.—PARENTS AND CROSS-PROGENY OF BARLEY.
A little less than Natural Size.

(distichous), while the barren spikelets from opposite groups are placed close together along the centre of the flat face of the ear, hiding the axis. This characterises *Hordeum distichum*, *L.*, which includes all the two-rowed forms; the ears may be white or coloured, and the glumes may be adherent or free from the grain. On the other hand, the two lateral spikelets may be fertile and the central barren, giving a four-rowed variety (*H. vulgare*, *L.*). If all three spikelets in each group are perfect, a six-rowed ear results (*H. hexastichum*, *L.*). If we accept the view that these forms, which Linnæus regarded as distinct species, are really merely varieties of one, we see a reason for the ease with which cross-fertilisation has been carried out between them. Messrs. Garton tried to obtain a variety in which all the spikelets should be perfect, while the size and quality of the seed should equal that of the best cultivated two-ranked forms. By crossing a six-ranked with one of the best two-ranked varieties, known as Golden Melon, they succeeded, after further crossing, in getting composite varieties bearing grains equal in size and quality to those of the Golden Melon, but, being six-ranked, three times more numerous (see Fig. 3). Similarly, by the repeated crossing of the three well-marked forms of oats, a considerable quantity of luxuriant new forms have been obtained.

As Mr. Carruthers observes, the important services rendered to agriculture by these gentlemen will be more appreciated when they have secured enough seed of the new varieties to permit of their being grown as farm crops.

For the interesting illustrations which accompany this article we are indebted, through the kindness of Mr. Carruthers, to the Royal Agricultural Society.

A. B. Rendle.

IV.

Neuter Insects and Darwinism.

MR. PLATT BALL (5) does not think that Herbert Spencer's reply (2) to Weismann's argument concerning neuter insects, in the *Contemporary* controversy, is convincing, and he adduces certain new points to which he thinks Spencer's arguments do not apply. I propose to examine again the questions in dispute, and to try to ascertain how much weight is to be attributed to Mr. Ball's contribution to the discussion. I do not propose to take the question of use-inheritance as my chief point, but to consider what are the most logical conclusions we can draw from the facts before us as to the explanation of the phenomena presented by social polymorphic insects, or those in which several forms are produced by one parent. As I have no original knowledge of these insects, I intend to take the facts chiefly as they are accepted and presented by the three disputants above mentioned.

Weismann (1) limits himself to the phenomena presented by ants. He says that it may be taken for granted that the ant workers have arisen through phyletic metamorphosis of fruitful females. What other origin could they have had? he asks. As evidence of this he mentions that to this day there are some species in which the workers closely resemble the females, and that in other cases intermediate forms have frequently been found. This is the most extraordinary assumption with which to begin his argument, for the one thing obvious and certain is that the ant workers have not arisen by the phyletic metamorphosis of fruitful females. The very fact that the workers are sterile precludes this assumption. They are the daughters and sisters of fruitful females, not the offspring of parents possessing their own peculiarities. No animal can be said to have arisen by phyletic metamorphosis from its mother; and as all the ancestors of the neuter ants were fruitful females, it is difficult to see where the phyletic metamorphosis comes in. None of these ancestors have exhibited degrees of modification which lead to the peculiarities seen in the workers.

Whether the natural selection of females which have possessed in different degrees the property of generating workers adapted to their work is the true explanation of the evolution of the workers, that is the question I am about to consider. But to call this hypothetical process the phyletic metamorphosis of fruitful females is simply a misuse of terms. Phyletic metamorphosis means the gradual change occurring in a series of organisms of which each is the offspring of the preceding. The origin of the neuter social insect from the perfect female is immediate and sudden. In fact, it is not what has always been understood as phyletic metamorphosis, but what is commonly and universally known as sexual reproduction.

But the problem is why is the neuter insect different from its mother, instead of being similar to her? Mr. Spencer has given the obvious answer which every biologist might have been supposed to know, namely, that the larva of the neuter insect is underfed, an explanation which is ignored by Weismann throughout his article. There are various instances which support the conclusion that in all cases the peculiarities of the sterile persons are due to the conditions to which the larva is exposed, but the one thoroughly-established fact is that the hive-bees do actually produce perfect queens out of any worker-egg or worker larva taken at random. This is sufficient proof that the difference between a worker and a queen is not a constitutional difference, but a difference due to the conditions of development. Without at present going into the theory of biological determinants, it must be admitted that peculiarities which are hereditary and to be regarded as evolved are predetermined in the egg. The fact above-mentioned concerning the bees, as well as other similar facts to which Spencer alludes, show that the peculiarities of neuter insects are not predetermined in the egg, but related to certain definite conditions of development. They are not, therefore, either inherited or evolved. It may be said that we do not know this for ants, but at least we know nothing to the contrary.

It follows from this that Weismann is not justified in describing the differences between the worker ant and the perfect female as retrogressive and progressive, implying and maintaining that these differences have been gradually evolved. Among the instances of retrogression he refers to are the absence of the receptaculum seminis, and the reduction in the number of egg-tubes, a reduction which appears in different degrees in different species of ant, the persistent tubes numbering 12, 5, 3, 1, or none at all. It is clear that since the larval ant has the inherent potentiality of perfect generative organs, the reduction in the worker is not due to degeneration but to arrested development. It may be maintained that certain qualities in bullocks can be produced by the selection of bulls and cows, not by the appearance of these qualities in themselves, but entirely because they breed the kind of bullocks required. But no one will maintain that the sterility of the bullock is one of the characters that have been so produced. It makes no difference to the argument that in one case the testes are removed by amputation, in the other the ovaries are not fully developed. The cases are similar in the predetermination of the organs in the ovum. Supposing a certain number of young males in a herd of deer were regularly castrated, it could not be said that a caste of stags without antlers had been evolved by natural selection or by phyletic metamorphosis.

Other cases of retrogression mentioned by Weismann are the reduction in the number of facets in the compound eyes and the absence of wings. It is obvious that here again we must hold, until the contrary is proved, that the organs fail to develop in consequence of the insufficient nutrition of the larva, and that the eggs in respect of their potentialities or "determinants" are all alike. It is well-known that in true cases of phyletic degeneration there is in the majority of instances actual retrogression in the course of individual development, as, for example, in the cases of the teeth and hind limbs of whales. No evidence has been produced that anything of the kind occurs in the development of the neuters of the social insects.

A very important factor in the peculiar polymorphism of these insects is the phenomenon of insect metamorphosis. The wings and other important organs of the perfect insect are developed not continuously, but within a certain brief period, *i.e.*, during the pupa stage. There is good reason for the conclusion that the conditions to which the larvæ are exposed effect definite differences in the metamorphosis. It is known that temperature alone produces definite results in the colours of certain lepidoptera, that is to say, the temperature to which the larvæ are artificially exposed. Weismann says that the changes in the thorax of the worker ant are just those which would arise through transmission of the deteriorating effect of disuse, but the workers are sterile. He ignores, what is much more important, that the changes are just those which would arise from incomplete development in the metamorphosis, and the worker larvæ are reared in conditions which are known to lead to such incompleteness in the metamorphosis.

Are we to be told, then, it will be asked, that the workers have always been exactly as they are now; have had their peculiar differences fully expressed since the first moment when the solitary ancestor began to be social? To which I reply that the conditions under which the worker larvæ are reared may have been gradually diverging from the conditions required for the production of the perfect insect, and the constitutional peculiarities of the perfect insect have probably undergone gradual modification, but the differences between the worker and the perfect female have always been the direct result of the differences in the conditions under which the larvæ were reared. There is no reason, so far as minus differences in structure are concerned, to suppose that the females have acquired by variation and selection the constitutional property of producing workers of a certain kind. There is no reason to suppose that in the beginning the eggs of the female ant could not be developed into wingless neuter ants as they are now.

Let us now turn to the alleged progressive development of the workers, and consider whether the argument of the selectionist is any stronger in regard to these. The first instance cited by Weismann is the great increase in the brain. The females, never having had any brains to speak of themselves, are alleged to have acquired, as the result of selection, the property of generating workers with large brains. In the first place, I would point out that I know of no careful comparison between the brains of a newly-emerged worker ant and a newly-emerged queen. It is in accordance with well-established facts to conclude that after emergence the brain of the worker ant grows larger, while that of the perfect female diminishes, simply as a result of use and disuse in the individual. Spencer maintains that apparent gains on the part of the worker are really due to the persistence of organs and characters which have diminished in the fertile insects. I am not prepared to say that these two principles fully explain all the apparent plus modification exhibited by sterile workers; but I do maintain that no sufficient evidence has yet been brought forward to show that constitutional characters are present in the workers which have been evolved in them alone, and are neither due to the action of conditions on the individual development nor to inheritance from the original ancestors.

Weismann lays great emphasis on the enlarged heads and jaws in the so-called soldier caste in certain species, such as *Pheidole megacephala* and *Colobopsis truncata*. But it must be pointed out that the very fact that this character distinguishes a special caste of workers is difficult to reconcile with the explanation upheld by Weismann. For, as Lubbock says, the question arises whether those different kinds of workers are produced from different eggs. Lubbock (3) speaks from special and original knowledge of these insects, and he is disposed to concur with Westwood, that the inhabitants of the nest have the instinct so to modify the circumstances producing this state of imperfection, that some neuters shall exhibit characters at variance with those of the common kind. Considering the established fact concerning bees, it is by no means an extravagant suggestion that where there are two or even more castes of workers, the eggs are all essentially similar, and simply developed under definite differences of conditions. If this is the case, and the presumption is that it is, then there is no evolution of the castes in the sense of the modification of the characters predetermined in the eggs. It must be remembered that in all these polymorphic social insects the larvæ may be said to be artificially developed. The conditions in which the larvæ live are contrived by the full-grown workers, and are kept wonderfully constant. We cannot say, as even Weismann would admit, that the small feet of Chinese ladies are due to phyletic metamorphosis or to Natural Selection. Their growth is moulded and checked by the unyielding influence of material bonds, and we have good reason to suppose that equally rigid external conditions mould the developing larvæ of ants, although Lubbock assures us that the exact mode by which the differences are produced is still entirely unknown.

Into what obvious fallacies Weismann is capable of falling in consequence of his over-zeal for his own views is shown by two cases which I will cite from his first article in the *Contemporary*. To prove that panmixis alone suffices to bring about the complete disappearance of characters, he adduces the degeneration of the feeding instinct in *Polyergus rufescens*, which starves to death unless crammed from the crop of a slave-ant. He states correctly that not only the males and females, but the workers also in this species, have altogether forgotten how to recognise their food. He says that this would be an excellent example of the transmission of functional degeneration—"if only these amazons were not sterile." But, of course, the males and females are not sterile, and Weismann is inadvertently aiming weapons at himself. Another curious fallacy in the same article is the reference to the skin armature of hermit-crabs as one of those passive organs which cannot be strengthened by use, and yet which disappear when they cease to be useful. This case seems so convincing to Weismann that he can only suppose that Spencer ignores it because the philosopher is unacquainted by personal observation with facts so familiar to the naturalist. And yet the wonder really is that Weismann should ignore the fact that the rigid cuticle of crustacea is not merely an armour of defence, but an external skeleton to which the muscles are attached, and which is necessary to their movements. Every naturalist ought to know that in the tail of the hermit-crab the muscles and the cuticle are equally degenerate, have diminished *pari passu*, except certain appendages forming the apparatus at the end of the tail by which the hermit holds on to the shell he inhabits, and in this apparatus both the muscles and the cuticle are well-developed. In this case the weapon so confidently aimed at the despised philosopher bursts in the naturalist's hands, and does more damage to himself than to his adversary.

I have not hither to dealt with the question of habits and instincts. It is confidently held by selectionists like Mr. Platt Ball that the wonderful instincts of the sterile forms of social insects could never have been present in the ancestral perfect insects, and can only be explained by the natural selection of parents which had the power of producing workers that possessed them. Spencer maintains that the instincts are inherited from ancestral perfect insects, in which they were developed by habit and practice. That this is largely true there can be little doubt, when we consider the numerous intermediate cases between solitary females and the most highly-developed communities. What remains, it seems to me, is easily explained as the result of individual education. It is certain that the newly-emerged worker wasp begins making cells and feeding larvæ in imitation of her mother, having no sexual instinct and no males to mate with. The worker wasp inherits much directly from her mother, although not sexual instincts, and learns much by imitation. It is true that

Spencer probably falls into error in deriving the swarming of bees from a nuptial flight, because the nuptial flight takes place separately in a different manner. But it must be remembered that it is the old female which leads out a swarm, and her successor leads out the next, and so on. It is well-known to all experts in bee-keeping, and is stated in the manuals, that the real cause of swarming is simply want of room. The cells are full either of honey or larvæ, and there is not room for any more combs. The workers force the old queen to come with them to find a new home. The story is that they prevent her from destroying the young queens, in order that the old hive may not be left without a queen. But in most that has been written about bees, there is a great deal of teleology and anthropomorphism, which it is impossible to accept without scepticism. The fact is that the workers have one set of instincts, to collect honey, build cells, and rear the progeny of a perfect female. When there is no more room to do this in the cavity they inhabit, they take the female to another cavity. It is practically the custom among skilled apiarians to prevent swarming by simply adding super-hives.

We see, therefore, that although Mr. Spencer's suggestion that swarming is to be regarded as a modification of the nuptial flight leads to difficulties which Mr. Platt Ball rightly holds to be insuperable, it has not been shown that the present condition of the hive bee can only be explained by the natural selection of indefinite variations. The true explanation can only be reached by regarding the structures and habits of bees, not as advantageous, but necessary, that is to say, as the necessary results of conditions. Mr. Ball argues that the special instincts commenced in fertile daughters who helped the queen-mother at the cost of delay or neglect of their own maternal functions, a step towards the formation of a neuter caste. It seems to me impossible to believe anything of the kind. It is much more reasonable to believe with Mr. Spencer that the workers looked after the eggs and larvæ of the perfect female simply because they were themselves sterile. They were sterile through imperfect nutrition in the larval state, and, therefore, having no sexual instincts, but retaining the maternal, they proceeded from hereditary instinct and from imitation to rear their brothers and sisters. No one can deny that it is the queen or perfect female which has been modified rather than the workers, in view of the fact that the pollen-brush on the legs is entirely wanting in the queen bee, though well-developed in the neuter, while in every other species the pollen-brush is present in the perfect female. Are we not entitled to regard this as evidence of the transmission of the effects of disuse? The female bee transmits the pollen-brush to her imperfect descendants in every generation, simply because they remain permanently at an earlier stage of development. No doubt the pollen-brush would be found to be represented as a transitory stage in the development of the queen bee, if the history of her metamorphosis were completely traced.

Anyone who candidly and thoughtfully considers the views I have tried to express will see that Mr. Platt Ball's objections are superficial difficulties due to zeal for the dogma of natural selection. In science everyone should take as his watchword *surtout point de zèle*. It is true we cannot maintain that the honey-pot modification in ants was originally possessed by perfect males and females. But why should we believe that the peculiarity is inherited at all? There is nothing unusual in ants or bees regurgitating honey, feeding one another or larvæ. A differentiation of habits must ensue when a number of neuter insects live together in a community, simply because all the individuals cannot be similarly related to their conditions and their work. Mutual relations are established between them, and those persons which remain in the nest, receive food, and give it back again, may well, when food is plentiful, become distended. The fact that one of these honey ants lives in Mexico and one in Australia shows that the peculiarity has arisen twice independently. It is not yet perfectly certain that the persons with the distended abdomens are a separate caste: every individual may be at times in this condition.

Mr. Ball's statement of the case of the termites turns out to be a characteristic anachronism. Like a good many other faithful adherents of the theory of natural selection, he seems to have neglected to take advantage of sources of information more recent in date than the "Origin of Species." Not having made a special study of polymorphic insects, I found it difficult to obtain original papers containing the results of research on these social neuroptera. I had a strong conviction that when the subject was properly investigated it would be found that the different castes were reared under different conditions. At last I find that, according to Emery (4) the investigation has recently been carried out, with the results which I anticipated. Grassi, an Italian biologist, has satisfied himself and published direct evidence that the termites have the power of regulating the number of workers and soldiers by rearing them at will by appropriate feeding and treatment, as they also hasten the sexual maturity of other individuals by special nourishment, and so produce the supplementary sexual individuals which were so long a mystery. Emery concludes that the workers of all social insects are reared in a similar way from germs which are capable of producing normal sexual individuals.

Mr. Ball's last objection as to the evolution of sterility in neuters is a mere bladder which scarcely needs special pricking. It has been disposed of by the general position taken up by Spencer and myself. The only reasonable view is that the sterility of workers is the necessary result of the habit of the ancestral insect to bestow maternal care on her young. Is it not a fact that in the human species the eldest sister in a large and struggling family has her chance of marriage reduced? The characteristics and the usefulness of old maids in the human species are familiar enough; does anyone suppose that they are the result of the phyletic metamorphosis of fruitful females? Weismann triumphantly adduced the case of neuter insects in social species as an incontrovertible proof that natural selection could do every thing without the possibility of any transmission of somatogenic or so-called "acquired" characters. As in many other instances, the argument is produced by looking at the phenomenon upside down. I believe that some day it will be generally admitted that the whole natural selection doctrine is, in the etymological sense, preposterous. There was a time when it was universally held that the sun moved round the earth. So it does, apparently. It has a motion across the heavens from east to west in relation to a human observer. The belief was true up to a certain point. But Galileo discovered that the earth moved round its own axis. In relation to the whole solar system the sun is fixed—the earth moves. So it is with the evolution of organisms. Assuming the occurrence of the modifications, it may be said from an anthropomorphic point of view that natural selection preserves them. But it is a much deeper truth that evolution is the result of successive modifications or changes in succeeding generations, and the mere survival of these modifications is not the cause of them. Whatever may be the case in other instances, it is clear that the peculiarities of neuter insects as compared with the perfect individuals of their species, are the direct result of the conditions of life. Under similar conditions the eggs all develop into similar individuals; the differences of the individuals correspond to the differences of conditions. The differentiation has doubtless been progressive, because the differentiation of conditions has been progressive. If we start from a solitary perfect female which had developed the habit of bestowing maternal care on her young, the gradual development of the system naturally follows. There is no reason to believe that the arrest of the metamorphosis by insufficient food, etc., has been evolved specially in the social insect. It occurs in the Axolotl, and also in the common tadpole; in the former naturally, in the latter artificially. The social insect is not a community, it is a family. The queen is merely a breeding mother. As soon as she began to feed her larvæ piecemeal, instead of laying an egg in a store of food, it was inevitable that some of them should be inadequately nourished. These by instinct and imitation fed their brothers and sisters, and when food was abundant perfect insects were produced. But the mother having less work to do and more food, became increasingly fertile, so that in subsequent generations more workers were produced, and she had still less work to do. So long as the perfect female started in spring alone without help she continued to perform maternal duties herself. Where she survived the winter with a number of workers, the need for work on her part ceased. As soon as the workers existed the relations of these and the female to the outer world were different. The consequent modifications of the perfect female were transmitted to her descendants. Thus the workers also change, for though the eggs of one female are all alike, the imperfect development of these eggs may well result in a different worker now from that which was produced in previous generations. When the female with some workers survived the winter, her specialisation went much further, for after this she never worked at all. In considering how this change took place in the hive bee, we must remember that this form was originally domesticated in a warmer climate. It is not native to Britain in the wild state. In the case of ants and termites, the continuity of the community could probably be easily explained from their fossorial and constructive habits, which prevent their destruction by the seasons. It has been proved by Lubbock that a single female can originate an ant community, although she probably does not usually do so. The termite king and queen appear to be too much specialised for reproduction to found a community without the help of workers. So far, then, from being a triumphant proof of the all-sufficiency of natural selection, the peculiarities of social polymorphic insects, rightly regarded, offer the strongest support to Lamarckian principles. It may be said that the degeneration of working organs and instincts in the so-called queens, and their increased fertility, were advantages to the species and therefore survived, but it seems to me that it is difficult to avoid the conclusion that these modifications are the direct result of disuse and stimulation, and that they are transmitted.

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V.

Continental Growth and Geological Periods.

IN the early days of Geology a period indicated a certain section of the earth's history distinctly marked off from that which preceded and that which followed. Each period had a fauna and flora peculiar to itself by which it could be recognised through the fossil remains found embedded in its rocks. There is no doubt that the Mosaic account of the Creation gave traditional support to the notion of distinct breaks in the geological chain. Each period represented not unnaturally to early thinkers a separate creation followed by complete destruction. What was first noticed were the salient differences between the fossil contents of strata geologically far apart, such as the reptiles of the Lias and the fishes of the Chalk. Ingenious men found then, as Mr. Gladstone does now, a parallelism in the order of creation between the Mosaic account and the record of the rocks.

When, however, the record was further searched, interesting links were discovered, which, if they did not actually bridge over the differences, led men to think that, could all be restored, the earth's history would be found to be one continuous record unbroken by cataclysmic collapses and successive repairs. Curiously enough, these ideas held their ground in face of the uniformitarian theory of the earth given to the world by Hutton at the close of the last century. Lyell, following on the same lines, with a wealth of illustration and rare literary skill, showed that a true interpretation of nature in the past was to be sought in the action of present causes. The science of geology was thus put on a stable base, and men were taught to arrive at their opinions by reasoning upon facts instead of merely giving free scope to their imaginations. The doctrine of uniformity may not be theoretically correct; indeed, uniformitarianism is a misnomer even as applied to Lyell's conception of the history of the earth. It might with quite as much justice be called development. The popular conception, however, of uniformity was that things are now as they have been in the past and as they will be in the future. From this it resulted that "periods" came to be looked upon only as arbitrary divisions of geological history which enabled one to grasp the sequence of geological events. Indeed, it is but fair to say that there is not in the whole of Lyell's "Principles," for which no one has a profounder regard than myself, any indication of how the distinctive geological and physical features of the several periods came about, or, indeed, why they should exist at all. As a student of Lyell from my earliest dabblings in geology, this was long a perfect mystery to me. In putting forward the following suggestions as to how the periods were evolved, I do so with all humility, looking upon them as a development of the great master's work.

Sedimentation and Land Making.

It is a well-known axiom in geology that the land is being lowered at an average rate of about 1 foot in 4,000 years by meteoric action, by rain and rivers, or all those chemical and mechanical forces that come under the general term subaërial denudation. To this is to be added the mechanical abrasion of coasts. The matter carried into the ocean in solution in river waters is, I have shown on the average of many years, about one-third that in suspension. This seems at first blush a large proportion, but when we consider that the matter in solution is a much more constant quantity than the matter in suspension, our surprise is modified.

The sedimentary matter—which is chiefly silica either in the form of grains of sand, or in a much finer state of comminution, as flour of rock mixed with the decomposition products of various rocks, notably felspathic, forming what, when deposited, we call clay—is laid down in a more restricted area than the matter in solution. Mixed with these products of denudation are calcareous particles, mica and other minerals, which all go to make up one or other of the various sedimentary strata. These are, as a whole, often looked upon as the effects of mechanical erosion, but, so far as this is an expression of dynamic action, they are only partially so. Chemical forces have, in my opinion, much more to do with loosening the bonds of the rocky particles than has mere pounding of the boulders along shores and river-beds; they also effect the separation of the rock-masses. To be impressed with this fact one has only to look at some of the enormous masses of rock in mountain districts in Wales, moved to their present positions during the last phase of the Ice-age. Although they have been exposed to nothing more than meteorological influences since, they are frequently split up into many separate blocks and are much weathered. Likewise, in granitic districts enormous masses of granitic sand are, as we may say, liberated by the decomposition of granite.

To these sediments must be added boulders and pebbles which go to form conglomerates. These are, however, seldom delivered into the ocean by large rivers. They remain in the higher reaches or mountain tributaries, so that the boulder-beds found in the sea are either the products of coast erosion, the dynamic undermining of cliffs by wave action assisted by meteorological influences, or are formed by mountain torrents with swift gradients, or are carried by glacial agency or by floating ice.

These mechanical products of denudation are sifted out and arranged by the ocean waves, tides and currents, in the order of their sizes and specific gravities, so that the boulder-beds are mostly beach deposits, while the pebbles, gravel, grains of sand, and finely-triturated material are carried out further and further from the coast and into deeper water in the inverse order of the size of the particles.

It is well known that the thickest deposits accumulate nearest to the land-masses; I do not indeed think that any fixed line or margin can be drawn, within which limit deposits may be considered terrigenous and outside oceanic, but it is a general principle to be kept in mind. When coast waters are shallow and what is called the continental sub-aqueous plateau extends far out from land, then these mechanical sediments will under ordinary circumstances extend the furthest.[1] But in the extremely interesting "Reports on the Dredging operations off the west coast of Central America to the Galapagos, to the west coast of Mexico and the Gulf of California,"[2] by the U.S. Fish Commission steamer "Albatross," Alex. Agassiz says, "I was struck while trawling on our second line between the Galapagos and Acapulco to observe the great distance from shore to which true terrigenous deposits were carried. There was not a station there occupied of which the bottom could be characterised as strictly oceanic." . . . . "A very fine mud was the characteristic bottom we brought up, often very sticky, and enough of it usually remained on the trawl even when coming up from depths of over 2,000 fathoms materially to interfere with the assorting of the specimens contained in our trawls"; along with the mud, logs, branches of trees, twigs, and decayed vegetable matter usually came up. The distance of the Galapagos Islands from the nearest land in South America is between 500 and 600 geographical miles, while the line between Acapulco and the Galapagos is about 1,100 miles.

The 2,000-fathom line often comes within 100 miles of the coast. Doubtless opposite to the mouths of great rivers, such as the Amazons and the Congo, terrigenous deposits will have a wide extension over the ocean floor. The Indus and Ganges spread their deposits over 700,000 and 900,000 square miles respectively. ("Conditions of Sedimentary Deposition," p. 500.)

There is, however, no doubt that the matters in solution have a much wider extension, only limited, in fact, by the area of the ocean itself. These matters are removed from the water mostly by organic agencies and consist, in the largest proportion, of carbonates and sulphates of lime. Whether any direct precipitation of the matters in solution takes place in the ocean bottom is a subject of surmise, but

[1] *See* "Conditions of Sedimentary Deposition," by Bailey Willis, *Journal of Geology*, vol. i., no. 5, p. 498.

[2] Bulletin of the Museum of Comparative Zoology at Harvard College, vol. xxiii., 1892.

there are grounds for believing that they may be chemically deposited as well as organically separated.

Orographic Relation between Mountain Ranges and New Land-areas.

Leaving for future consideration the regional variations of level which occur in the earth's crust like slow pulsations, and which do not appear to be directly connected with sedimentation, we will briefly examine the evidence pointing to the relation between mountain ranges and new land areas. It is a pretty-well-established fact due to the labours of Hall, Le Conte, Dana, and numerous other investigators, that mountain ranges are built up out of great thicknesses of sediment. Upon this phenomenon is based my theory of the origin of mountain ranges by sedimentary loading and cumulative recurrent expansion.[3] The evidence that mountain ranges are composed of great thicknesses of sedimentary rocks, often with very little unconformity between the rock-groups of which they are built up, is an open book to anyone who takes the trouble to carefully examine the sections, maps, and descriptions of any of the known mountain areas in any part of the globe. It is true of the Rocky Mountains, the Andes, the Himalayas, the Alps, the Caucasians, the mountains of the Turco-Persian frontier as also of the older chains such as the Appalachians and Urals, which have been greatly denuded. It will no doubt turn out to be equally true of the Thian Shan and the great ranges of Central Asia bordering Chinese territory; but these have been so far very little studied.

An examination of the excellent geological map of the world recording all the information up to date, which the labours of Jules Marcou have given us, will show that the rocks comprising the newer mountain chains, which are generally considered to have been upheaved in Tertiary times, have a wide extension beyond the limits of the main mountain-masses. Roughly speaking, the Cretaceous and Tertiary may be said to occupy the half of Europe and a large area of Northern Africa, together, doubtless, with the bed of the Mediterranean Sea. It is just where these rock-groups are most developed and underlaid by more or less conformable Mesozoic groups of great thickness that the mountain-masses occur. This is true even of the Apuan Alps as shown in Stefani's excellent sections.[4] These rock groups appear to extend from the Caspian to the Himalayas, but further eastward we get largely into the unknown.

In North America, though we have not such full information as in Europe, the Cretaceous appears to occupy, or did occupy (having been

[3] "Origin of Mountain Ranges"; London, 1886.—*Also see* Outline of Mr. Mellard Reade's "Theory of the Origin of Mountain Ranges," *Phil. Mag.*, 1891, pp. 485–496.

[4] "Le Pieghe dello Alpi Apuane, contribuzione egli studi sull' origine delle Montagne." Firenze: 1889.

denuded from large areas), about half of the continent, and the same may be said of South America, though in both continents large areas remain to be geologically mapped. It must be understood that I am merely speaking in the rough, to convey the idea I wish to impress upon those who read this, and subject to future correction.

Though there are fresh-water and fluviatile deposits among these rock-groups, especially in the Tertiary, the greater bulk are of marine or estuarine origin. There are also great tabular masses of igneous rocks[5] especially in North America, and volcanic action has over all the areas named played a prominent part from the Tertiary until recent times.

Although there is such a development of Cretaceous and Tertiary rocks on the land areas, there is no doubt a great deal, we cannot say how much, below the sea. The West Indian Islands give evidences in their fauna of a former land-connection with South America,[6] and it may be that the whole area of the Gulf of Mexico and the Carribean Sea is occupied by the same deposits overlaid by great thicknesses of post-Tertiary accumulations. There is little doubt that much of the sea-bed of the Behring Sea and the Aleutian Islands, together with a strip of the sea-bed (none can say how wide) along the western coast of North America, was land in Pleistocene times, as proved by the discovery of mammoth remains on Pribilof Islands and the N.W. coast of America,[7] as also on Santa Rosa, one of the largest of the coast islands of California[8]; and it is not improbable that Cretaceous and Tertiary rocks may occupy much of this area also.

Without traversing the whole of the known globe and making incursions into the China Seas, Malayan Archipelago, New Guinea, New Caledonia, Australia, and New Zealand, it may be well to mention that Tertiary rocks are found far to the north on the land bordering the Arctic Seas.

It is in these Tertiary areas that the greatest mountain chains of the world are situated, and it is further conceded by most geologists that they are the highest because they are the newest and have not

[5] *See* "Report on the Geology of the High Plateaus of Utah," 1880, U.S. Geographical and Geological Survey of the Rocky Mountain Region, by Captain C. E. Dutton; *also*, "A Geological Reconnaissance in Southern Oregon," by Israel Russell. 4th Annual Rept. of the U.S. Geol. Survey.

[6] *See* letter No. 3 by Alex. Agassiz to C. P. Patterson, on the Dredging Operations of the U.S. Steamer "Blake" from 1878–9. *Bull. Museum of Comparative Zoology*, Harvard College, p. 299.

[7] Dr. Geo. Dawson, *Q.J.G.S.*, vol. l., pp. 1–9, 1894.

[8] "The Flora of the Coast Islands of California in Relation to Recent Changes of Physical Geology," J. Le Conte, Bulletin viii., California Academy of Sciences, pp. 515–520. Extraordinary fluctuations of level are also recorded in the successive sea cliffs up to 1,200 feet above sea level in the island of San Clemente off the coast of Southern California in Pleistocene times. *See* "Post-Pliocene Diastrophism of the Coast of Southern California," by A. C. Lawson, Bulletin of the Department of Geology, University of California, 1893.

been exposed to such long-continued denudation as the Appalachians and Urals, for instance.[9]

Establishment of New Land-areas Connected with Mountain Upheaval.

It is evident from the foregoing considerations that the establishment of new land-areas, whether as continental additions or otherwise, is closely connected with mountain upheaval: the two go together. As I have shown, mountain ranges are never formed on the sites of old denuded land-areas, they never arise in the middle of a continent, but are always preceded by great sedimentation. An old continent may subside in the middle or at the margin, and the inland seas or other submerged areas receiving the sediment may in process of time be upheaved vertically and folded horizontally by lateral pressure, and so become eventually an integral portion of the old land. In my "Origin of Mountain Ranges" I have sought to show that this movement is due to expansion, the initial cause being the heating of the sediments and undercrust by the rise of the isogeotherms or surfaces of equal temperature brought about by the accumulation of sediment. It is unnecessary to explain this principle here, as it can be studied in the original work, but I am pleased to point out that Mr. W. J. McGee adopts this theory in his "Memoir on the Pleistocene History of North-East Iowa" (eleventh annual report of U.S. Geol. Survey, 1889-90, pp. 351) with the suggestive addition, since that the sediments rest on inclined surfaces and are themselves inclined, the movement of expansion must have taken the line of least resistance, and the expanding strata must have moved seawards.[10] Sedimentation, land-making, and mountain building, we have every reason to believe, are directly related in the chain of cause and effect.

[9] "Contributions to the Study of Volcanoes," Judd, *Geol. Mag.*, 1875, pp. 143–152. "The Geological History of some of the Mountain Chains and Groups of Europe," Ramsay, *Mining Journ.*, 1875.

[10] Mr. McGee says:—"The sediments of the successive mantles wrapped about the young continent were dropped from the cold waters of deep ocean, and were long chilled by contact with the waters; yet by the end of the Silurian they were so deeply buried as to no longer feel the chill waters, and to be heated by conduction from the earth's interior; and so the isogeotherms, or planes of equal temperature, ose from the former ocean floor into and through the lower sediments, and their temperature was greatly increased. As they were heated they expanded; a part of this expansion was vertical, and so peripheral portions of the continent were elevated, not by the building up of successive sheets of sediment, but by their own expansion; yet a considerable part of the expansion must have been horizontal, and must have resulted in either mass or particle movement, or both combined; and since the sheets of sediment rested on inclined surfaces and were themselves inclined, the movement of expansion must have taken the line of least resistance, and the expanding strata must have crept seaward, while the strata at some distance from the shore line must have been compressed horizontally, perhaps buckled and crumpled, and thrown into anticlinal and synclinal folds concentric with the shore, or elsewhere crushed and broken into fragments along the planes of least strength."

Stability of Conditions Indicated by the Accumulation of Great Thicknesses of Sediment over certain Areas.

The accumulation of great thicknesses of sediments extending over millions of square miles, such as took place in Cretaceous and Tertiary times over what is now the western half of the North American Continent, points to an extraordinary constancy of conditions over a vast period of time. Greater than this, perhaps, is the record of the earth's history within the Appalachian chain at an earlier period ending with the close of the Palæozoic. We will, however, for the nonce, confine ourselves to the first-named area, in which are situated the Rockies, the Cascades and Coast Ranges, extending with their analogues through 60 degrees of latitude from Central America to Alaska. It is next to impossible with our present lack of information, though the geology of the North American continent has progressed with rapid strides, to sketch out the disposition of land and sea which endured through the Cretaceous and Tertiary.

It is highly probable, however, that the old Laurentian areas of Canada and the eastward areas of the United States, with other land stretching into the Atlantic, provided at least part of the sediment. It is pointed out that the deposition of sediment, leaving out of account matters in solution, takes place over a smaller area than that of the land from which it is derived. This would seem to indicate that though general conditions of stability of land-areas obtained, fluctuations of distribution occurred throughout the history of these periods in North America. Land to the westward, an extension of the Asiatic continent eastward, may very likely have sent important contributions towards the making of the future land. But, as I have said, these are speculations which, if we had all the complicated facts before us instead of buried beneath the sea, might not yield satisfactorily to imaginative reconstruction, much less to minds in the position that ours are now.

It is highly probable that many fluctuations of level occurred, and that sediments were raised above the level of the sea and again redistributed. Still, on the whole the locus was the same, and so in time the sea-bed got built up, until the internal forces of the earth, reacting upon this varied sedimentary load, began their rôle of mountain- and land-building, and the establishment of the western area of the North American continent.

In like manner, we might trace the growth of the European continent as it now exists, together with that of a large part of Asia, where the record of the rocks tells the tale of long-continued periods of sedimentation, culminating in the upheaval of the Alps, the Caucasians, the ranges of Turco-Persia, and the Himalayas.

The story might be extended to South America and Australasia, but for the purpose of illustration the two examples given are sufficient.

The later rocks of the series more or less represent land conditions consisting of lacustrine and fluviatile deposits, showing that the establishment of these land-areas dates from a very early time.

The history of these Cretaceous and Tertiary areas is one of both maturity and decay. They are in some portion of the latter stage now, and eventually will probably give place to new land-areas formed out of rocks now being constructed in the sea-beds from their own dissolution.

Lithologic Characteristics and Differences of the Rock-groups of some of the Great Periods.

It is a remarkable fact, but no less true, that there are not only palæontological homologies running through the rocks of the Tertiary group over the known world, but lithological analogies also. There are diversities truly, but similarities also. Though conditions are recurrent through the ages, as pointed out so strongly by the late Sir Andrew Ramsay, it is recurrence with a difference. There has been lithological evolution as well as organic.

When we go further back in the world's history and consider the rocks constituting the Carboniferous formation, the persistence of characteristics over large areas of the earth's surface is most striking. The repetition of coals, sandstones, and shales in the Carboniferous of the North-American Continent and in that of Great Britain seems almost to point to a common origin. They repose upon great limestone formations, indicating deep-sea conditions. The coal formations in both countries indicate, according to all reliable observers, a gradual sinking of the earth's crust and simultaneous building up of the land by sediments of sand and mud, so that successive terrestrial growths and land-surfaces are marked by each bed of coal, excepting indeed in those cases that may arise from floating vegetation gradually getting water-logged and sinking onto an estuarine floor. These long-prevailing conditions are represented by thousands of feet of rocks. It is evident from the lithological resemblances, the occurrence of minerals in the same form and from similar orders of succession, that the physiographic conditions producing them were of world-wide extent and vast continuance. The character of the flora was the same in the arctic as in the temperate regions, and doubtless the maintenance of similar geographic conditions was one element in this result.

If, again, we cast our eye over the description of the Trias of Great Britain and that of the United States, the same characteristics occur in both. They are not at all like the Carboniferous, which they succeed through the Permian phase; yet, though the broad Atlantic now divides them, they indicate like physiographical conditions—strange to say, they are even of the same colour, deep red and grey, and the characteristic fossils are footprints of reptiles. Red sandstone, red and grey marls, and beds of salt predominate. Gypsum is a characteristic mineral. There is strong evidence of inland salt lakes, lagoons, and tidal shores.

It is often said, and with great force, that it is impossible to determine the age of a rock or the formation to which it belongs by its lithology. That is true, looking at the rocks separately and individually, for the same individual conditions occur in all the ages, but notwithstanding this there are broad lithological resemblances or groupings, what is called *facies* when applied to the organic remains. There are coal beds in the Western States of North America, but no one would mistake the Laramie or Tertiary rocks of those countries for Carboniferous any more than the Oolite rocks in Scotland, in which coal is found, could be mistaken for the Coal-measures; nor yet the Lias, though ironstone is found and worked to a large extent in the Cleveland district of Yorkshire. There may be land and sea conditions and deep-sea conditions represented in the rocks of any age, but independently of the fossils there are characteristic rock-groups which distinguish the one period from the other.

Even so superficial a stratum as the Drift has common characteristics over Britain, Europe, Asia, and North America, a fact which does not merely point towards analogous climatic conditions but towards similar physiographic conditions on a large scale. Indeed some geologists think the Glacial period resulted from the physiographic conditions which then obtained. Then again, to come towards historic time, the post-Glacial deposits that fringe our coasts, the estuarine clays and forest-beds have a striking resemblance over very large areas, and even continents. Indeed, so important seemed these characteristic similarities and differences to our predecessors in the science of Geology, that they constructed, wiped out, and reconstructed the earth's surface and crust again and again by the aid of cataclysmic convulsions. The influence of Lyell was all towards showing the fallacy of these inferences, but then the pendulum swung too much the other way, and we were led to dwell inordinately on continuity and recurrence.

The uniformitarian theory was a great boon in bringing men's minds down from the region of pure imagination to that of fact. It was a good working hypothesis, but, like most generalisations, was a little one-sided. It represented too exclusively one side of the phenomena of the earth's history to the neglect of another—that of development. I am not one of those who think the doctrine of uniformity a "fetish," but rather a theory that kept us within the range of practical fact. For my part, I am prepared to accept anything that can be *proved*, but until the proof is forthcoming we are on safe ground if we confine ourselves to agencies of which we have experience.

T. Mellard Reade.

(*To be continued.*)

SOME NEW BOOKS.

DISCOVERY OF LAKES RUDOLF AND STEFANIE, a narrative of Count Samuel Teleki's exploring and hunting expedition in Eastern Equatorial Africa in 1887 and 1888. By his companion Lieut. Ludwig von Höhnel. Translated by Nancy Bell (N. d'Anvers). 2 vols. London: Longmans, 1894. Price 42s.

THE lately issued English translation of Ritter v. Höhnel's narrative of the discovery of Lakes Rudolf and Stefanie has brought this most interesting expedition before the notice of the British public, and gives us an opportunity of taking stock of the principal results arrived at. It will be obvious to any one who reads the volume, or who knows anything of the history of the business, that Count Teleki's main object in starting it was "sport"—that is, the killing and slaying of the larger mammals. The hunting passion is still so prevalent, even among the most highly-civilised races of mankind, that parties of American, German, Austrian, Italian, and, above all, British sportsmen are every year engaged in hewing their way into the still untraversed interior of the Ethiopian Continent in order to shoot the elephant, the giraffe, the rhinoceros, and specimens of the hundred species of antelopes by which it is so abundantly tenanted. To give some idea of the exuberance of mammal life in Africa as soon as the ordinary tracks are left, we have only to turn to the writings of any of the latest explorers. Vice-Consul Sharpe, speaking of a recent journey to Lake Mweru (*Geogr. Journ.*, vol. i., p. 524) says, "I doubt if game can, anywhere in Central Africa, be more plentiful than in the Mweru and Luapula countries, though there may be districts which have a greater variety. *Cobus vardoni* and *C. lechee* run in enormous herds. Buffaloes and zebras are also there in vast quantities." Captain Swayne gives a similar account of the abundance of larger animals in the interior of Somali-land, which he has lately visited.

In the present instance, however, unlike some of his brother shooters, Count Teleki was not wholly devoted to sport. He had the good sense to take with him Ludwig, Ritter von Höhnel, a lieutenant in the Austrian navy, whose acknowledged abilities have converted what was planned primarily as a sporting excursion into a scientific expedition of first-rate importance, it having resulted in the discovery of two new large African lakes previously only known in Europe from vague rumours.

Count Teleki and Lieutenant von Höhnel started from Zanzibar with a full equipment, including, among other articles, a large canvas boat, in February, 1887. Landing at Pangani, in German territory, they made the best of their way to Taveta, the "hunter's paradise" as it has been termed, at the foot of Mount Kilima-njaro. Hence, a slight *détour* to Kilima-njaro and the adjoining smaller volcanic crater of Meru was successfully carried out. The summit of Kilima-njaro was not quite attained, but Count Teleki reached a (calculated) height of 17,387 feet, and a collection of the highest-growing plants was made.

On July 15 the expedition finally left Taveta on its way north, passing round the eastern slopes of Kilima-njaro, and thence taking nearly the same route through Masai-land as that traversed by Mr. Joseph Thomson in the Royal Geographical Society's East African Expedition of 1883-4. In Kikuyu-land, where much difficulty was experienced with the natives, the party diverged to the right, and in the beginning of October reached Ndoro, at the eastern base of Mount Kenia, where they were glad to have a short respite from their laborious journey. The tents here were pitched facing Mount Kenia, so that the travellers might look at its snowy summit whenever the canopy of clouds which generally shrouds it from mortal eyes was lifted. The western side of Mount Kenia is so steep that snow can only remain on it here and there, and it is therefore termed by the Masai the "Oldonyo egeré," or "spotted mountain." From this station Count Teleki attempted an ascent of Mount Kenia. This mountain is surrounded by a belt of dense forest, through which the explorer and his men had to cut their way. At a height of about 10,100 feet the bamboo thicket was left behind; 500 feet higher the trees became much less numerous, and beyond that height only a few isolated specimens occurred. As on Kilima-njaro so on Mount Kenia, the characteristic tree is a gigantic Groundsel, allied to, but not identical with, *Senecio Johnstoni*, discovered by Mr. H. H. Johnston on the former mountain.[1] When, however, the English translator tells us that a "humming-bird was found on Kilima-njaro at a height of 13,100 feet," we are compelled to refer to the German original for an explanation, and find, as we had anticipated, that the bird in question was not a Humming-bird but a Sun-bird (*Nectarinia*), and probably *N. johnstoni*, a specimen of which has lately been brought back from Mount Kenia by Dr. J. W. Gregory. At the height of about 15,000 feet Count Teleki had a good view of the crater of Kenia, which he calculated to be from 1,000 to 1,200 feet in circumference. The bottom of the crater lay some 600 feet lower than the rim, covered with snow and ice. Count Teleki made the excursion to Kenia alone, his companion being left at Ndoro to recover his health, which had suffered much from the journey.

On November 4, after a month's stay at Ndoro, v. Höhnel's health was re-established, and he left to join Count Teleki, who had advanced a little for shooting purposes. Proceeding north-west over the spurs of the Aberdare Range, which lay to their left, at an elevation of about 7,000 feet above the sea-level, the united party crossed the Equator on November 9, and found themselves in a district inhabited by numerous bands of Masai, with whom, however, they managed to keep on good terms. Proceeding a little further, it was determined that Count Teleki should go direct to Lake Baringo with the main body of the caravan, while v. Höhnel should make a diversion eastwards, through Leikipia, as this high steppe is called, and follow up the river Guaso Nyiro, which flows to the north after rising from Mount Kenia and the Aberdare Range. Von Höhnel pursued the course of this hitherto unexplored stream for several days, when he was compelled by bad health to turn back and rejoin his companion at what Mr. Joseph Thomson calls "the pleasant resting place" of Nyemps situated near the south end of Lake Baringo. Here a prolonged stay of two months was made, during which period various

[1] Mr. E. G. Baker kindly informs me that the Senecio of Kenia is new, and will shortly be published as *S. Keniensis*. There are, therefore, now known four of these curious arborescent groundsels of the African mountains—namely, *S gigas*, from Abyssinia, *S. Manni*, from the Cameroons, and the two above mentioned.

sporting excursions were carried out by the Count, while von Höhnel was again brought nearly to death's door by fever and dysentery.

We now come to the adventures detailed in the second volume of the English translation, which are of greater interest, as relating to a country previously unexplored. The new lakes lying north of Baringo had been heard of by Joseph Thomson, and are conjecturally represented in the route-map of his East African expedition. A bold push was also made towards them by Messrs. Jackson and Gedge during their journey to Uganda through Masai-land in 1889-90, subsequent to Count Teleki's expedition. But these explorers were turned back by the natives in the plains of Ngaboto, in consequence, as they believe, of the bad behaviour of some members of Count Teleki's party so that, in fact, Count Teleki and Lieutenant v. Höhnel are the only Europeans that have, as yet, visited Lakes Rudolf and Stefanie.

After their halt at Lake Baringo the party finally left for the north in the beginning of February, 1888, and soon found themselves in difficulties from want of water. They would have been also miserably short of provisions had it not been for the successful shooting by Count Teleki. Quantities of game, chiefly buffaloes and rhinoceroses, were met with on the plateau now crossed, which was bordered on the east by a new chain of mountains—named General Matthews' range, after the well-known premier of Zanzibar. After about fifty miles transit over the waterless steppe, a half-dried-up swamp was found at the base of Mount Nyiro containing "a little thick, green, slimy fluid" with which the travellers were at last able to wet their lips. Here also the first natives of the Samburu district were met with. They are a pastoral race, called Burkeneji, closely related to the Masai in genealogy and language. According to their information the two much-looked-for lakes were not far off to the north. A few days later, accordingly, the party arrived within view of the southern end of Lake Rudolf. Before them lay a district entirely covered with black streams of lava and dotted over with extinct craters, while from one conical mountain (afterwards named the Teleki volcano) ceaseless clouds of smoke arose. Almost at their last gasp, the travellers rushed on down to the water which lay before them clear as crystal, but to their bitter disappointment when they reached it found it to be saline. Nevertheless, it afforded them a refreshing bath, and upon treatment with tartaric acid was sufficiently improved to quench their thirst. Proceeding onwards from March 6 for nearly a month, the travellers pursued their route northwards along the eastern shores of Lake Rudolf through a miserable and thirsty country. The large "Crater-Island" in the lake which they passed presented an extraordinary appearance, being made up of a series of apparently extinct volcanoes, some of which rose to a height of 400 feet. Further north, fortunately, the country improved a little, and sufficient game was obtained to support the lives of the party, while the discovery of a small stream of fresh water flowing from Mount Kulall, apparently an extinct volcano of about 4,000 feet in altitude, materially improved their position. Further on, hippopotami and elephants were found, while the shore was haunted by immense numbers of lake-loving birds. At length, after fifty-four days' wandering in an all but uninhabited land, nearly bare of fresh water and vegetation, the travellers found themselves among the Reshiat, a pastoral race of Gallas that inhabit the northern shores of Lake Rudolf. Beyond them stretched a flat tract of country overgrown by impenetrable forest, from which a five-peaked mountain-mass (Nakuà) and other heights rose in the distance. On the whole, the month's stay among the Reshiat was a peaceful one, and the travellers had every reason to be satisfied with their reception, although their plans for returning southwards on the other side of the lake were not approved of and could not ultimately be carried out. They managed, however, to effect a successful reconnaissance of Lake Stefanie, a much smaller sheet of water, about 70 miles long and from 13 to 15 broad, which lies to the east of the northern end of Lake Rudolf. Like Lake Rudolf, Lake Stefanie is brackish, and has apparently no exit; its altitude was calculated at 1,740 feet, about 440 feet above that of Lake Rudolf. There are said to be two villages belonging to one of the Galla tribes near the northern shore of Lake Stefanie, where a small stream runs into it, but the adjoining district is almost uninhabited.

After a month's stay among the Reshiat, Count Teleki and his followers turned homewards, pursuing the same track along the eastern shore of Lake Rudolf, but then diverging westwards through the districts of Turkana and Suk, to their former quarters on Lake Baringo. In their return hence to the coast we need not follow them; it will suffice to say that they reached Mombasa on the morning of October 24, 1888, after about twenty-one months' absence.

The scientific results of Count Teleki's expedition have been by no means inconsiderable. The geographical and ethnological information amassed has been worked up by v. Höhnel, and published in a special part of *Petermanns Mittheilungen*, while the Geological observations have appeared in the *Denkschriften* of the Imperial Academy of Sciences of Vienna. The Zoological and Botanical collections have been entrusted to various specialists, and memoirs upon them have appeared in the *Sitzungsberichte* of the same Academy. More than a thousand specimens of Coleoptera were collected by v. Höhnel during the journey, and are referred to 247 species, among which nearly one-fourth are found to be new to science. Dr. Schweinfurth, of Berlin, a well-known authority on African Botany, undertook the flowering plants, among which we see registered *Senecio serra*, "the most elevated flowering-plant on Kilima-njaro, growing at a height of 16,278 feet, between volcanic ashes and rocks"; a curious new *Lobelia* (*L. Telekii*) from the western slope of Kenia, and a new form of Compositæ (*Höhnelia*) from Ndoro.

Of the mammals met with during the expedition, no account seems to be given except Count Teleki's "game list," and certain incidental remarks in the narrative, upon some of which a few comments may be added. The supposed new rhinoceros found on Lake Rudolf is not very clearly described. Its chief peculiarity is its "small head" and diminutive size, being one-third less than that of the ordinary *R. bicornis*. On the other hand, the horns are "finer and more pointed" and much more flattened. The dimensions of the horns are not given, nor is it stated whether specimens of them were brought home. The occurrence of Grévy's Zebra (*Equus grevyi*) on the shores of Lake Rudolf is a fact of much interest, as it shows that the fauna of the Shoa Highlands descends nearly to this district. Originally described from a living animal sent to Paris by King Menelek, this zebra has recently been obtained by Captain Swayne and other explorers in the interior of Somali-land. But Ritter von Höhnel might as well have given us an original drawing of this zebra, instead of copying (without acknowledgment) the figure of the flat skin published in 1890 in the *Proceedings* of the Zoological Society of London. The "unknown Gazelle" of which the horns are figured (vol. i., p. 256, in the English translation) would appear to be Grant's

Gazelle (*Gazella granti*), which is mentioned by name in other passages of the narrative. The so-called "Kaama" antelope met with in the Baringo district (vol. ii., p. 11), is, no doubt, *Bubalis jacksoni*, lately described by Mr. Oldfield Thomas. The occurrence of Waller's Gazelle (*Lithocranius walleri*) in the vicinity of Lake Rudolf is likewise of much interest, especially the observation that it "so much resembles the giraffe in its long neck and sloping haunches" that the explorers named it the "Giraffe-antelope."

On the whole, the English translation of v. Höhnel's volume is fair enough and reads well. The paper, the printing, and the impressions of the numerous illustrations are certainly superior to those of the German original. But its exactness can by no means be relied upon, and some ridiculous blunders are made as regards the scientific terms. We are, for instance, introduced to "humming-birds" and "tigers" in Africa, the horns of an antelope are called "antlers," and we are told that *Hydnora* belongs to the "Cytinaceæ genus." The proofs of the sheets should have been submitted to someone who had an elementary knowledge of Natural History.

P. L. Sclater.

Man, the Primeval Savage: His Haunts and Relics from the Hill-tops of Bedfordshire to Blackwall. By Worthington G. Smith, F.A.I., F.L.S. With two hundred and forty-two illustrations by the author. 8vo. Pp. xvi., 350. London: Stanford, 1894. Price 10s. 6d.

Mr. Worthington Smith has done yeoman's service for the elucidation of the history of primitive man in this country, and he has now made us still further his debtors by collecting together his contributions to various journals, and filling in the details of those discoveries which he has from time to time brought briefly to our notice.

The first part of the book contains an account of the lake-side dwelling of man, with his weapons of stone, found at Caddington, near Dunstable, of which the first description was contributed by Mr. Smith to Natural Science for November, 1892. The latter part describes some of the relics of primitive man as found on the banks of the Lea, from its source near Dunstable, in Bedfordshire, to London; together with a description of a primeval living place, or Palæolithic floor, at Stoke Newington, London, of which, it will be remembered, the first notice appeared some years ago in *Nature*.

But the book is by no means a mere reprint; the majority of it is entirely new and rewritten; the facts remain, added to and supplemented by Mr. Smith's later discoveries and re-examinations.

By "primeval savages," Mr. Smith means Palæolithic men—the men who designed, made, and used the most ancient of all stone weapons and tools recognised as such by antiquaries and anthropologists. Our knowledge of the primeval savage and his mode of life is at present little better than a shadow. But his weapons are common and well-known, and from these weapons we may gather much that is instructive of the men who formed and used them. The author believes that "man did not live in what is now Britain before what is known as the last great Glacial period."

In his introductory chapter, Mr. Worthington Smith gives a sketch of the more important osseous remains of primitive men yet discovered, and furnishes illustrations of the Neanderthal, Canstadt, Spy, Engis, Cro-Magnon, Grenelle, Furfooz, and Truchère skulls and crania, comparing them with those of present-day

Melanesians and Chimpanzees, and showing the great physical and mental gulf between man and any living member of the anthropoid apes. Of course such material as we possess is quite insufficient to permit of any accurate deductions, and it is only by the patient and careful research of such investigators as Mr. Smith that we can hope to obtain the light necessary to partially solve this important and interesting question. After a brief and vivid, though not particularly pleasing, sketch of the habits and life of our ancestors in their wild state and savage homes, Mr. Smith plunges into the main subject of his work, Caddington.

Caddington, the site of the discovery of an undisturbed living and working place of primeval man, is thirty miles from London, and the excavations, specially made for Mr. Smith, are half a mile west of the village, in so-called brick-earth resting upon chalk-rock, about 600 feet above Ordnance datum. The nature of the deposits and the contour of the country around leads Mr. Smith to the conclusion that in former times the higher ground bordered a lake, or series of large and confluent pools of water.

Chapter IV. treats of the geology of the Caddington position, the nature of the deposits, and of the old Palæolithic floor, with the flints found thereon. Of the flakes found on this floor Mr. Smith has replaced more than 500 on to either other flakes, or more or less perfect implements, or cores, from which they were originally struck off. This proves that the remains left behind by the inhabitants of this part have suffered little or no disturbance since their time.

Chapter V. is devoted to the story of the discovery of implements in the Dunstable district, and the gradual tracking of the gravel which contained them to various pits and excavations, until at last the reward came, and the Caddington gravel pits yielded up their treasures. There are two or more types of implements described by Mr. Smith. The first, or "ochreous" type, which came from the upper brown stony clay, and which are all slightly abraded, and the white, lustrous, and sharp-edged type found on the Palæolithic floor itself. The evidence at hand goes to show that the latter are the more recent of the two sets.

It was in May, 1889, while making an examination of the exposed vertical bank of a clay pit, that Mr. Smith noticed indications of a horizontal streak in the brick-earth, at about six feet from the surface. He had previously suspected the existence of a floor, or working site, from the fact that the sharp and unabraded chips of flint were usually met with in the fallen material. In this streak, he here and there noticed a stone embedded, and at one place saw a small flint half projecting from the face of the excavation. On removing the flake, he found it to be a beautifully made scraper, and saw that it was identical with one he had found two years before in the same locality. More discoveries followed, but it was not until the end of March, 1890, that he established the fact of the finding of a Palæolithic floor or living surface, similar to the one discovered by him several years previously at Stoke Newington.

The succeeding sixty pages of the book are taken up with a description of the flint implements and flakes found on this Palæolithic floor, beautifully illustrated by Mr. Smith's own drawings, and showing the actual implements themselves, as well as the restoration of them to the rough block from which, in many cases, they were made, by the fitting on of chipped fragments found associated with them.

In Chapter X. we have a description of the Caddington position in

Palæolithic times, and in Chapter XI. a discussion as to the age of the implements themselves. Pages 179-306 deal with "Traces of primeval man," and contain a record of discoveries of implements found between Bedfordshire and London, dozens of which are figured and all of which are of Palæolithic age. The rest of Mr. Smith's work treats of Neolithic weapons which have been found from time to time over the same area, together with notes on earthworks, roads, and trackways near Dunstable; early British hut-remains, deneholes, graves, tumuli and skeletons from Dunstable Downs. In the above imperfect sketch we have endeavoured to show the contents of this interesting book, and have not pretended to offer any critical remarks. The book is emphatically one to buy, to read, and to ponder over. From it those interested in the early history of their race will learn much, while the sketch map will enable them to follow the author in his topographical details, and assist them to obtain an excellent idea of the mode and conditions of life of their remote ancestors. Of the illustrations of flint implements we need scarcely speak, suffice it to say that they are Mr. Worthington Smith's, and that the variety and number of them should enable many a tyro to supplement our knowledge of their distribution.

We observe with pleasure, from a circular recently received, that Mr. Smith will conduct an excursion of the Geologists' Association to Caddington on May 26, in order to explain to them the structure of the district and his discoveries. May we be there to see!

Horned Reptiles in Scotland.

On Some New Reptiles from the Elgin Sandstones. By E. T. Newton. *Phil. Trans.*, vol. clxxxiv., B., pp. 431-503, pls. xxvi-xli. (1893).

For some years past, palæontologists have been tantalised with reports of the occurrence of remains of reptiles allied to the Dicynodonts of Africa and India in the Triassic sandstones of Elgin; but with the dilatoriness of most Government departments—whether it be in deciding to build ships or to describe fossils—the Geological Survey of Scotland, to whom the specimens belonged or were confided, maintained a strange reserve on the subject. After a protracted period of patient (or shall we say impatient?) suspense, those interested in the subject have, however, been rewarded with the appearance of a memoir on the remains in question, which leaves little to be desired in point of completeness or in wealth of illustration; and we here beg to offer our congratulations to the Council of the Royal Society in having displayed such a wise liberality to the author in the way of plates.

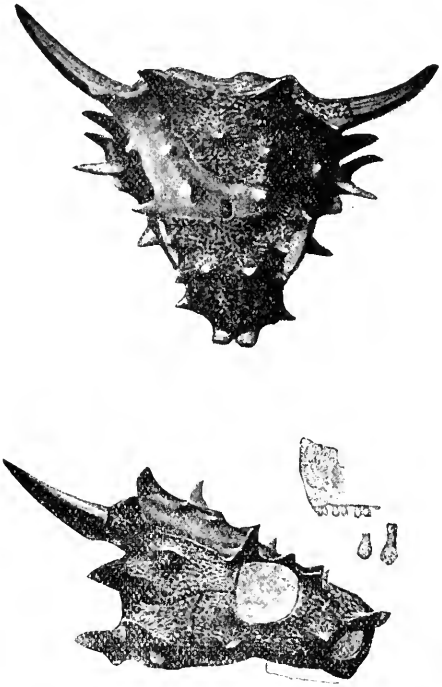
Not only does the memoir before us fully endorse the aforesaid reports as to the occurrence of Anomodont reptiles in the Elgin sandstones, but it likewise shows that these animals were represented by numerous and diversified types, all of which were, however, more or less closely allied to South African forms. Unlike the African representatives of the group, which for the most part occur in the form of well-preserved skulls and limb-bones, the Elgin specimens when placed in the hands of the author of the memoir before us were in the shape of most unpromising impressions. Fortunately, he hit upon the plan of taking gutta-percha casts from these natural moulds, with the result that, after much patient labour, he succeeded in restoring the skulls of these ancient reptiles in a manner which makes their characters fully apparent; and it is from such casts that most of the figures in the memoir have been drawn.

The first remains that the author takes in hand are certain skulls indicating reptiles closely allied to the typical African genus *Dicynodon*, which are referred to several distinct species. He is, however, of opinion that they cannot be included in that genus, and accordingly refers them to a new one, for which the name *Gordonia* is suggested; but we have considerable misgivings whether the features he regards as of generic value are really entitled to such importance. Be this as it may, we cannot help thinking that in giving to each species of this reputed genus the name of a person, the author has paid a poor compliment to him in whose honour the genus itself is named. If a genus founded on a personal name means anything at all, it means that the animals so named are dedicated to the person whose name is thus employed. Accordingly, *Gordonia* will signify Gordon's reptiles; but if we are to have *Gordonia traquairi*, *Gordonia huxleyana*, etc., etc., the system of what we may call personal nomenclature appears, to our thinking, reduced to an absurdity. We are not fond of personal nomenclature at all, but the degree to which it is carried here is certainly excessive, seeing that, out of the nine forms described, seven have such names both generically and specifically; while an eighth has its generic name alone thus compounded.

As the so-called *Gordonia* is closely allied to *Dicynodon*, so the skull described as *Geikia* displays equally close affinities with *Lystrosaurus* (*Ptychognathus*); but if palæontologists are right in keeping, on account of the absence of tusks, *Udenodon* apart from *Dicynodon*, the author will be justified in giving a new name to the tuskless Elgin form. We wish, however, that he would not continue to employ names like *Ptychognathus*, which, on account of preoccupation, are shown to be inadmissible; and he need not have gone out of his way here, and in the case of *Pariasaurus*, to ignore the most elementary principles of classical transliteration, by an adherence to an incorrect way of spelling which has been put right in some of the very works he quotes.

Perhaps the most interesting of all the forms described is the remarkable horned skull designated *Elginia*, two of the figures of which are here reproduced on a greatly reduced scale. After describing the characters of this extraordinary skull, which, it will be observed, has the whole of the temporal region completely roofed over, the author proceeds to discuss its affinities. Here he, unfortunately, displays such a total want of grasp of the relationships of the various recent groups of reptiles as cannot but detract from the value of his deductions. He says, for instance, that "although the Elgin Reptile undoubtedly possesses several important Lacertilian characters, and apparently finds its nearest living allies in that group, yet it presents peculiarities of structure which prevents its being referred to the Lacertilia." Seeing that it has a fixed quadrate, a lower temporal arcade, and pterygoids meeting in the middle line, we perfectly agree with the latter part of this sentence. Imagine, however, our astonishment when, after reading a few lines further, we found that the author actually includes the living New Zealand *Sphenodon* among Lacertilia, although he has separated it from the true Lacertilia. This is about as good as if some new shining light in zoology were to propose to class tigers and elephants in the same order!

When an author appears so incapable as this of grasping the relative importance of structural features in recent reptiles, it is not much good attempting to follow him in his discussions on fossils. He considers, however, that *Elginia* has its nearest ally in the gigantic *Pariasaurus* of the South African Karoo beds; and in this we believe he is right. When, however, he proceeds to observe that both have little or no affinity with the Anomodonts, and show Lacertilian resemblances, we are again so staggered that, did we not recall the circumstance that he includes *Sphenodon* among Lizards, we can hardly realise that he intends to be serious. Has the author, we may ask, ever compared the pelvis and humerus of *Pariasaurus* with those of a typical Anomodont? and if so, does he still hold the opinion he expresses? In the same section we find a great deal of discussion as to which apertures are the posterior nares in the skulls of the African and Elgin forms, and much importance is attached to the conclusion reached. We would, however, remind the author that the Chelonia and Crocodilia show that the position of these apertures is of extremely little classificatory import. Even if he be right in stating that they have the same position as in *Sphenodon*, this in no way



Superior and right lateral aspects of cranium of *Elginia mirabilis*, together with a side view of the anterior teeth. About one-quarter natural size.

shows that the forms under discussion are more nearly related to Lizards than to Anomodonts; since we thought every tyro knew the structural resemblances between the tuatera and the last-named group.

Although we regret we cannot congratulate the author on the manner in which he has handled an admittedly difficult subject, yet science is indebted to him for having so carefully restored the skulls of the Elgin Anomodonts, and for having provided us with figures which admit of our drawing our own conclusions.

We may add that the close similarity of the Elgin fauna to that of the African Karoo beds, and the Indian Panchet and Maleri beds, serves to confirm the original view as to the Triassic age of both the latter.

R. L.

The Australian Mud-Fish.

Travels for Zoological Research in Australia and the Malay Archipelago. [Zoologische Forschungsreisen in Australien und dem malayischen Archipel.] Pts. I. II. Edited by Richard Semon. Jena: Gustav Fischer, 1893.

The munificence of Dr. Paul von Ritter, founder of the Professorship of Phylogeny and Theories of Descent at Jena, has already rendered signal service to Biological Science. We have often referred to the researches of the Ritter Professor, Dr. W. Kükenthal, which are of fundamental importance for the understanding of the vertebrate animals. We now have to welcome the first instalment of another great work rendered possible by the same generous patron. Between June, 1891, and the end of the following year, Professor Richard Semon, of the University of Jena, was enabled to undertake one of the most important scientific expeditions for collecting that has hitherto been made, to Australia and the Malay Archipelago. Now, the collections have been assorted and arranged, and the publication of the results is commenced in a series of fine quarto volumes. Dr. Semon estimates that there will be five volumes devoted to the Vertebrata, the first relating to the *Ceratodus*, the second and third to the Monotremes and Marsupials, the fourth and fifth to Sirenians, Edentates, *Amphioxus*, and miscellaneous other types.

Professor Haeckel appropriately prefaces the work with some general observations on the relationship of the Australian Fauna, and then Dr. Semon contributes a brief sketch of his journey, enumerating the various centres at which collections were made. Biologists, however, will turn at once with greatest interest to the first part of Dr. Semon's detailed monograph of *Ceratodus*, which is destined to inaugurate a new era in our knowledge of the recent mud-fishes. As patriotic Britons we peruse it with mingled feelings; for had not the collector despatched ten years ago by the Royal Society of London and the University of Cambridge betrayed his trust, the credit of unravelling these problems would have belonged to our own nation.

It is impossible to do justice to Dr. Semon's work on the Australian mud-fish in a brief notice; and it is too early to discuss the conclusions, only the first stages in the life-history of the animal being as yet described in a general way. The facts in reference to the distribution, mode of life, and propagation of *Ceratodus* are set forth in a more exhaustive manner than by previous observers; and the embryological part is illustrated by exquisite plates of segmenting eggs and of immature fishes. *Ceratodus* is believed to be confined to the Burnett and Mary rivers, Queensland; and although, as already generally known, it crops the vegetation with its great teeth, the most important part of its food consists in the small animals living between the fronds and leaves. It seems to be quite powerless to move on land, and it never lies dormant in "cocoons." The eggs are laid separately and loosely among the vegetation; the fore-limbs begin to appear at the end of about fourteen days, and the hind-limbs not before two-and-a-half months. In the course of development, *Ceratodus* presents most resemblance to the Cyclostomes and the Amphibia; but it is noteworthy that external gills are absent at all stages, and there is no trace of a suctorial mouth. There is no rudiment of a connection between the pectoral and pelvic fins; and many features are entirely peculiar. The large dental plates result from the fusions of small teeth, exactly as might have been expected from what is known of extinct mud-fishes. As to the all-important question of the mode of development of the limbs, we must be content to wait for the details to be published later; we can only hope that the delay in issuing the remaining sections of the volume will not be long.

Geography as it is Taught.

Philip's Systematic Atlas, Physical and Political, specially designed for the use of Higher Schools and Private Students. Containing over 250 maps and diagrams, in 52 plates, with an introduction and index of 12,000 names. By E. G. Ravenstein, F.R.G.S. London: George Philip & Son, 1894.

This astonishing production is, say Messrs. J. Scott Keltie, H. J. Mackinder, and E. G. Ravenstein, in a preface, "intended to meet the requirements of pupils in higher schools, of teachers and of other students of geography, for whom neither the ordinary school atlas nor the general reference atlas is entirely adequate." If, then, this atlas represents in any way the methods of teaching favoured by these gentlemen, we are sincerely sorry for any students who come under the hands of Messrs. J. Scott Keltie, H. J. Mackinder, and E. G. Ravenstein. Geography, as certainly Mr. Scott Keltie and Mr. Ravenstein ought to know, is much too important and interesting a science to be distorted and obscured by the wholesale introduction of imperfect text-book information from other sciences. There are, for instance, two plates supposed to illustrate the geographical distribution of plants and of animals. On one plate there are eleven separate maps, on the other nineteen, most including at least a hemisphere and illustrating such points as the range of rhubarb, the Cassowary tree, "nut" trees, Wallace's zoogeographical regions, serpents and lizards, the beaver, and the orang-utang, the orders of mammals, and so forth. It is needless to say that it is impossible to give correct information on such a scale, and that the maps as they appear are useless to the zoologist and botanist and pernicious to the general student. There is, again, a "geological" map of Europe on the scale of 637 miles to the inch, coloured to show "Cainozoic and Recent," "Mesozoic," "Palæozoic," and "Igneous" formations. Two little hemispheres of about three inches diameter show the religions of mankind under the simple if unsatisfactory headings "Heathen, Hindu, Bhuddist (*sic*), Mohammedans, Christians." Two similar maps show the races of mankind—"Aryans, Semites, Hamites, Mongolians, Malays, Hottentots, Negroes, Australians and Papuas, Eskimo, American Indians, Mixed." Do Messrs. Scott Keltie, Mackinder, and Ravenstein regard these tit-bits of inaccurate folly as geography? They certainly are neither geology nor anthropology.

This desire to crowd in a senseless appearance of information reaches even the topographical plates. Thus in a corner of the plate entitled Great Britain and Ireland is a "map" of London on the scale of three miles to the inch, with the following eight references:—1. Zoological Gardens; 2. Kensington Museum; 3. National Gallery; 4. Westminster Abbey; 5. British Museum; 6. Law Courts; 7. St. Paul's Cathedral; 8. The Tower. For whose benefit is this, and why the invidious exclusion of the Houses of Parliament and Madame Tussaud's?

Apart from the singularly incompetent choice of subjects and editing, the plates are clearly printed and, at least by daylight, well coloured. The physical maps are specially useful; the political maps are up to date; the maps showing densities of population are of a kind to please those people who like to think they know about things. The commercial maps are not so satisfactory; it is difficult to follow the highways of commerce by land and by sea upon them. The editors say that, in the construction of the maps showing the distribution of plants and animals, "particular attention has been paid to such products as are useful to man and enter largely into commerce." We have already referred to the absurd inadequacy of these, but in the introduction, as distinguished from the preface, the contradictory statement is made that "our maps show the supposed native countries of these plants" (*i.e.*, characteristic plants and those of economic importance), "and not the countries in which they are being cultivated at the present time." Messrs. Scott Keltie, Mackinder, and Ravenstein have associated their names with what is in many places a mere burlesque of the great science of geography.

Dredging and Distribution in Danish Seas.

Det videnskabelige Udbytte af Kanonbaaden "Hauchs" Tvogter i de danske Have indenfor Skagen i Aarene, 1883-86 (Chef: Premierlieutenant C. F. Drechsel). Udgivet paa Bekostning af Ministeriet for Kirke- og Undervisningsvæsenet ved C. G. Johan Petersen. Pp. 464, 6 pls. and 2 maps, 4to; atlas of 43 maps, fol. Kjöbenhaven, 1889-93.

This work, which has just been published under the auspices of the Danish Government, is one of no common interest for those who believe that a careful investigation of the conditions affecting the distribution of common animals within a limited area is likely to be of as much utility in the solution of important biological problems as is the collection of new species from far-off lands.

In the year 1883, Captain Drechsel applied to the authorities of the Zoological Museum in Copenhagen to recommend him a naturalist who would spend a few weeks on board his ship making collections for the Museum and investigating the animal life of the Danish seas in general. The choice fell upon Dr. Petersen, and has been amply justified by the results of his work published in the volume now under notice.

During the first season Captain Drechsel and Dr. Petersen elaborated a plan of campaign, which was "not merely to seek for species new to the fauna of the district, but first and foremost to acquire a knowledge of the distribution of the commonest animals, and at the same time to investigate as far as possible those natural conditions, such as temperature, composition of the bottom, etc., which might be supposed to exercise an influence upon the distribution and life of the animals. This plan was carried out in the course of the three following summers, 1884-86, and, with this object in view, dredgings were made at as many stations as possible in the Kattegat, so that on the basis of these observations conclusions might be drawn regarding the distribution in those waters of at all events the commonest animals, especially the invertebrata." Wherever possible both dredge and trawl were used, and the process was carried on till it became possible to predict with a fair amount of certainty what species would be obtained from any particular haul.

More than 500 stations were occupied, and in almost every case, in addition to the exact geographical position, there are given the depth, the nature of the bottom, the temperature of the water and its specific gravity both at the surface and the bottom. The material obtained was placed in the hands of different specialists for examination, and their reports are incorporated in the present volume. The five fascicules of text include memoirs by different specialists—on the Echinodermata and Mollusca, by Dr. Petersen himself; on the Cephalopoda, by Dr. H. J. Posselt; on the Polyzoa, Annulata, Cœlenterata and Sponges, by Inspector Levinsen; on the Crustacea Malacostraca, by Dr. Meinert; on the Diatoms, by Professor Cleve; and on the Bottom Deposits and the Hydrography of the Kattegat, by Dr. Rördam.

Turning first to the chemical and physical portions of the work, we notice that the greatest percentage of calcium carbonate is found in the deepest part of the Kattegat, perhaps in correlation with the saltness of the water, while the deposits from the bottom of the Baltic contain little, if any, of this substance. It appeared that during the three years (1884–86) in which the observations were made, the saltness of the water in the Kattegat increased, while at the same time the mean temperature diminished. This result is confirmed by independent observations from other sources, and is attributed to an unusual prevalence of N. and N.W. winds during those seasons. These facts are shown very clearly by a plate containing nine little maps.

The account of the Echinodermata and Mollusca by Dr. Petersen need not be noticed at length here, except for the purpose of calling attention to the admirable series of 26 maps by which the distribution of the various species is illustrated. No new forms are here described, though some additions to the Danish fauna are recorded. The Mollusca, in particular, have already been discussed by the same author in an elaborate thesis published about five years ago.[1] The section dealing with the Cephalopoda by Dr. Posselt is not merely an account of the few taken by the "Hauch," but is virtually a systematic monograph of the Danish forms, and contains some novel information of great importance. Dr. Meinert's report on the Malacostracous Crustacea is a very important piece of work, being in fact a revision of the Danish fauna, so far as this group of animals is concerned. The number of species recorded is increased from 177 to 253, and nine new species are described, of which three are referred to new genera. The memoir is illustrated by fourteen maps and two copper plates. Inspector Levinsen has dealt with the Porifera, Polyzoa, Hydroida, and Anthozoa, and in regard to the first three of these groups has given us a complete account of the Danish forms, with a very convenient dichotomous key for their identification.

The whole work is completed by a discussion of the general results by Dr. Petersen, which he has considerately printed both in Danish and English; this is naturally the most important section of all and some account of its more salient features must be attempted. The bottom of the sea is covered with three kinds of deposits, stones, sand or gravel, and clay or ooze, the last of which occurs only in the deepest places and is the most unfavourable for animal life. As to vegetation, about half the Kattegat and nearly all the Skagerack are destitute of it, and, next to the inshore waters, the richest places are the protected situations in the Kattegat. The salinity, too, increases with the depth, though it varies greatly with the seasons, the melting ice in the Baltic being, perhaps, the most important factor in this connection. As might have been expected, the temperature is most variable in the inshore waters, where it reaches 19–23° C., and least variable in the Skagerack, the deep eastern Kattegat being intermediate in this respect.

[1] Petersen, "Om de skalbærende Molluskers Udbredningsforhold i de danske Have indenfor Skagen," 8vo., pp. viii., 162, map, Kjöbenhaven: 1888.

The temperature of the bottom mud seems to be somewhat higher than that of the water in winter; for instance, while the water was about 0° C., the temperature 3–4 feet down in the mud was + 7° C. This is doubtless the reason why many animals (Gobiidæ *Carcinus*, *Cerithium*, etc.) bury themselves in winter. The influence of the physical conditions on the distribution of various animals is then discussed, and fourteen examples are given in some detail, special reference being made to different species of the same genus which appear to represent each other in different parts of the area under consideration. The author claims to have shown "that each species is distributed according to certain rules," it is seldom, however, "that one single factor is decisive, but the distribution is the result of groups of concurrent circumstances." One point of interest is brought prominently forward—"no species of animal is found everywhere in our seas." When an animal is once recognised as common it is usual in faunistic works to describe it as found "in all our sounds and fjords" as occurring "everywhere along the Danish shores," so that frequently the more abundant a species the less information is available as to its actual distribution. Dr. Petersen's careful maps furnish a marked contrast to this mode of work. After a short chapter on the distribution of certain animals outside the Danish waters, we have some observations on distribution in the post-Glacial period, from which it appears that the Baltic and Kattegat may be compared to a Norwegian fjord in which the cold water forms are not yet shut in, but in which they and the warm water forms move in and out according to circumstances. As representatives of the "cold fauna" we have *Astarte borealis*, *Idotea entomon*, *Halicryptus spinulosus*, etc., of the "warm fauna" *Ostrea edulis*, *Tapes pullastra*, and *Pecten varius*. This concludes a most important and interesting contribution to the natural history of the Kattegat—"the greatest battlefield on the coast of Europe between the ocean water and the fresh water."

Wm. E. Hoyle.

The British Oniscidæ or "Woodlice"—a group of animals somewhat neglected by naturalists—are described by Dr. R. F. Scharff in the *Irish Naturalist* for January and February, all our native species being well figured on a single plate. Fourteen species are common to Great Britain and Ireland, two occur in the large island which are not found in the smaller, while three species have been found in Ireland which have not yet been observed in England or Scotland. There are not many groups in which Ireland can claim a richer fauna than Great Britain. Foreign species receive attention at the hands of M. Adrien Dollfus, who continues his researches on the Isopoda and their geographical distribution. Four of his papers have recently come to hand, and furnish us with information on the woodlice of Venezuela, the Pyrenees, and the Seychelles.

The Termite Ants are so constantly being brought forward in discussions on Natural Selection (see Mr. Platt Ball's paper, Natural Science, Feb., 1894, and Mr. Cunningham's in the present number), that those interested in the problem will be glad to know of an exhaustive paper on the constitution and development of the Termite colony, with notes on their habits, which is now begun by Drs. B. Grassi and A. Sandias in *Atti della Accademia Gioenia in Catania* (ser. 4, vol. vi.).

NEWS OF UNIVERSITIES, MUSEUMS, AND SOCIETIES.

THE following appointments have recently been made in the Botanical world:—Mr. R. J. Harvey Gibson to the Professorship of Botany at University College, Liverpool, the endowment of which has recently been completed by a donation from Mr. Holbrook Gaskell; Dr. Carlo Casali to be assistant in Botany at the University of Rome; Dr. C. Avetta to be Professor in the University of Padua, and Director of the Botanic Gardens; Mr. J. H. Burrage, of New College, Oxford, to be Demonstrator to Professor Balfour at Edinburgh; Dr. Richard Otto, recently assistant in the Institute of Plant Physiology at the Royal Agricultural School in Berlin, to be teacher of Chemistry at the Royal Pomological Institute at Proskau o/S, while Dr. Fr. Krüger of Geisenheim takes his place at Berlin. We also note that Dr. V. Schiffner will temporarily take the place of Dr. Hallier as an assistant in the Botanic Garden at Buitenzorg in Java while Dr. Hallier makes a visit to Borneo; that Professor Julius Klein has gone to Naples to undertake some botanical studies at the Zoological Station; that Dr. Robert Regel, who has for the last few years been a junior curator in the Herbarium of the Royal Botanic Gardens at St. Petersburg, has resigned this position to become Privatdocent in the University, where he takes classes in the relation of Botany to Horticulture; that Mr. Alboff, who, at the cost of the Boissier Herbarium, has for the last six months been investigating the mountain flora of the Caucasus, has returned with rich spoils; and that Dr. L. Guignard has been elected President of the Botanical Society of France for 1894. We are glad to learn from the *Kew Bulletin* that the Government of Queensland has reconsidered its decision, and that Mr. F. M. Bailey, the abolition of whose post was recently reported, has been re-instated as Colonial Botanist. It would be poor economy to do away with so important a post, especially when it has been filled so long and ably by a man like Mr. Bailey, who has added largely to our knowledge of the plant products of the colony.

FURTHER good news for Botanists is that the botanical explorer, Captain John Donnell Smith of Baltimore, Md., has opened his private herbarium and library to the students of botany of the Johns Hopkins University. This herbarium is one of the largest and best selected private herbaria in existence, containing not only collections from all parts of the world, but also the plants collected by Mr. Smith and his correspondents in Guatemala, many of which are the type specimens of new species. The owner intends to present both herbarium and library to the University, so soon as a building shall be offered for their reception, and provision made for their maintenance. The library contains about 1,300 volumes, chiefly relating to American botany. Captain Donnell Smith has recently started on another visit to Central America.

MEANWHILE Botanists nearer home are likewise busy, as the following items show. Dr. Baroni of Florence intends to monograph the genus *Atriplex*, and requests materials from his colleagues. The tenth Congress organised by the French Nationa Society of Horticulture will meet at Paris during the General Horticultural Exposition, May 23–28. Among others, the following subjects will be discussed:—Chlorophyll in its relation to the vigour of cultivated plants; capillarity and the preparation of the soil; and means for hastening the nitrification of nitrogenous substances and rendering them more easy of assimilation. Under the direction of Professor P. Lachmann a botanical garden has been established in the mountains near Grenoble, at a height of 1,875 metres. Nor should we forget the Royal Botanic Society of London, on whose pecuniary difficulties we commented in our last number (p. 233). We then suggested that they were in part due to the Society's exclusiveness as regarded its Gardens in Regent's Park; but an important step has since been taken by the Council. A regulation has been made which will doubtless increase the popularity of the Gardens. Permission is now given to smoke therein.

AMONG Zoologists the following appointments are to be chronicled:—Dr. F. Zschokke to the Professorship of Zoology at Basle University, in place of Dr. L. Rütimeyer, who has long been in failing health; Dr. K. Zelinka to be Professor-extraordinarius of Zoology at the University of Vienna; Mr. S. H. Reynolds to be Demonstrator of Biology in University College, Bristol; and Dr. Harrison Allen to be Director of the Wistar Institute of Anatomy at the University at Pennsylvania. Professor W. Krause of Göttingen has moved to Berlin (Brückenallee, 31), where he has been placed in charge of the Anatomical Institute of the University. Mr. J. Willis Clark succeeds Professor M. Foster as Rede Lecturer at Cambridge University. We also note that Mr. C. R. Beazley, Fellow of Merton College, has been elected to the Geographical Studentship at Oxford University for the present year; and finally that Dr. Hans Bruno Geinitz, the veteran geologist and palæontologist of Dresden, now in his eightieth year, retires this month from his professorship in the Technical High School, where he will be succeeded by Professor E. Kalkowsky, of Jena.

SEVERAL scientific men have of late received honours from various universities. Cambridge University has conferred the degree of Doctor of Science on Dr. Santiago Ramon y Cajal, Professor of Histology and Pathological Anatomy in the University of Madrid, who, on March 8, delivered the Croonian lecture before the Royal Society, his subject being the minute structure of the nervous system, of which he has done so much to advance our knowledge. On the same day the degree of LL.D. *honoris causa* was conferred by Cambridge University on the Right Hon. the Earl of Kintore, Governor of South Australia, who, it will be remembered, recently travelled from Port Darwin to Adelaide in company with Dr. E. C. Stirling. The Senate of Aberdeen University has conferred the honorary degree of LL.D. on Mr. Henry Ogg Forbes, the well-known explorer, now Director of Museums in Liverpool.

THE following prizes and scholarships are open to competition. The Italian Geological Society offer a prize of 1,800 francs for the best memoir on the present knowledge of the Palæozoic and Mesozoic rocks in Italy. The memoir must be presented by the end of March, 1896. The Royal Society of New South Wales offers its medal and £25 for the best original communication (provided it be of sufficient merit) upon each of the following subjects, to be sent in not later than May 1, 1895,—on the silver ore deposits of New South Wales; on the physiological action of the poison of any Australian snake, spider or tick; on the chemistry of the Australian gums and resins. And the following to be sent in not later than May 1, 1896,—on the origin of multiple hydatids in man; on the occurrence of precious stones in New South Wales, with a description of the deposits in which they are found; on the effect of the Australian climate on the physical development of the Australian-born population. Competitors are requested to write upon foolscap paper, on one side only. A motto must be used instead of the writer's name, which latter must be enclosed in a sealed envelope; all communications to be addressed to the Hon. Secretaries, T. W. E. David and J. H. Maiden, at the Society's House, Sydney. Cambridge University announce that the Arnold

Gerstenberg Studentship, worth about £90 a year, will be awarded next May, on the results of an examination in Psychology and Logic, beginning on May 21. Candidates must have obtained honours in one part of the Natural Sciences Tripos, and have entered into residence before April, 1888. The student elected is required to devote himself to mental or moral philosophy. Guy's Hospital announce that two open scholarships in science, of the value of £150 and £60, will be examined for in September next; particulars may be obtained from the Dean of the Hospital.

AMONG appointments to be filled up we note the following:—An Assistant-Lectureship in Agriculture at the Durham College of Science, Newcastle-on-Tyne. A practical acquaintance with agriculture is necessary, and a special knowledge of animal anatomy and physiology desirable. The stipend is £150 *per annum*, with a share of certain fees. Applications and testimonials must be sent on or before April 6 to the Secretary, Mr. H. F. Stockdale, from whom further particulars may be obtained.

FOR many years the idea of a Free Local Museum to illustrate the Natural History, Archæology, etc., of the district of Epping Forest has been advocated by those interested in the subject, and especially by the members of the Essex Field Club. The Epping Forest Committee of the Corporation of London having carefully preserved the old building known as Queen Elizabeth's Lodge at Chingford, they will be approached with a view to the housing and arranging of the proposed collection in the Banqueting Hall of the Lodge. The district that the promoters propose to illustrate is, roughly speaking, that bounded by the Northern and Eastern Railway on the west, and the London and Ongar Railway on the east; and is about sixteen miles long by four wide. The Essex Field Club are willing to undertake the gathering of specimens, as well as the curatorial work necessary for the proper arrangement of the collection. A general meeting was held, in Queen Elizabeth's Lodge, on the 24th February, to consider the question. The Rev. A. F. Russell (Rector of Chingford) was in the chair, and speeches were made by Professor C. Stewart, Mr. J. E. Harting, Professor Meldola, Mr. Howard Saunders, Professor Boulger and other well-known naturalists. From a letter we have received from Mr. W. Cole, the Hon. Sec. to the Essex Field Club, we learn that the Conservators have given the Club provisional permission to place specimens in the room; but that it will be necessary to raise a small fund before the Conservators can be approached for full permission to carry out the proposed Museum. It is estimated that the sum of £300 would enable the committee to provide the necessary cases, cabinets, and museum appliances, and, considering the excellence of the idea, this money should be easily obtained. Those who desire to help the committee in furthering the educational value of this delightful forest should communicate with Mr. Cole at Buckhurst Hill.

WE learn from the *Daily News* that the Geological Department of the British Museum has recently been enriched by over three hundred fine specimens of fossil plants, from the Coal-measures of Somerset, collected by the late Jas. M'Murtrie of Radstock. The same institution has been presented by the Governors of Cheltenham Hospital with the skeleton that belonged to a young Chimpanzee (*Troglodytes niger*), from Angola, which was dissected by Dr Edward Tyson and described in his work "*Orang-outang, sive Homo Sylvestris*; or the Anatomy of a Pigmie compared with that of a *Monkey*, an *Ape* and a *Man*." This, the first account of any man-like ape that could pretend to scientific accuracy or completeness, was published by the Royal Society in 1699.

THE town of Macclesfield has accepted the offer of Miss Marian Brocklehurst to build and endow a Museum in the Public Park. The basis of the collection will be a large series of Egyptian antiquities obtained by the donor herself while travelling in the East; but it is intended also to add a general collection of Natural History, with special reference to the fauna, flora, and geology of East Cheshire. Miss Brocklehurst proposes, in association with her brother, to arrange for an endowment of £100 per annum, half to be devoted to maintenance, half to the Park Keeper for curating. As the munificent donor requests to be favoured with suggestions, we would venture to remark, from our knowledge of the culture of the average Town Councillor, that no institution of the character she proposes to found can flourish under the direction of a Corporation Committee without the guidance of some educated and experienced curator. Unless adequate provision be made for such an officer, the Museum will become a mere storehouse of "curiosities" of no value to anyone.

WE have received the Seventh Annual Report of the Liverpool Marine Biology Committee and their Biological Station at Port Erin, Isle of Man, drawn up by Professor W. A. Herdman. The work of the Committee was transferred to Port Erin from Puffin Island in 1892, and the present report shows how it has benefited by the change. Two dozen workers (not 60, as the report says) have stayed at the station for varying periods during the year. The Curator for most of this period was Mr. J. H. Vanstone, who resigned in September; a new Curator will be appointed by the committee after Easter. A separate aquarium and tank-house have been built for the storage of living marine animals and plants, for facilitating observations on habits and life histories, and for exhibition to the public. During the latter part of the summer a charge of 3d. was made for admission to the aquarium, and this in four weeks produced £1 17s. 10d., from which we infer that one visitor was let in cheap or else did not get his proper change. To make the aquarium more permanently attractive than the come and go of living material renders possible, it is intended to display round the walls a large collection of Manx Invertebrata presented by Mr. G. W. Wood. It was hoped that the Lancashire Sea-Fisheries Committee would by this time have erected a fish hatching-establishment alongside of the Biological Station, especially as Captain Dannevig of the Norwegian hatchery at Flödewig reported favourably on this scheme. Unexpected difficulties have, however, arisen; but the reporter seems confident that sooner or later Port Erin will become an important centre for the propagation of young food-fishes. During 1893 eight dredging expeditions were carried out, mostly under the auspices of a Committee of the British Association, and a considerable amount of the Irish Sea was explored. Over a thousand species of marine animals were collected and identified, of which 38 were new records to the British fauna, 224 new to the particular district, and 17 new to science. The Report contains four plates illustrating the arrangements of the station, a chart of the Irish Sea and a considerable quantity of interesting matter. The expenses of the year amount to about £180, in return for which a great deal of good work has been done; but we regret to see that this is not quite covered by the yearly income. Subscriptions may be sent to Mr. I. C. Thompson, 19, Waverley Road, Liverpool, while applications to be allowed to work at the station or for specimens should be addressed to Professor Herdman, University College, Liverpool.

THE City of London Entomological and Natural History Society has published its Report for the year 1893. The President for this year is Mr. J. E. Clark, and the Secretary Mr. C. Nicholson, 202 Evering Road, Upper Clapton, N.E. This Society has for its object the diffusion of the science of Natural History, by means of papers, discussions, exhibitions, and the formation of collections for reference. The meetings take place on the first and third Tuesdays in each month, from 7.30 to 9.30 p.m., at the London Institution, Finsbury Circus. The entrance fee is two shillings, and the annual subscription five shillings. The papers in the Report deal entirely with entomological matters, but that by Dr. Buckell on "Specific Nomenclature: Present, Past, and Future," should interest all systematists; while Mr. J. E. Robson's discussion of the cause of Melanism in Lepidoptera, which he ascribes to anything that impedes the direct rays of the sun, should be noted by all who deal with the problem of animal colouration.

THE annual meeting of the Quekett Microscopical Club was held on February 16. Mr. E. M. Nelson, the President, gave an address, in the course of which he reviewed the work done in connection with the microscope during the past year. There was, he feared, a serious danger likely to occur to the "microscopy" of the future owing to the neglect of viewing opaque subjects with a stereoscopic binocular. He did not believe any observer, however eminent, who had not previously passed through a special training of viewing such objects in that way, could form correct ideas of the shape of objects solely by alteration of focus. The Club has now over 340 members, and on May 4 will hold an exhibition at Freemasons' Tavern.

THE lecture programme of the Royal Dublin Society, recently issued, includes "Creeping and Flying Reptiles, and their Modern Descendants," by Professor A. C. Haddon; "Our Western Fisheries," by Rev. W. S. Green; "Nature and Myth in India," by Dr. V. Ball; "Bacteria," by Dr. E. J. McWeeney; "Food, what it is and what it does," by Dr. J. M. Purser; "Reproduction and Rejuvenescence," and "On the Borderline between Animal and Vegetable," by Professor M. M. Hartog. Meanwhile, a very successful course of lectures on Geology has lately been given by Professor Grenville A. J. Cole at Belfast. A specially encouraging feature was the readiness of the students to take up practical work. Interest in glacial problems seems to be reviving in Ireland; we notice in the *Irish Naturalist* for January a paper by Professor Sollas on the drift-beds of the coast south of Dublin, while in the February number of the same magazine Miss Thompson gives an account of what is being done to elucidate glacial problems around Belfast.

THE Natural Science Club of Cambridge University signalised its five-hundredth meeting by a conversazione on March 12, at which lectures were delivered by Messrs. A. Russel Wallace, W. M. Conway, and C. V. Boys. The Brighton and Sussex Natural History and Philosophical Society also held a successful *soirée* at the Brighton Pavilion on March 2, this being the first gathering of the kind for nine years. Mr. W. M. Conway lectured on his Karakoram experiences with the aid of a magic lantern. Among a large number of exhibits calculated to attract the general public, we noticed a case of objects discovered in the Lavant Caves in Goodwood Park, and shown by Mr. J. Lewis, of New Shoreham, who favoured us with the following information:—The caves are situate on the southern slope of the Downs. One of the Roman encampments is in the vicinity, showing the district to have been inhabited at an early day; and other evidence to this effect is afforded by the circumstance that there is a levelled plateau above the caves. The caves were accidentally discovered about a year ago, and were explored by Mr. Dawson and Mr. Lewis. They consist of subterranean passages and galleries branching one from the other, and comprise about an acre of flooring. The average height of the passages is 45 feet, and these are carefully arched. The caves appear to have been hewn out by some early race with picks and wedges of deerhorn. There are indications that the object of the excavators was not, as at Cissbury, to find flints; but the caves were probably used as stores or hiding places by the people dwelling in the neighbourhood. The objects found therein were Neolithic flint implements, flint spear heads and scrapers, a portion of red deer-horn used as a pick, a lamp made of chalk, pottery, bronze articles, a Scandinavian ornament, etc., all which indicate that the occupation of these caves must have extended over a considerable period.

THE excited protests of some of our effeminate fellow-citizens will not, of course, have any effect on the foundation of the British Institute of Preventive

Medicine in Chelsea, as mentioned in our last number (p. 233). This action of what we are pleased to think is only a small section of the enlightened British public may, however, be instructively contrasted with that of certain foreign nations on whom your average Britisher would probably look with scorn. Not to mention New York and Calcutta, the Hungarian Government has established a similar institute at Buda-Pesth, while even "the unspeakable Turk" contemplates founding in the chief town of every province what our contemporary *Nature* is pleased to term an "antirabific laboratory." One such institution has for some time been doing excellent work at Constantinople.

The North Pole is certainly being boomed just at present. Nansen started for it not so long ago, and Mr. F. G. Jackson has not been back two months from his trial trip. Now we learn that the latter gentleman is soon to set off again, while some Americans are going to have a look for Nansen. Mr. A. C. W. Harmsworth, a Fellow of the Royal Geographical Society, has generously offered to pay all the expenses of a fully-equipped expedition led by Mr. Jackson, which will proceed to Franz Josef Land with a view to exploring it in a northerly direction, and advancing as far as possible towards the Pole. The American expedition, the cost of which will be defrayed by the *Chicago Herald* and other journals, will be commanded by Mr. Walter Wellman. The whaler "Ragnvald Jarl" of Aalsund, has been chartered and will be manned by Norwegians. The immediate object of this expedition will be to discover the whereabouts of Nansen, but a return will be made to Europe for the winter if possible, although stores will be taken which will enable the explorers to winter in Spitzbergen. Both these expeditions will leave about May. We also heard a short time ago of an elaborate expedition inaugurated by Mr. R. Stein, of the United States Geological Survey, and patronised by the National Geographical Society of America. The proposal is to establish a depôt at Cape Tennyson, at the northern entrance to Jones's Sound, and then to follow the coast of Ellesmere Land westward, where an advanced depôt will be established to form the base of operations in the following year, when an endeavour will be made to connect with the discoveries of the Greely party on Greely Fjord. In this connection we may mention that Dr. Erich von Drygalski gives an account in the *Verhandlungen der Gesellschaft für Erdkunde zu Berlin* (vol. xx., nos. 8 and 9, 1893) of his journey along the West Coast of Greenland in 1892–3. Starting from Christianshaab, the party journeyed by boat and sledge round the fjords and islands to some miles north of Upernik. The object of the expedition, the cost of which seems to have been defrayed by the Society, was to settle certain points concerning the Ice-Age. In the same journal, Dr. Vanhöffen gives an account of the fauna and flora observed at spring-time in the northern part of the island.

The British Association will hold its sixty-third meeting at Oxford, in the week beginning Wednesday, August 8. This date is not very convenient for University people, but was chosen to suit the president, Lord Salisbury, the attraction of whose presence will doubtless counterbalance the inconvenience of date. The list of presidents of the various sections has been announced as follows:—(*A*) Mathematics and Physics, Professor A. W. Rücker; (*B*) Chemistry, Professor H. B. Dixon; (*C*) Geology, Mr. L. Fletcher; (*D*) Biology, Professor Bayley Balfour; (*E*) Geography, Captain Wharton; (*F*) Economic Science and Statistics, Professor Bastable; (*G*) Mechanical Science, Professor Kennedy; (*H*) Anthropology, Sir W. H. Flower; and (*I*) Physiology, Professor Schäfer. On the Friday night Professor J. Shield Nicholson of Edinburgh will give a lecture, and on Monday Mr. W. H. White is expected to discourse on naval construction.

The German Zoological Society will meet in the Zoological Institute, Munich, from April 9 to 11, and on Thursday a visit will be paid to the fish-breeding establishment on the Starnberger See. Foreign Zoologists are specially invited.

CORRESPONDENCE.

Professor Milne-Edwards, M. Grandidier, and Æpyornis.

I venture to think a protest ought to be raised by some British naturalist against the tone of the note in this month's Natural Science on the recent French discovery of *Æpyornis* bones. For many years there has been a generous rivalry, fruitful of enterprise and hard work, between the French and ourselves in the matter of Mascarene Zoological discovery. When, then, as in the case referred to in your article, the French have succeeded in first making known to the world a set of new and interesting fossils, it ill becomes a British Journal of the standing of Natural Science to complain in so cavalier a manner of the exact method in which the discovery is announced.

Were the complaints correct in themselves there would still be little excuse for such an attack, but as a matter of fact the only alleged fault of the authors which, if true, would have caused difficulty to the real worker on specimens, as opposed to the mere critic, practically does not exist at all in the paper referred to. Far from its being the case that "names are applied to collections of limb-bones which may or may not belong to the same species, and no particular bone is taken as the type specimen," the species are distinguished mainly on size, and in four cases out of seven one bone only, either tibia or tarso-metatarsus, has its dimensions fully and exactly recorded, and is therefore clearly in each case the type of the species. Of the other three cases, one was founded on these two bones together and the other two on the two chief leg bones, which may have been found in conjunction, and are in all cases most carefully measured. In a group where size is of the most vital and diagnostic importance, to dismiss these measurements with the remark that "though some measurements are published, we have sought in vain for any adequate diagnosis" is surely rather disingenuous.

Considering the fact that one of the authors attacked, Professor A. Milne-Edwards, holds the highest position in the French zoological world, is a naturalist of whom any nation might be proud, and one to whom many British zoologists, especially those of our National Museum, have been again and again indebted for assistance in various ways, while the other, Mons. Grandidier, simply as a private person, has spent a fortune and a lifetime in furtherance of the scientific knowledge of Madagascar, it would surely have been better had Natural Science recognised in a somewhat different way the magnificent work done by the two eminent Frenchmen it now, not for the first time, so gratuitously attacks.

Natural History Museum, O. T.
March 5, 1894.

[Mr. Thomas seems to believe that some personal animus has influenced our remarks on the work done by MM. Milne-Edwards and Grandidier on the Æpyornithidæ. Let us at once assure him that none more than ourselves have greater respect for the personality of these eminent Frenchmen. It is the principles, not the men, that we attack; and in reply to the second paragraph of Mr. Thomas's letter we have to say:—That in three cases (*Æ. mulleri*, *ingens*, and *betsilei*) specific names are given to a collection of bones, or more than one bone, and since it is not definitely stated that they belong to the same skeleton, it must not be assumed that they do. The inconvenience resulting from this mode of procedure is apparent; for in the case of *Æ. ingens* measurements are given of the femur, tibio-tarsus, and metatarsus. Now it is stated that the femur is different from that of *Æ. titan* described by Andrews. On referring to the paper quoted, we find that the femur of *Æ. titan* is *not* described, though a femur is provisionally referred to that species. On the other hand, the femur referred to *Æ. ingens* by Milne-Edwards may well have belonged to *Æ. titan;* and, indeed, if the bones referred to *ingens* *were* associated, then, as far as one can judge from measurements, *ingens* is a synonym of *titan;* for the measurements of the tibia of *ingens* given by Milne-Edwards agree almost exactly with those of the type tibia of *titan:*—

	ingens.	*titan.*
Length	81 cm.	80 cm.
Circumference at narrowest	20·5 ,,	20·7 ,,

It is true that the authors state that *Æ. titan*, though as tall as *Æ. ingens*, was less massive and its leg articulations were smaller. If this opinion is founded on the femur, we have shown that it rests on an insecure foundation. If it rests on the tibia, why are no measurements given of the articular ends in which the main difference seems to lie? Slight variations of measurement are of small value and insufficient for the establishment of specific distinctions, for among individuals in the Ratite birds size varies very greatly.

Of the new genus proposed, "*Mullerornis*," no diagnosis is published, the only detail furnished being "that they are of medium size, not having the massive and heavy appearance of *Æpyornis*, approaching rather the Cassowaries. We only know the bones of the foot."—Ed.]

Liverpool Marine Biological Station.

In reply to an enquiry of ours about the Port Erin Biological Station, which we notice on p. 316, Professor Herdman writes to us:—"We are organising a Liverpool Marine Biology Committee dredging expedition for Easter week-end, like those we have had at the same time in recent years. Besides that party, several zoologists and botanists will be at work at the station during the last week of this month and during April, including Professor Weiss, Dr. Hurst, and Mr. Gamble of Owens College, Mr. Beaumont of Emmanuel College, Cambridge, Mr. Thompson of Liverpool, and myself."

A correspondent calls our attention to the fact that Professor Lapworth is also "new blood" on the council of the Geological Society. We regret that in our note last month his name was omitted; apparently we could not realise the fact that so distinguished a geologist had not been on the council before.

Strange are the ways of the American place-hunter and strange, as we have noted before now, is the system under which scientific appointments are made in the United States. One of our Transatlantic correspondents complains that he has no time for scientific work. "At present," he writes, "I am very busy, being engaged in politics, as I am a candidate before the Republican Convention for the nomination of State Geologist and have the most flattering prospects; my only opponent is a local collector." As our friend might possibly obtain the appointment, we have sufficient regard for his reputation to suppress his name.

TO CORRESPONDENTS.

All communications for the Editor *to be addressed to the* Editorial Offices, 5 John Street, Bedford Row, London, W.C.

All communications for the Publishers *to be addressed to* Macmillan and Co., 29 *Bedford Street, Strand, London, W.C.*

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NOTES AND COMMENTS.

The Extinction of Wild Animals.

WE were glad to see in the *Pall Mall Gazette*, early in April, an excellent, if somewhat tardy, notice of Dr. Hart Merriam's Bulletin on the American Hawks and Owls. Zoological periodicals, from time to time, attempt to impress upon the public the necessity for concerted effort, to prevent the wholesale extinction all over the world of those animals which interest the sportsman, either directly for their own sakes, or indirectly because they rival, or are supposed to rival, him in his attacks upon game. But, save by publishing an occasional set of letters, on the decoration of the human female by the skins of birds, the general papers take little interest in wild animals. So-called birds of prey form one field in which general papers like the morning and evening dailies might both interest their readers and assist zoologists. Here is another. The extremely interesting and peculiar fauna of Africa is becoming rarer year by year. At a recent meeting of the Zoological Society, African hunters from various parts of that continent were present, and all of them had to tell how animals, a few years ago abundant near the coast, must now be sought a month's journey inland. Will no paper take up the cry "Africa for African animals"? At the least the various European Powers might be persuaded to do something for the indigenous fauna of their vast hinterlands. The hunter is a curious survival of the instincts of primitive man, and it may be that he, too, should have place in the international preserves of Africa. But the mere sportsman must be either suppressed or regulated, else the highlands of Africa will become as devoid of large animals as the heights of Dartmoor.

Lord Lilford on the Preservation of Wild Birds.

On the same subject hear Lord Lilford: "A cry comes up from many parts of our islands," he remarks (in the *National Review* for April), "that many of our native birds are rapidly disappearing."

We regret to have to agree with such a competent ornithologist that the cry is probably well-founded. Interesting hawks and owls are apt to be classified under the simple title of "vermin"; and, in spite of a well-known remark of the late Professor Thorold Rogers, vermin are not as a rule allowed much law. Nor is this antipathy to the winged creation, which justly arouses Lord Lilford's anger, at all confined to the present century; he quotes from a statute of the sixteenth to this effect: "45 item that no person shall suffre no kyte, busserd, pye, nor fleshe crow to brede, and their yonge to fly away from the grownd uppon payne of losing xiid." Presumably the fine was large enough to secure obedience. Nor, unfortunately, does the redundancy of negatives in the above sentence imply an affirmative. There is no doubt at all about the relentless policy ordained.

Lord Lilford alludes to the sparrow in North America. A few years ago, comparatively speaking, there were no sparrows at all in the United States. Now there are so many that a bulky volume has been written to bring home to them their iniquities. And after the impeachment, the sentence is pronounced that the unfortunate birds are to be dealt with by the help of "London purple" and "Paris green." These are, it is perhaps hardly necessary to state, euphemisms for deadly compounds of arsenic. The sparrow has, however, triumphed over these kindly attentions on the part of its hosts; not so the rarer Accipitres of our islands. Lord Lilford makes the honourable boast that he himself has never offered a price for the killing of any bird. We respectfully offer him our congratulations; but it is clear that he is a real *rara avis* among ornithologists. The main claim for distinction in that science, as it appears to us, is to possess the largest possible collection. It is all very well for ornithologists to complain; but they are among the chief sinners, and the blood of most rare birds lies upon their heads.

A propos of the persecution of rare birds so ill-advised as to occasionally visit the inhospitable shores of Great Britain, anyone who takes up those for the most part exceedingly arid catalogues of the birds of a county cannot fail to have been struck by the remark, of not infrequent occurrence, that such and such a rare species is known by one example "shot" at this or that locality. The excuse offered is that the visits are literally flying visits, and that there is no chance of a permanent settlement. This may be true, but it is by no means proved. The birds have had no chance of proving or disproving the allegation. The British Ornithologists' Union comprises nearly, if not quite, all of the ornithologists of this country, and Lord Lilford is its president. If they were to follow the excellent example of the president and resolutely decline to buy any specimen of a scarce bird shot in this country, the supply would cease with the cessation of the demand. At the very lowest estimate no harm would be done by the adoption of such a course. And it is possible that the fauna of the country would be ultimately enriched, to the benefit not only of the professed ornithologist but also of the lover of birds who is not an ornithologist.

Wild Cats at the Zoo.

Still *à propos*! A writer in the *Spectator* accepts the two reputed wild cats in the Zoological Gardens as genuine specimens of the real *Felis catus*. He may be perfectly correct, and, if so, the Zoological Society is greatly to be congratulated. For the true wild cat will be soon—and, in the opinion of some, is already—as defunct as the dodo. No doubt there are plenty of large and fierce tabby cats to be found in Sutherlandshire, and in other places in the extreme wilds of Scotland; but there is also no reason to hesitate before referring a good many of these to a mixture of the original wild cat with various pussies whom the delights of sport have permanently allured from the domestic fire-side. Anyone who lives in a neighbourhood where there is game, knows how mysteriously grimalkin disappears, to be possibly recognised later nailed to some tree trunk or barn door. We believe that a true character of the wild cat is the entire absence of white hairs about the body. Many cats, most flagrantly domestic, have the black feet and short tail tipped with black of the wild cat; as a matter of fact, there seems to be little doubt but that the domestic cat is of mixed breed like the domestic dog. There is, doubtless, a considerable strain of *Felis catus* to be traced therein, but also some mixture of Egyptian or Oriental breeds. The gamekeeper, who is so praised by the writers of that rapidly-increasing class of book which has been termed "scientifico-literary," is looked upon with abhorrence by the naturalist. Under the heading of "Vermin," it is probable that the last genuine wild cat, if not already extinct, will soon pass away. The author of that delightful book, "The Naturalist in Siluria" (Sonnenschein, 1889), thought he had records of wild cats in Ross; but in the description of the supposed *Felis catus* there is too much of what De Quincey has called "demoniac inaccuracy" to admit of an unprejudiced judgment. When one has the misfortune to come across the carcass of a "wild" cat gracing a barn door, it would be worth while to secure the skull. Dead cats *do* tell tales, for Dr. Hamilton assures us that the skull of the true *Felis catus* is a perfect image in little of that of the tiger, while the domestic cat reveals its Egyptian strain by a much narrower cranium.

The White Rhinoceros.

Some thirteen years ago that mighty hunter, Mr. Selous, contributed to the *Proceedings of the Zoological Society* an excellent paper upon the African Rhinoceroses. Formerly, and chiefly through the energies of the late Dr. Gray of the British Museum, a goodly number of species were believed to exist in that continent. Mr. Selous showed that there were really only two—the "white" and the "black." The distinctions of previous writers were mainly based upon the varying lengths and the proportions of the horns. The African Rhinoceros "Theodore," until recently alive at the Zoological Gardens, during the course of his long life in that menagerie belonged, on those assumptions, to two, if not three, different species at various times.

At a recent meeting of the Zoological Society, Mr. Coryndon gave some additional and welcome details about the now very rare "white" Rhinoceros. It is curious that this animal should have got the name, for it would appear to be blacker than the "black" Rhinoceros. The question of colour gets more involved from the circumstance that the older writers on the natural history of Africa distinctly speak of it as paler than the black *Rhinoceros bicornis*. *Rhinoceros simus* is now so rare that till quite lately there was only a single specimen in Europe. The Museum which had this unique animal was Leyden. Now, however, that Mr. Coryndon has succeeded in procuring two specimens in Mashonaland, we shall shortly see one at the British Museum; of the other the skin is to be placed in the Tring Museum, and the skeleton has been purchased by Cambridge University. The stuffed skin has been on exhibition at Mr. Rowland Ward's. In our opinion the head of Mr. Rothschild's specimen does not hang quite naturally, but the general effect is good, and the wrinkling of the skin round the nose and at the base of the ears is remarkably accurate. The bulk of the huge beast may be understood from the fact that it took thirty-seven "boys" to carry the skins and skeletons of two individuals. The approaching extinction of the animal is due chiefly to the fact that it cuts up into unusually good beef. The flavour of strange animals is almost invariably said to resemble veal, but this has apparently never been asserted of the white Rhinoceros. Opinions as to the disposition of the Rhinoceros vary. Mr. Selous regards them as not in the least dangerous, except through accident; though a wounded Rhinoceros may charge with terrible impetus, and may thereby produce direful results, he thinks that this is due to confusion and fright rather than to a wish for revenge. On the other hand, there are some who have stated that the Rhinoceroses of Africa are savage in their character.

Mr. Coryndon states that *Rhinoceros simus* stands, when fully adult, at least six feet high at the shoulder; it is, without doubt, the larger of the two certainly known species of Africa. Its main difference from *Rh. bicornis* is the square muzzle and the habit of cropping grass; the black Rhinoceros, on the other hand, has a pointed and slightly prehensile upper lip, which permits it to feed more easily upon the succulent twigs of shrubs.

The Lepidosiren and the Minhocão.

One of the most interesting exhibits of the season was made at the same meeting of the Zoological Society held on April 3 last, when Dr. Günther showed a few examples of the American *Lepidosiren paradoxa.* Considerable doubts in the minds of some people hung over the real existence of an American Dipnoid as distinct from the well-known African *Protopterus.* Dr. Howard Ayers, of the United States, declined to believe in its separate individuality. A few years ago (*Zool. Jahrbucher*, 1887) Dr. Baur emphasised the distinctness of the American from the African fish, and there is now not the faintest doubt about the matter. On all hands, however, it was admitted that the *Lepidosiren* of South America was a rare animal. According to Dr. Baur there were only four specimens of the fish in European Museums in 1887. Since then Professor Giglioli has got others, and the total number is increased by a quantity of specimens in the hands of a London dealer. But all this time in certain districts of Paraguay *Lepidosiren* was a common article of food. Few though the specimens of the *Lepidosiren* were in the Museums of this part of the world (apparently there were none at all in Rio de Janeiro), they succeeded in getting two names: it was attempted to distinguish *L. dissimilis* from *L. paradoxa.* The rarity of the fish induced various legends. It was reported by Saint Hilaire, on the authority of a Brazilian gentleman, that the *Lepidosiren* inhabited the great depths of huge lakes, into the waters of which, like the celebrated Snapping Turtle, it was able to drag horses and horned cattle. The native name was *Minhocão*, which signifies "large earthworm." And a further legend (no doubt derived from the name) shifted the scene of its operations to the soil, from which, as it passed through, it uprooted trees. Nothing more has been recently heard about this terrestrial sea-serpent; but there is no longer any room for doubt that the American *Lepidosiren* is an altogether distinct form from the African *Protopterus.*

In the fish exhibited at the Zoological Society Dr. Günther and Mr. Howes pointed out the curious peculiarity that the hind limbs of the male were ornamented with numerous branched villous processes. Figures of these were subsequently published by Professor E. Ray Lankester in *Nature* for April 12. Nothing of the kind is to be seen in its ally, the mud-fish of Africa.

A Blood-Sucking (?) Earthworm.

Speaking of wild beasts that are at once large, ferocious, and African, a correspondent sends us an interesting note about an earthworm. Africa has already produced the largest earthworm (*Microchæta rappi*) known to science, with the possible exception of *Megascolides australis* from Australia; but these are giants of a perfectly harmless kind. The worm to which we now refer is said, by Mr. Alvan Millson, Assistant Colonial Secretary at Lagos, on the West Coast of Africa, to inspire dread among the natives of that coast. Its appearance is against it: the worm is not only large—three or four feet

—but it is either of a rich, raw-beefy colour or of a lowering black, the difference of colour being a mark of a difference of species. On one occasion a number of natives were collected together when one of these giants strolled casually into the camp; the result appears to have been a rapid flight on the part of the natives. The reason for the awe-inspiring character of the worm is its reputed habit of sucking blood. It does not seem probable that the most recent results of zoological research are known in tropical Africa; but it is a curious coincidence that this research has tended to show that the line of separation between the leeches and earthworms is by no means so wide as it was at one time thought to be. This big earthworm of West Africa inhabits a locality that is remarkable; it does not, as do most earthworms, burrow constantly in the ground, throwing up castings, but lives in deserted hills of Termites.

Another Formidable Invertebrate.

Latrodectus formidabilis is an apparently well-named spider which flourishes in Chili to the detriment of any human beings who have rashly interfered with it. The spider is not large as spiders go; it is only 10 *mm.* (not quite half-an-inch) long. But, like many small creatures, its malignity and venom are out of all proportion to its size. Dr. Philippi tells us (*Zool. Garten*, vol. xxxv., no. 2), on behalf of a correspondent, Herr Möhlen, that an unfortunate man, bitten by the Arachnid, lost consciousness in half-an-hour, and was weak in the joints for a month afterwards. Children have been known to be killed by it. The pest is not a rarity either, for in a certain section of country two or three webs were found in every suitable locality that was examined. Another species, closely allied, lives in Spain and Italy. The Chilian spider is "warningly" coloured, with two bright red spots above, and two below upon its black abdomen. As we have noted before, Professor F. P. Borne has an elaborate monograph on this spider; several parts have already appeared in the *Actes Soc. Sci. Chili.*

Continuity in Species.

Once upon a time it was thought an obstacle to the theory of Descent in general, and to evolution by means of Natural Selection in particular, that the gaps existing between genera and between species were so hard to bridge over. Connecting links were absolutely demanded by the theorisers, but the working naturalist was unable to supply them. Let us not be misunderstood! We do not refer to intermediate forms between the larger groups, for these the ingenuity of morphologists soon discovered to exist in almost embarrassing profusion, nor do we refer to such interesting series as that furnished by the ancestors of the horse; but we refer to those minute gradations of form, each inappreciably different from the one before it, but all constituting a chain that should join, without a single break, two clearly distinct species. Anyone reading the interesting and most valuable book by Mr. Bateson that we review on another page, would suppose that precisely the same difficulty occurred to-day. It is the Discontinuity, as he phrases it, between existing species that has led Mr. Bateson to seek among the facts of variation for some means of overcoming or getting round this initial difficulty; and he thinks that he has found the solution of the problem in a precisely parallel Discontinuity of Variation. In short, *Natura facit saltum.*

Now we are not concerned to deny that discontinuous variations, more commonly known as "sports," often occur; though whether these, under natural conditions, give rise to similarly modified offspring, such as might be held to constitute a new species, or even variety, is a very different question, that has hitherto been answered in the affirmative only in a very few instances. But this also may pass. What we wish now, is to warn our readers against taking this difficulty of discontinuity too seriously. One noticeable form of advance, during recent years, has been the often successful attempt to work out the problem of the Origin of Species in particular cases. This is not to be done by collecting large numbers of co-existing specimens and arranging them in a line. By such methods discontinuity is likely enough to be found even within the limits of a species, as shown in our note on "Mathematical Biology" (vol. iv., p. 83.) The safest, if not the only method, is to take the actual historical facts presented by fossils from successive horizons, elucidating them by the facts of individual growth. It is thus that Beecher has traced the evolution of the species of *Bilobites* (*Orthis biloba*), and that Hyatt and others have been able to conneet the species of Ammonites, *e.g.*, *Coroniceras* (NATURAL SCIENCE, vol. ii., p. 279). Even sixteen years ago, in a very remarkable paper on "Transition Forms in Crinoids" (*Proc. Acad. Nat. Sci. Philadelphia*), Wachsmuth and Springer came to the conclusion that the changes between Burlington and Keokuk species "were made by a series of slow and gradual modifications of specific characters, which correspond in a striking manner with the changes in individual life by growth." To this conclusion, which is supported in the paper by abundant detail, they were led through the examination of a previously unworked passage-bed between the Keokuk and the Burlington. Had this never been discovered, or had it not been so fortunately rich in Crinoids, the species of the Keokuk would be still regarded as "discontinuous" both with one another and with their Burlington ancestors.

We cannot give more instances of continuity here. Mr. Bateson, of course, does not dispute them, or if he does, there are plenty more to be found in palæontological literature, especially of recent years. Neither do we dispute Mr. Bateson's instances of discontinuity. But we do wish to suggest that many cases of apparent discontinuity between species, or examples of discontinuous curves of error within the limits of one species, may be due merely to the fact that we are totally unacquainted with the ancestors of the individuals in question.

Faunal Sequence in Europe and South America.

In recent numbers we have had something to say about the correlation of geological horizons in different parts of the world (vol. iii., p. 404, and vol. iv., p. 8). In this connection, a paper by Mr. W. Möricke on fossils from the Lias and Inferior Oolite of Chili (*Neues Jahrbuch für Min.*, Beilageband ix., 1894) proves of considerable interest. It is astonishing to see how many species are considered to be identical with those of Europe, and still more so to see how the European succession is paralleled on the other side of the globe. Thus, a Lower Lias fauna is indicated by *Arietites cf. rotiformis*, *Spiriferina rostrata*, *Terebratula perforata*, Piette, *Rhynchonella plicatissima* and *R. belemnitica*, Quenst.; a Middle Lias fauna, by *Hildoceras lilli*, *Ægoceras jamesoni*, *Deroceras armatum*, *D. submuticum*, etc.; an Upper Lias fauna by *Harpoceras subplanatum*, *Hildoceras levisoni*, *H. comense*, *Pholadomya fidicula*, etc. In the Inferior Oolite the exactitude of the correlation seems even more remarkable: the Upper Lias strata "are followed by red, sandy limestones, which correspond to the zone of *A. sowerbyi* and *A. sauzei*. Besides *Sphæroceras sauzei* itself, they contain *S. cf. brocchi*, *S. polyschides*, *S. polymerum*, *Hammatoceras* (*Sonninia*) *polyacanthum*, Waagen, etc. . . . These limestones with *A. sauzei* are overlaid by a reddish-brown iron-shot oolite, several metres thick, which is rich in fossils . . . and yields the following species: — *Coeloceras humphriesianum* (d'Orb. *non* Sow.), *C. blagdeni* (Sow.), *Hammatoceras alleoni* (Dum.), *H. gonionotum* (Ben.)," etc. These are considered to indicate the *Humphriesianum*-beds.

It is certainly startling to read of South American species as definitely occurring in the *Humphriesianum*- or *Sauzei*-beds, especially when we remember that the latter have only been recognised in this country within the last few years. It is, however, possible to suggest a doubt as to the correctness of all these determinations and correlations. *Hammatoceras alleoni* and *H. gonionotum*, for instance, belong to a decidedly lower horizon in Europe; while species, as yet unnamed, which might be mistaken for *C. humphriesianum* or *C. blagdeni*, occur in this country in close association with those *Hammatocerata*. Moreover, it may not prove safe to trust these identifications too closely; at all events, fig. 4 of plate ii., which is named *Leioceras subplanatum* (Oppel), shows a specimen differing from that species in numerous points, and rather resembling *Grammoceras fallaciosum*, Bayle.

Apart from these minor doubts, we are fully prepared to learn that the faunal sequence in South America corresponds remarkably with that in Europe. Whether, as a consequence of this, it will be necessary to allow for the deposition of the strata of any given zone a vastly greater length of time than has hitherto been conceded, or whether Dr. Walther's explanation, quoted in our last number (p. 245), will suffice—these are questions that will soon demand an answer.

The Legs of Trilobites.

In Natural Science for September, 1893, we called attention to the interesting discoveries of Messrs. Valiant, Matthew, and Beecher, which enabled them to give a somewhat definite account of the appendages and antennæ of these extinct crustacea. Dr. Beecher has followed up his account by two more papers, the first of which (*American Geologist*, January, 1894) deals with "the mode of occurrence, and the structure and development of *Triarthrus becki*, and is founded on specimens obtained from the Utica shale (?) of Rome, New York. In this paper the definite structure of the legs of the thorax has been worked out in detail, and shows each limb to consist of "two nearly equal members, one of which was evidently used for crawling, and the other for swimming." "Each limb is composed of a stem, or shaft, with an outer branch (exopodite), and an inner branch (endopodite)." "The precise form of the coxal joint of the stem (coxopodite) has not yet been clearly made out. It is followed by a broad joint about twice as long as wide, which may be referred to the protopodite." Dr. Beecher says: "The final conclusions to be reached from a complete study of the development and structure of these animals can only yet be surmised. It is quite evident, however, that they are related to the true Crustacea."

In the second paper (*Amer. Journ. Sci.*, April, 1894) the structure of the appendages of the pygidium of *Triarthrus becki* is shown to be as follows: "The endopodites preserve their slender, jointed distal portion, but the proximal part is composed of segments which are considerably expanded transversely, thus making a paddle-like organ, the anterior edge of which is straight, while the posterior one is serrated by the projecting points of the expanded segments. These points bear small bundles of setæ."

An Eocene Pteropod.

The identification of a Pteropod in British Eocene strata is of considerable interest, when we remember that no less than six species are known from similar beds in the Paris basin. Mr. G. F. Harris gives a description and a figure of the new form, which he names *Euchilotheca elegans*, in the *Proceedings of the Malacological Society* (vol. i., no. 2). The specimen is incomplete, was found at Bracklesham, and belongs to the well-known Edwards Collection in the Natural History Museum. In the same journal, Mr. R. B. Newton redeems in part a promise made in his Systematic List of the Edwards Collection, by describing, in conjunction with Mr. Harris, several of the molluscan species recorded under *nomina nuda* in that Systematic List. We hope that these authors will continue the good work now begun, and rid scientific literature of a mass of names which are of no value and should never have got into print. An excellent point in these descriptions, is the placing of n. sp. (new species) after the names where given, and so making it clear that this is the first occurrence of the new specific name in literature.

Aids to Geologists.

It has often been our duty to criticise geological and palæontological text-books with a certain severity, and we have lamented the want of a good elementary text-book of palæontology in the English language. We, therefore, take the more pleasure in directing the attention of students to the second edition of Professor Cole's very useful "Aids to Practical Geology" (8vo. London: Griffin & Co. Price 8s. 6d.) It is true that this does not pose as a text-book, is indeed intended to supplement the text-book, but for all that it will prove more reliable and intelligible than many more pretentious manuals. The style is clear, the figures truly illustrative of the text, the examples of genera on the whole well chosen, the information commendably up to date, and the views of the more advanced as well as of conservative workers prudently set forth. As the first edition was, we believe, stereotyped, there are not many alterations in the body of the text, but this edition has been brought up to date by the insertion of notes in smaller type. As a rule the English student has to rely on foreign text-books in these branches of science; but this is a case in which we honestly think even the Germans might do worse than translate from us. We also take this opportunity of recommending to students, and indeed to all geologists, the thoroughly practical work of Mr. W. H. Penning, "A Text-book of Field Geology, with a section on Palæontology by A. J. Jukes-Browne" (Stanford), which has for some time been out of print. A second edition, however, has just been re-issued, with the addition of a chapter on Pioneer Surveying, chiefly illustrated by South African instances. It is a pity that the whole work could not have been brought a little more up to date, and issued as a third edition; but even in its present form, it is the best of the kind available.

Fossil Palm-Fruits.

In a recently-published monograph of the genus *Nipadites* (*Journal Linnean Society*, vol. xxx., p.143), Mr. Rendle figures a fine specimen of these fossil palm-fruits from the south coast. It measures five inches by four and a half, and is by far the finest example yet found in this country. For its discovery we have to thank Mr. Clement

Reid, who came upon a number of the fruits on a newly-exposed portion of the beach at West Wittering, near Selsea, in West Sussex, and who has since seen it at Hengistbury Head in Hampshire. More than fifty years ago, James Scott Bowerbank, the founder of the genus, described a number of species from the London clay at Sheppey; these are of various sizes, from that of an almond fruit upwards, but are all smaller than the specimens now in question, which closely resemble those found, often enclosed in concretionary nodules, at Schaerbeek and Woluwe, near Brussels. The only living representative is *Nipa fruticans*, a dwarf palm confined to the brackish estuaries and sea-board marshes of India and Malaya as far as Borneo, New Guinea, and the Philippines. The fruits are borne in large heads, and when ripe drop into the water, where they may float for some time. It is of interest to note that many of the fossil fruits are much bored by *Teredo*, showing that they also floated before becoming water-logged.

Anatomy and Plant Classification.

We would refer our readers to last month's number of the *Journal of Botany* for an able review, by Mr. C. B. Clarke, of the recently-issued volume of De Candolle's "Monographiæ Phanerogamarum," vol. viii., comprising the Guttiferæ, and the work of Julian Vesque. A novel feature is the wholesale use of anatomical details, special importance being assigned to the histological characters of the leaf. As the reviewer observes, the anatomical structure of leaves is rapidly altered by the environment, moisture, shade, and warmth. Hackel, a most painstaking and competent worker, could make no use of it in the grasses. Anatomical, like all other characters, have a variable value, and "are only one among a large number of other characters at least equally entitled to weight. Therefore, anatomical characters are not to be given a superior value, and to be allowed to swamp all other considerations, any more than the number of the stamens. There is no reason to suppose that the anatomy of the leaf is a better clue to the affinity of the plant than the position of the ovule." Mr. Clarke refers to Dr. Palla's revision of the genus *Scirpus*, where the attempt at a classification on a single character, the anatomy of the stem, has brought together plants from the whole range of the large tribes Cypereæ and Scirpeæ, which, though otherwise very different, display similar stem-characters. Happily, Mr. Vesque has not done this. His characters from leaf-anatomy are strictly subordinated to the general weight of all other characters, and "the utmost that can be said against the anatomical method, as introduced by Mr. Vesque, is that it makes his book 15 per cent. heavier than it otherwise would be; it does not make it more troublesome to find other matters."

An instance of the limits to the use of anatomy in the classification of plants is supplied by a paper by Miss Smith in the last issue of the *Journal of the Linnean Society* on the anatomy of a plant from Senegambia. The plant is one of striking and unusual appearance, but has neither flower nor fruit; and suggestions as to its affinity ranged from Lycopods and Conifers to Melastomaceæ, Acanthaceæ, and Thymelæaceæ. In plain English, nobody could make it out. Examination of the internal structure of the stem revealed the fact that it belonged to the Dicotyledonous division of flowering plants, while, according to the author, the occurrence of islands of soft bast tissue in the wood, and groups of phloëm at the periphery of the pith "considerably narrows down the systematic limits within which the plant must come." This notwithstanding, Miss Smith is doubtful whether its affinity is with the Loganiaceæ, Acanthaceæ, Peneaceæ, Gentianaceæ, or Melastomaceæ—a somewhat wide range —or even with any of these families.

The Preservation of Herbaria.

Botanists who dry plants may be glad to know of a time-saving device suggested by C. Michener in *Erythea* (March). Elsewhere, as in the climate of San Francisco, the problem is, how to dry your driers? for given a good supply of dry warm driers the rest is easy in comparison. The method described is as follows: In one corner of each drier, about an inch from its edges, a brass eyelet is inserted; through the eyelet is run a piece of light strong fish-line twenty-five to thirty feet long. On each line are strung from seventy-five to one hundred driers, which are kept from slipping off by a small iron ring at the ends of the cord. The eyelets are of such a size that the cord slips through them easily, and is no hindrance to using the driers, which remain strung during the whole operation, while laying the plant piles, changing the driers, and drying them. The outdoor part of the apparatus consists of several upright posts about thirty feet apart, into which hooks are screwed at every two feet. To dry a set of driers, the rings at the end of the cord are slipped over the hooks, and the driers distributed along the cord. Two posts can carry three or four lines, stretched one above the other. To bring the driers in, and get them into a pile ready for the next change, it is only necessary to push them along the line till they are in contact, and then unfasten the rings from the hooks. The author claims these advantages for his method: it does away with half the labour of spreading the driers to dry, and nine-tenths of the labour of picking them up when dried; both sides of the drier are exposed, and hence they do not come in contact with any surface, damp from dew, frost, or moisture; and the length of time required to dry them is also reduced. In the case of a sudden shower, the driers can be very quickly brought in, and there is no danger of their being blown away.

Recent Researches in Botany.

One of the early numbers of Natural Science contained an account of Treub's researches into the embryology of the genus *Casuarina*. So many new and important facts were brought to light in the course of his work that Treub was impelled to separate the family Casuarineæ, which this single genus constitutes, from the apetalous group of Dicotyledons, where it had hitherto been placed near the Cupuliferæ, and make it the sole member of a new class of flowering plants. This new class he named *Chalazogams*, the rest of the Phanerogams forming one great class of *Porogams*, the main distinctive character being the mode of approach of the pollen-tube to the embryo-sac in the process of fertilisation. In the second class the tube followed the normal course, namely, down the micropyle of the ovule, and so directly on to the top of the embryo-sac; but in the Casuarineæ an indirect route was taken, the tube passing along the side of the ovule down the chalaza, and entering one of the many macrospores or embryo-sacs at the lower end. Other points of interest in the embryology of this anomalous genus were the existence, not of a single macrospore, but of a number, which formed a sporogenous tissue, and of which several might develop very considerably; the presence of long tails to the developing macrospores, up which the pollen-tube ultimately made its way; the frequent appearance in the sporogenous tissue of pitted cells (tracheids), for which Treub could suggest no function; the branching of the pollen-tube, with the formation of recurved blind endings; the absence of antipodal cells in the embryo-sac; and finally the early assumption of a cell-wall by the egg-cell before the arrival of the end of the pollen-tube in its neighbourhood.

In the *Transactions of the Linnean Society* (2nd series, Botany, vol. iii., p. 409), Miss Benson now describes the results of some work on the Embryology of the Amentiferæ which, following on the above, are of great interest and importance. In the first place, she shows that it is no longer possible to classify merely the Casuarineæ by themselves as Chalazogams, for in the alder, birch, hazel, and hornbeam the pollen-tube takes the same indirect route, while there are other points of agreement between the strange Australian genus and our British catkin-bearing trees. Thus, whereas in the normal type hitherto found to be almost universal among Angiosperms, the macrospore originates from one of a single "axile row" of cells (archesporium), in the genera studied by Miss Benson a large number of such rows was present, forming a sporogenous tissue, in which, moreover, spindle-shaped cells frequently arose, developing, in the case of *Castanea*, into large and conspicuous tracheids. The prevalence of "cæca," formed by the embryo-sac, recalling the "tails" of the macrospores in *Casuarina*, is remarkable, as is also the branching of the pollen-tube and the formation of recurved endings.

These points of agreement are, however, "so mixed up with striking distinctions," that, so far, the author cannot claim to have found a counterpart to the extraordinary facts recorded by Treub. "We know nothing of an embryo-sac without antipodals, for they are present and very conspicuous in the British Amentiferæ. In *Betula*, *Alnus*, and the Cupuliferæ I have observed the fusing of the polar nuclei, and in every genus the presence of synergidæ and a *naked* egg-cell."

Miss Benson, in continuing her work, hopes to find some clue to the solution of the vexed problem of the homology of the antipodal cells and the fusion of the polar nuclei of the embryo-sac.

THE four papers contained in the first instalment of volume viii. of the *Annals of Botany* are somewhat diverse in origin. The first, by Professor Campbell, hails from California, and includes the result of some work on the development of *Marattia Douglasii*, the author having been fortunate in finding a large number of very young plants, and also the prothallia and embryos, while collecting in the Hawaiian islands two years ago. Professor Campbell claims to have shed more light on the position of the Marattiaceæ and the origin of Eusporangiatæ from the Bryophytes. Points of resemblance between the sexual generation of *Marattia* and the Liverwort *Anthoceros* are adduced in support of this descent.

In the next, Mr. H. H. Dixon describes his researches on the fertilisation of the Scotch Fir, carried out in the Botanical Institute of the Bonn University under Professor Strasburger's supervision. It is found that in *Pinus silvestris*, as already shown for the Yew by Belajeff, the nucleus of the pollen-tube is not the one efficient in fertilisation, as was formerly believed to be the case in Gymnosperms. As Strasburger had previously demonstrated, in Angiosperms this nucleus is asexual, the male sexual nucleus arising from one of the cells originally behind the nucleus of the pollen-tube. In the Scotch Fir a pair of cells borne on a stalk-cell are formed as the result of a few cell-divisions on the side of the pollen-grain opposite the point from which the tube emerges, and it is the nucleus of one cell of the pair which is sexually functional. The author traces their separation from the stalk-cell and passage down the tube, in which they are pursued and ultimately passed by the nucleus of the stalk-cell, which then becomes indistinguishable from the original nucleus of the pollen-tube. All four nuclei pass into the female cell, their path through which can often be traced by the grains of starch which enter at the same time. Only one of the pair of nuclei unites with the female nucleus, the other remaining in the protoplasm with the two asexual nuclei from the pollen-tube. In the Angiosperms, where a similar division into two similar sexual cells occurs, Strasburger was able to observe in one case the fertilisation of an oosphere by the two nuclei, indicating that both cells are truly sexual. It is suggested that the formation of two sexual cells in *Pinus* came about when the branching of the pollen-tube, which the author observed, was the rule, there being some probability of two branches reaching different oospheres. The author was unable to demonstrate a perforation of the pollen-tube, as Karsten has recently done, in the genus *Gnetum*, though the apex was often seen to be provided with a deep pit.

Mr. Farmer contributes the only indigenous paper—some studies on Liverworts, in which the histology of the nucleus is discussed in some detail. The last communication, by Mr. G. T. Peirce, is dated from Leipzig, and is a somewhat exhaustive account of the mode of twining of the dodder, including its response to geotropism and other external stimuli, and the mode of growth and penetration of the suckers into the tissue of the host-plant; in the last process chemical activity is found to take part.

Antarctic Explorations.

On p. 234 of our March number, we called attention to the efforts of the Scottish Geographical Society to awaken interest in Antarctic problems. We have now to record a paper by Dr. John Murray in the *Scottish Geographical Magazine* for April, entitled "Notes on an Important Geographical Discovery in the Antarctic Regions." The Norwegian schooner "Jason," Captain Larsen, while looking for seals, in November last year, found a comparatively open sea to the south of Louis Philippe Land and Joinville Island, and proceeded down along the margin of Antarctica to 68° 10′ S. latitude. This is over three degrees further than Ross's 1843 limit, and deserves the importance assigned to it by Dr. Murray. Some new islands were discovered by Captain Larsen at a point near 65° 7′ S. and 58° 22′ W., two of which were active volcanoes; and to these were given the names of "Sarsoe" and "Jason." The latitude reached by this sealing schooner was not so far south as that reached by Weddel in 1823, for he penetrated past the 74th meridian; but its interest lies in the fact that, in this last exploration, the margin of the land was followed the whole way, and thus nearly 300 miles of the southerly extension of Antarctica have become known to us.

In giving publicity to this interesting record, Dr. Murray points out what additions can be made to our geographical knowledge by a small sealing schooner, and urges the importance of a British expedition, properly equipped, and provided with steam-power, to investigate the geographical and natural history problems awaiting solution. We are glad to read that Captain Larsen left the Falkland Islands on the 17th January for another trip to the south, and we trust that this hardy seaman will have further discoveries to announce on his return home.

Johns Hopkins' University.

As we dealt largely in the April number with various English institutions, it is interesting to compare with them an institution in

America that combines many of the features scattered among various bodies in London. This institution is the University founded in Baltimore by Johns Hopkins, who died in 1837. The University Circular for February of this year contains an account of the foundation for the twenty years now completed, written by the President, Daniel C. Gilman. The aims of this University were formulated in an inaugural address by the President, as follows:—"An enduring foundation; a slow development; first local, then regional, then national influence; the most liberal promotion of all useful knowledge; the special provisions of such departments as are elsewhere neglected in the country; a generous affiliation with all other institutions, avoiding interferences and engaging in no rivalry; the encouragement of research; the promotion of young men, and the advancement of individual scholars, who by their excellences will advance the science they pursue, and the society where they dwell."

After paying a tribute to members of the academic staff, Dr. Gilman writes:—"The first requisite of success in any institution is a body of professors, each of whom gives freely the best of which he is capable. The best varies with the individual; one may be an admirable lecturer or teacher; another a profound thinker; a third a keen investigator; another a skilful experimenter; the next a man of great acquisitions; one may excel by his industry, another by his enthusiasm, another by his learning, another by his genius; but every member of a faculty should be distinguished by some uncommon attainments and by some special aptitudes, while the faculty as a whole should be united and co-operative. Each professor, according to his subject and his talents, should have his own best mode of working adjusted to and controlled by the exigencies of the institution with which he is associated."

About some Little-known Molluscs.

For many years past conchologists have been accustomed to reckon the three marine genera *Siphonaria*, *Gadinia*, and *Amphibola* as Pulmonates, despite certain striking peculiarities in their anatomy, on account of the common possession of a pulmonary cavity, supplemented, it is true, in the case of *Siphonaria*, by a gill.

In 1892, however, Haller showed that the last-named was, in point of fact, an Opisthobranch, and its true position next to *Umbrella*. Just lately Plati has come to the conclusion, from a careful investigation of *Gadinia*, that it, too, is an Opisthobranch, so that only *Amphibola* is left with the Pulmonates by Bouvier, who studied it in 1892.

I.

Continental Growth and Geological Periods.

(*Continued from p.* 298.)

Persistency of Drainage Lines.

THE ideas and considerations dealt with in the preceding part of this article bring us naturally to what is taking place in our own time. Since the Tertiary upheavals new lines of drainage and channels of erosion have been established, by which the waste of the land has been and is conveyed to the lowest levels, which are generally, but not always, in the ocean. That is to say, in some cases the drainage lines terminate in inland seas or hydrographic basins, in which the evaporation exceeds the rainfall. Such are the Aralo-Caspian basin and the Central Asian basin[11] in which are situated Lakes Balkash and Alakul, the Great Salt Lake and other areas in North America. Mediterranean seas, connected by an outflow or inflow, or both, like the Black Sea and the Mediterranean, bays such as the Gulf of Mexico, the Gulf of California, Hudson's Bay, etc., also receive their quota of sediment.

Though the general levels of the Continental lands have fluctuated, the main drainage lines—established and deeply cut into the strata they traverse—seem to be very persistent, so that the waste of a large part of the North American Continent has travelled down the Mississippi to the sea since Tertiary times. Similarly, that of the South American Continent has followed the lines of the Amazons, La Plata, and Orinoco, while that of the western area of both continents, cut off by the divide of the Andes and Rockies, extending from south lat. 50° to north lat. 70°, has perforce been cast into the Pacific Ocean or the embayments connected with it.

In the Continent of Africa the Congo delivers its load into the broad Atlantic, almost opposite to the Amazons, with a flood almost equal to, if not superior to it. The same persistence is seen in the rivers of Europe and Asiatic Russia and the Northern portion of North America delivering into the Arctic Ocean, and in the great rivers of China flowing eastward into the shallower eastern seas. These lines of drainage, as I have sought to show in the "Origin of Mountain

[11] *See* the "Physical Conditions of the Aralo-Caspian Region," Wm. Hewitt, Pres. Address L'pool Geol. Soc., *Proceedings*, 1892-3.

Ranges," have become fixed in their positions through the upheavals of mountain ranges; and the modifications they have undergone in their courses have been mainly confined to the hydrographic basins in which they exist, the most fluctuating portion of the rivers being on their own deltas. In cases where the levels of the watershed may not have been very marked, alterations of the drainage basins themselves have arisen through differential subsidence or elevation. Changes such as have been noted in the Oxus and Jaxartes in Central Asia have hardly involved a rearrangement of drainage basins considered on the large scale. The Ganges and Brahmapootra have rolled their floods into the Bay of Bengal since the final upheaval of the Himalayas. But it is unnecessary to multiply these instances.[12]

A Future Period.

It is now time to ask ourselves what is the meaning of this constancy and the persistence of these important physical features. Though differential subsidence and elevation on the large scale are marked on the one hand by raised beaches on the land, and on the other by deep-cut river beds below the level of the sea, as in the Congo and the great rivers on the North American Continent, what may be called the rugosities of surface represented by mountains never disappear excepting by denudation. Further rugosities get developed by faulting and mountain elevation in the locus of mountain ranges, by a persistence of the movements which have initiated them; but the great levellers, the waters and the atmosphere, with their combined chemical and dynamic action, bring their materials again under the displacing action of gravity, whereby, like water itself, they finally find their lowest level. Hence sediments accumulate and have been accumulating through Quaternary time, and were these actions to continue long enough without compensatory elevation, the whole of the land, as has been pointed out again and again, would disappear. On the other hand, were compensatory elevation to go on long enough, the whole of the sedimentary deposits would be stripped from the land, and we should be permitted to see what no one is certain he has ever yet seen, that is, the original crust of the earth.

It thus appears that, though these denudations are of long continuance, they must in the course of geologic history come to an end, for we find most of the land-areas covered with sedimentary deposits.

It follows, then, if the geologic history of our planet is to continue in the form in which it has done in the past, and not to terminate in stripped land-areas or universal levelling, that the sediments on the coasts and seas bounding our continents, which have been accumulating since Tertiary upheavals, must be themselves eventually raised above the waters, and joined on to the dry land. In what way has

12. Ramsay's "River Courses of England and Wales," *Q.J.G.S.*, 1872, and "On the Physical History of the Rhine," *Royal Instn.*, 1874, may be studied with advantage in this connection.

this occurred in the past? If we ascertain correctly, it will be the key to the future—a truly geological prophecy. That there is a relation of cause and effect between subsidence, sedimentation, and subsequent upheaval, it has been my object to point out in the "Origin of Mountain Ranges." In development of this idea, I seek to show how, as a consequence of this action and interaction, the earth's strata come to be divided into rock-groups containing distinguishing fossils and having each its characteristic lithological grouping, which we know as Periods.

If a great group of physical features lasts throughout vast eons of time, such as I have shown has happened even during the Quaternary period (which we are living in now, and which is likely to continue much longer), it is evident that the deposits will have a characteristic lithology—looked at in the large way—aud a fossiliferous *facies* will distinguish them from the Tertiary and preceding rock-groups. Representatives of the modern mollusca and the vertebrate and mammalian fauna and of the modern flora will be here and there embalmed to give further distinction to the strata and joy to future geologists. Among these fossils, works of art and fragments of ships, together with bricks and clinkers from ocean steamers, such as even now are occasionally dredged up in the Atlantic, will be a feature. I understand that when soundings come up with cinders attached to them the heart of the mariner rejoices, knowing that he is on beaten tracks, if so inappropriate a phrase is allowable in ocean navigation. Truly, if the world continueth through another geologic period, and there seems no reason to assume that it will not, as the internal forces are still alive making for rejuvenescence, the Quaternary will be the most distinct and remarkable period of all. Not only will the remains of man and his works up to the present be embalmed, but also those works still in the potentialities of the future to which we may, considering the progress of the last fifty years, look forward with mysterious expectation, if not awe. The future great period will include the present and terminate with the completion of the Quaternary.

Sediments of Existing Seas.

If the preceding reasoning has any cogency in it, there must exist on our coasts, at the mouths of the great continental rivers, enormous sedimentary deposits laid down since the close of the Tertiary. The denudation of the land since then, though late in geologic time, has been enormous. Whole areas have been stripped of their Tertiary covering and in mountain districts thousands of feet of strata removed. To go no further than our own isles, the Tertiary rocks that remain are but a fragment of what once existed.

The Miocene rocks of Antrim, Staffa, Eigg, Rum, and Skye consist chiefly of lava flows and ashes of great terrestrial volcanoes, which fill up the undulating valleys of the Chalk in Antrim, and those of Oolite and Silurian gneiss in what is now the West of Scotland.

According to Ramsay, these islands formed part of a "vast continent, to which the British Islands were united, and which, embracing Iceland, spread far to the north and west into the area of what is now the Atlantic, and on the south was united to Africa, when as yet the Mediterranean had no existence."[13]

Long before the extreme denudations represented by these fragments of a once continuous sheet took place, old rivers intersected this ancient land and scooped out valleys in the Miocene lavas and hills, which were again partly filled by torrents of basalt and obsidian. "Thus it happens that in the old volcanic plateaux, valleys a thousand feet deep have been excavated, and the whole region has by denudation been changed into a line of fragmentary islands the high sea-cliffs of which attest the greatness of the waste they have in time undergone."[14] Sir A. Geikie[15] says, speaking of Eigg, "Lastly, from the geology of this interesting island we learn, what can be nowhere in Britain more eloquently impressed upon us, that, geologically recent as that portion of the Tertiary period may be during which the volcanic rocks of Eigg were produced, it is yet separated from our own day by an interval sufficient for the removal of mountains, the obliteration of valleys, and the excavation of new valleys and glens where the hills then stood." Though we may not claim all this denudation for Quaternary time, since much of it may have taken place during the Pliocene with resultant Pliocene rocks now sunk beneath the sea, these quotations from eminent geologists may well serve to give us an inkling of the powers we are dealing with. According to Dana, the length of the Quaternary period up to now is one-third of the Tertiary.[16] This is but an approximate guess, but nevertheless a valuable one.

Turning our attention to North America, we may say that the Mississippi is at least as old as the Quaternary, and probably very much older. The elevation of the Rocky Mountain regions compelled the drainage of the continent to take a south-western course, while the older land of the Laurentian Highlands and the Appalachians blocked it from direct connection with the Atlantic except in the northern portions. It has been shown that since the elevation of the Uinta Mountains, which began in Cretaceous times, $3\frac{1}{2}$ cubic miles of rock have been removed from every square mile of their surface.[17] A large area of the central Mississippi Valley is occupied with Cretaceous rocks, while the southern part, bordering the Gulf of

[13] "Physical Geology and Geography of Great Britain," 5th ed., p. 263.

[14] "Physical Geology and Geography of Great Britain," 5th ed., p. 356.

[15] "On Tertiary Volcanic Rocks," *Q.J.G.S.*, vol. xxvii., p. 310.

[16] "Manual of Geology," 2nd ed., p. 586.

[17] "Origin of Mountain Ranges," p. 243. In a most interesting paper by Dr. Andrew Lawson, entitled, "The Post-Pliocene Diastrophism of the Coast of Southern California" (*Bulletin* of Dept. of Geol. University of California), it is shown that Pliocene sediments of over a mile thick, called the Merced series, were laid down on the Californian coast. This is an extraordinary example of the accumulation that has taken place in only the closing phases of the Tertiary period.

Mexico, is Tertiary (Eocene and Miocene), and a smaller portion consists of Quaternary deposits. This would seem to show that for a considerable period of time after the upheaval of the Rocky Mountain region continental conditions prevailed over this area, and that the sediments from its erosion and waste now lie at the bottom of the Atlantic.

Unfortunately we cannot read the earth's history with any fulness or accuracy. We may only see as through a glass darkly, but still we are justified in concluding from a consideration of these examples, which could be multiplied from well-nigh all the known world, that an enormous erosion of the land has taken place during the Quaternary period, and that these sediments, probably with those of an earlier period, now lie on the ocean floor, are still accumulating, and will accumulate until such time as the earth's living forces bring them up from below the waters to take their place as mountain, plain and valley in the unceasing cycle of the earth's changes.

Conditions of the Earth's Crust in which Sediments Accumulate, and Rate of Accumulation.

The conditions of the crust of the earth upon which these sediments are being laid down are as varied as the sediments themselves. While in the north-eastern portions of North America, from New York to Baffins Bay, there are no evidences of volcanic activity either in the present time or late geological past, south of New York we gradually approach a volcanic and earthquake area, crossing the Gulf of Mexico, and culminating in Central America. The West India Islands give frequent evidence of volcanic instability by the raised coral formations which are there met with, together with foraminiferal deposits considered to be of deep-sea origin.[18] Within this basin-shaped and almost closed Gulf of Mexico, deep-sea oozes are being laid down, and into this area, at one locality or another, the Mississippi has delivered its daily burden of sediment through, at least, Quaternary time. These spoils of the continental land will probably be interbedded with the lime deposits worn from coral reefs and with the more purely oceanic accumulations of foraminifera and other deep-sea forms of life.[19]

Fluctuations of level of the Mississippi mouth and valley may have given the terrigenous deposits a wider distribution than what obtains now. Borings in the Mississippi Valley show a subsidence of at least 630 feet at New Orleans.

If the land were upraised so as to represent the physiography of the time of this elevation, the sediments now being brought down this great drainage channel would be delivered further into the

[18] "On the Elevated Coral Reefs of Cuba," W. O. Crosby, *Proc. Boston Soc. of Nat. Hist.*, vol. xxii. ; "The Geology of Barbados," Jukes-Brown and Harrison, *Q.J.G.S.*, 1892, pp. 170–226.

[19] *See* three letters by Alex. Agassiz—"On the Dredging of the U.S. Steamer 'Blake,'" *Bull. Museum of Comparative Zoology, Harvard*, vol. v., 1878.

Mexican Gulf. Likely enough in portions of the Gulf in time past there may have been outflows of lava on the sea-bed. Volcanic intrusions in the form of sheets insinuated between the sedimentary beds are another form in which it is highly probable these inland igneous forces have developed themselves. If there be any justice in these inductions there must be immense accumulations existing in the Gulf of Mexico, for its area is not above one-third of that from which the sediments have beeen derived.[20] In addition we have the great denudations from the mountainous regions of tropical America and from Mexico.

The land sediments and the lime and silica eliminated from the waters of the sea by organic agencies, and ever being renewed by the decomposition of the rocks through the solvent action of rain-water aided by humic acids, must, together with igneous flows, intrusions and ashes, be building up rock-groups which will eventually form the framework of new land. None the less is this the case when the earth's crust has been long in apparent repose; for there surely will come a critical time when they will begin to react on the earth's interior, so that before being elevated into new land these portions of the earth may go through the volcanic cycle of change. We might in this way travel over the earth's surface and find in every part modified phases of the same actions in progress—for our planet has not yet lost its vitality. All along the west coast of the two Americas volcanic activity is adding to the thickness of the sea-bottom, and the ceaseless denudation of the great mountain ranges provides a covering on a still grander scale. On the Atlantic coast of South America the conditions of the coast are more general, but here a still greater load of sediment is being deposited by the Amazons, La Plata, Orinoco and other great rivers. On the African coast it is the same, and two of the greatest rivers of the world—the Amazons and Congo—pour their tropical floods and the spoils of the land on opposite sides of the Atlantic in the same parallels of latitude.

I have shown that the sediment from 21,000,000 square miles of land, the estimated area of the land draining into the Atlantic, would, at the rate of one foot per 3,000 years, fill up the North and South Atlantic, estimated at 21,000,000 square miles, two miles deep, in 32,000,000 years.[21]

With all this variety I have little doubt that the deposits as a whole will be differentiated from any that have gone before so as to justly enable the time in which they were laid down to be called a Period.

[20] In a valuable paper, entitled, "The Gulf of Mexico as a Measure of Isostacy" (*Ann. Journ. of Science*, vol. xliv., 1892, p. 188), McGee estimates the area of degradation at 1,800,000 square miles, and that of deposition at 100,000 square miles or one eighteenth. This may be true in relation to what is now taking place, but my assumption is that the area of deposition has shifted from one *locus* to another, being conditioned by elevation and subsidence.

[21] "Denudation of the Two Americas," Presidental Address, L'pool. Geol. Soc., 1885.

This will be due mainly to the persistence of the physiographic features of the land-areas, which will only change when the internal forces of the earth, reacting on the sedimentary mantle, develop expansion therein, and by lateral and vertical pressures and movements oftentimes renewed, develop those ridges of the earth called mountain chains, and so diversify the planet's surface by sketching out new land-surfaces where now is sea, thus modifying the form and conditions of the old continents.

General Conclusions.

The result of our reflections upon the group of facts which it has been the object of this paper to bring together in systematic order tends to show that the growth of land-areas of the globe is governed by certain laws of development. The records of the rocks tell us pretty plainly that there must, throughout geologic time, have existed land-areas on the globe comparable in extent with those now existing. It is not my intention to touch upon that vexed question, the permanence of ocean basins, or to sketch out the lines of former land-extensions. We have seen that land-areas grow by accretion from existing land. The ruins of former continents have added to their extent, so that by process of accretion their outlines and physiographic features have altered; therefore, the present continents, though the outgrowth of earlier ones, may be vastly different in form, position and orography from their predecessors. That the land-areas should have been preserved through geologic time, considering that their mean heights are so little above the water, has always presented itself to my mind as a geological crux. We now see that the waste of the land and the collection of the resultant sediments in the bordering seas is Nature's means of renewal, and we further gather that continuity of land-areas throughout geologic time, so necessary for the preservation of terrestrial life, is in this way secured. The origin of mountain ranges and the growth and decay of continents are thus closely related. New lands are the consequents of sedimentary loading and recurrent expansion, acting through a chain of events which I have dealt with in the "Origin of Mountain Ranges," and which seem to me to be the explanation which brings together all the hitherto isolated facts of geology into one comprehensible whole. Our planet's history is not one of fortuitous accident, but of development by law, and, as I believe, in the manner herein of necessity slightly and concisely sketched out.

It is through the labours of many geologists gathering facts out in the field in both hemispheres that we are enabled to approach the subject with any probability of a reasonable solution. As these facts accumulate we shall be in a better position to test, modify, and develop our theory. In the meantime, I have reasonable hopes that this outline may form a not unsuccessful guide in directing future investigators towards a true explanation of the earth's geologic vitality.

T. Mellard Reade.

II.

Wind and Flight.

IT is generally known that all birds turn their heads to the wind when they wish to rise. But the reason of this is not so simple as it is thought to be. If the wind were of perfectly uniform velocity, the bird could gain no assistance from it, and it would make no difference whether he looked down the wind or against it. The moment he left the ground, becoming part of the moving current, he would have, independently of what was gained by his own efforts, no relative velocity. What we feel as a wind might be looked upon as due to the earth revolving within its envelope of air, and this could not possibly affect the bird when once he had left the ground. However strong a breeze may be blowing, people in a balloon will not be conscious of it, unless they look down towards the earth and see the trees and the houses passing rapidly beneath them. If, however, as he rises, the bird is continually entering more rapid currents, then the inertia due to his having just left a stratum where the velocity is less, will cause the wind to act upon him as upon a kite, and assist in lifting him; whereas, if he has no inertia or momentum, he will not rise any more than a kite that has broken its string. It is well to insist upon this point, since even Professor Marey ("Vol des Oiseaux," p. 286) seems to have fallen into the error of supposing that a perfectly uniform breeze can be of assistance to a bird in mounting, if he turns his head towards it.

Mr. R. C. Gilson recently proposed to me to make some experiments in order to discover the rate of increase of velocity with increase of altitude, and to determine, if possible, up to what altitude the increase continues. These experiments were carried out, as far as circumstances allowed, with the assistance of Mr. J. T. Gilson last January. The place chosen was New Romney. There the large extent of flat sands and the absence of trees or cliffs render any irregular diversion of current unlikely. Experiments were first made at low levels with an anemometer. The following figures represent the averages struck from a considerable series of observations. It will be seen that with an occasional exception, due no doubt to the gustiness common to almost all winds, the increase in velocity grows less rapid as the elevation increases.

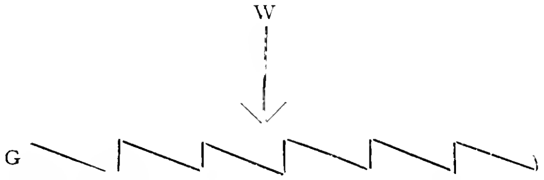
Altitude.	Velocity of wind per minute.	Altitude.	Velocity of wind per minute.
2 inches.	515 feet.	4 ft.	918 feet.
1 ft.	736½ ,,	7 ft. 6 in.	1,021 ,,
2 ft.	770 ,,		

A smaller series of similar experiments carried up to a height of 10 ft. 6 in. showed the same tendency. For greater altitudes the anemometer was to have been run up the string of a kite by means of a second string working through a pulley. But, unfortunately, an accident to the anemometer after a few trials made this method for the time impossible. We then fastened the kite to a spring balance and observed the pull at different heights, using a sextant to discover the exact elevation. Owing to alternating hurricanes and calms all work of the kind was often out of the question, and it is much to be regretted that we had not time to repeat the experiments. They seem to show, however, that there is a steady, though diminishing, increase up to a height of 240 ft. The pull registered at 357 ft. strikes the only false note in the scale, and when that was measured there was a drop in the wind that was perceptible to ourselves.

Altitude.	Pull of Kite.	Altitude.	Pull of Kite.
350 feet.	24 lbs.	126 feet	15–20 lbs.
420 ,,	25 ,,	60 ,,	14–19 ,,
357 ,,	19 ,,	42 ,,	11–20 ,,
204 ,,	18 ,,		

At low levels the jerking of the kite was a difficulty; there is also the question whether the greater length of string carried as the kite mounted higher may not have to some extent modified the results. Probably, however, the error due to the latter course was but slight.

Since making these experiments with a kite, I have tried the plan of letting go a number of small balloons, inflated with hydrogen gas in different degrees and allowing them to race; the larger rising to a height of 500 ft. or more, quite outpaced the lower. But as far as I could judge, small differences of elevation at the higher levels did not much affect the velocity. It would seem that larks in mounting continue to face the wind when they are too high to derive any benefit from it.



W = Direction of wind. G = Line of gull's flight.

While at New Romney I saw two illustrations of the cleverness of birds in turning the comparative slowness of the lower currents to account. Some gulls, wishing to make headway against the blizzard, flew so close to the ground that their wings almost touched it. On another occasion several were progressing at right angles to the wind, without any apparent movement of their wings, by flying downwards and then making a rapid turn and facing the wind, which, naturally, lifted them as they rose from the slower to the more rapid currents.

The annexed diagram will show this clearly.

At the same place I also made some experiments with a vane working vertically up and down. These were suggested by Lilienthal's book, "Der Vogelflug als Grundlage der Fliegekunst," where he comes to the fantastic conclusion that the normal direction of a wind blowing over a level plain is from 3° to 4° upward. If a vane under these conditions were to point upward, it would be more reasonable to regard the fact as an indication of the eccentricity of all vertical vanes, or of that particular one. My own vane had for its larger arm a piece of thin deal 1 ft. long by 6 in. broad, exactly balanced by a lump of lead attached to the shorter arm. It is true that so small a deviation as 3° to 4° would be hard to detect, but this instrument seemed to indicate that a wind blowing over a level expanse is perfectly horizontal. Experiments on the direction of the wind on, or on either side of, a small barrier, had more interest for me. While standing on a bank only 2 ft. high, its tripod lifting it 4 ft. above the bank, the vane pointed decidedly upward. Five yards to leeward of a bank 8 ft. high, it indicated that the wind blew downward, making a large angle with the horizon; there was but rarely an upward gust. Ten yards from the bank the direction was still mainly downward, but with not infrequent upward movements. At twenty and thirty yards distance the wind came in wild gusts, as often upward as downward. To windward of a bank only rising 5 ft. above the level at a distance of 12 yards, the vane was not quite steady, but, on the whole, horizontal. At six yards there were occasional upward swings; at four yards there was a decided upward tendency, and this though the bank itself presented only a very gentle upward incline.

These results seem to me most important in connection with the soaring of birds. Near a mountain top there must be a perpetual alternation of up and down gusts which a bird can utilise. Happily, there are still hilltops in Great Britain over which the raven and the buzzard can be seen rising in majestic spirals without a motion of the wings. Over a level plain is there any varying velocity available? It is hardly likely that after, say, 400 feet from the ground there is any appreciable increase of velocity with increase of altitude. There is, however, as I have remarked above, an irregularity of another kind even in the steadiest wind. It comes in gusts, and a gyrating adjutant or vulture, long practised in feeling the pulse of the wind, may perhaps make use of this fact, descending when the breeze blows strong, turning when it slackens, and holding himself so that the breeze, when it freshens again, may lift him like a kite.

F. W. Headley.

III.

The Natural History of the Flower.

THE past year was one of some interest in connection with this subject, in that it was the hundredth year since the publication of Christian Conrad Sprengel's book "Das entdeckte Geheimniss der Natur im Bau und in der Befruchtung der Blumen,"—"The Secret of Nature revealed in the Formation and Fertilisation of Flowers." Many papers have been written to celebrate the centenary: we may mention those of Knuth, Kirchner and Potonié, and one by the writer (in this Journal for April, 1893). A facsimile reprint of the classic work has also been published by Mayer and Müller, Berlin (8 marks), and will be found almost indispensable by those who take up this subject. Though it is 100 years since Sprengel started the study of flowers from this point of view, it is only during the last 40 years that any further work has been done, during which time the progress made has been very considerable. Of this work an excellent historical review is contained in the important paper by Macleod (see list), to which we refer later on. It is, unfortunately, in Dutch, but is not difficult to read.

The number of papers published during the last year is not very great, but many are large and some important. We shall deal in the first place with some of the smaller ones. Baroni has described *Rohdea japonica*, showing that it is fertilised by snails, insects, and perhaps worms. Briquet, in his monograph of *Galeopsis*, describes its mechanisms in detail. In *Freycinetia* Burck discovers the first case of a flower visited by bats. The male and female flowers are on separate plants (diœcious), and have large, bright rose-coloured fleshy bracts. These are visited and eaten by a bat (*Pteropus edulis*), which carries the pollen on its head from flower to flower. Miss Keller gives an account of the fertilisation of *Monarda fistulosa*, making the remarkable statement that in this conspicuous flower the anthers open in the bud and discharge some of their pollen upon the stigmas, which also open. The latter close; the flower opens and goes through the usual subsequent history, showing the protandry common in the genus. The same flower has also been described by Robertson and by the writer, who have agreed in looking upon it as well adapted to obtain cross-fertilisation by the agency chiefly of butterflies and large bees. Miss Keller's flowers were examined in November, and the lateness of the season may account for the curious results obtained. Kirchner gives an account of various plants, usually, but according to him wrongly, supposed to be fertilised by wind alone. These he states to be, to some extent at least, fertilised by insects. Among them are the vine (*Vitis vinifera*), mistletoe (*Viscum album*), *Castanea sativa*, *Chenopodium album*, and others. He also discusses many Umbelliferæ, and gives several examples of protogynous species (that is, having flowers in which the pistil matures before the stamens), chiefly American, in this usually protandrous order (that is, having flowers in which the anthers are ready to shed their pollen before the pistil is ready to receive it). Lagerheim describes insect fertilisation (entomophily) in one of the Cyperaceæ (*Dichromena ciliata*), found near Panama, which possesses colour as an attraction to the insects. Meehan again mentions a number of flowers that appear to be regularly self-fertilised, *e.g.*, Eye-bright (*Euphrasia officinalis*), evening primrose (*Œnothera biennis*), *Cakile americana*, *Trifolium hybridum*, *Malva rotundifolia* (apparently fertilised in the bud), and others. Raunkiaer describes the Danish Cyperaceæ, stating that they are all protogynous, but especially the hermaphrodite ones. Robertson continues his series of papers on flowers and insects in Illinois, describing the mechanisms and insect visitors of various flowers. One paper deals entirely with Umbelliferæ and one with Labiatæ, and reviews of these orders are given, summing up their general features. Scott Elliot describes the visitors of a few British plants, but no points of special interest are brought out. The writer has described several species of *Phacelia*, all showing a method of fertilisation similar to that of *Hydrophyllum*, but some of them adapted for cross-, some for self-fertilisation.

We now turn to the larger papers upon flowers and insects. Several such have appeared, notably by Heinsius, Knuth, Macleod, and Verhœff. Each of these deals fully with a number of plants in some definite locality, and describes the mechanisms and the insect visitors, so that a comparison can be drawn between the various districts. Heinsius describes a number of flowers and their visitors in the Netherlands: 410 visits were noted, 341 on plants also investigated by Müller. In only 140 of these cases were the visitors identical with those noted by Müller; but their general character, as to families, was almost the same. Knuth gives a sketch of the flowers and insects of Capri; only 43 species of the latter were found visiting flowers, while on the mainland there are at least 5,000; the flowers are in consequence sparingly visited and depend mainly upon self-fertilisation, in some cases showing modifications in the floral mechanism calculated to ensure this. The same writer describes the flowers and insects of the North Frisian Islands for comparison with the mainland. Verhœff describes those of Norderney (West Frisian Islands). The results of these writers agree fairly well with one another, and with those of previous workers, and tend to show the relative poorness of the islands in insects and the correlated fact that many flowers usually fertilised by insects have taken more fully to self-fertilisation, or to vegetative reproduction; the number of wind-fertilised plants, on the other hand, is larger in proportion than on the mainland. Lastly, Macleod publishes the first instalment of a great paper discussing the whole flora of West Flanders. A few new mechanisms are described, as well as many other plants which show some difference in their mechanism and visitors, when compared with the observations made by Müller and others who have studied them in different regions.

The chief interest of recent work upon flowers and their insect visitors seems thus to be in showing the variableness both of the mechanism and of the list of visitors, and the manner in which, when visitors are few, plants become more adapted to self-fertilisation, or take more largely to vegetative reproduction, a point which has been well brought out by Warming in his work upon flowers and insects in Greenland. It is evident from this that it is desirable to study each plant over a great part of its distribution area, and that it will not any longer suffice to say that a plant behaves in a certain way, or exhibits such and such a mechanism, without specifying where and when the observations were made. By careful study of plants in this manner, having regard not merely to their mechanisms for fertilisation in different places, but to the size and other relations of their parts, the profusion or otherwise of vegetative reproduction, the general composition of the flora (which largely determines the competition for insect visits), and other points, we may expect to obtain much valuable information bearing on the problems of geographical botany, of variation, and of evolution. It may here be pointed out that we possess at present scarcely any knowledge of the British flora in this direction. By a careful study of the genus *Medicago* in England, Burkill has observed that, while the mechanism is apparently the same as on the Continent, the visitors of the flower differ, and include a much larger proportion of flies than are observed abroad. The same worker, together with the present writer, has observed various flowers in Wales, and the results (as yet unpublished) support this view of the greater proportion of flies. Now this is just what Lindman and Aurivillius observed in the flora of northern Europe (Norway, Spitzbergen, Nova Zembla, etc.); hence our flora would seem rather more closely allied to these northern floras in this respect than to the nearer continental flora. It is to be hoped that this point may be worked out more fully.

Turning now to work in another direction, it is interesting to note that the experimental study of floral phenomena is making steady progress, and coming more and more into prominence. The most important paper of the year is probably that of Vöchting upon the influence of light upon the formation and development of flowers, especially cleistogamic flowers (those which never open and are necessarily self-fertilised). Plants of various kinds were grown at different distances from the laboratory windows during their flowering period; the flowers developed under these conditions being carefully measured and compared with the normal type. The first plant described is *Mimulus Tilingii*; here the flowers, developed in poor light, were smaller than the normal, and in the extreme cases did not develop at all, but aborted in the bud stage. An interesting point in the gradual diminution of the corolla was the difference in the rate of decrease of the upper and lower lips. Down to a certain size of flower their proportionate dimensions were nearly constant, but below this the upper lip decreased much more rapidly than the lower. In *Linaria spuria*, a plant which very commonly bears cleistogamic flowers in the wild state, the decrease of illumination resulted in flowers of this type only. Similarly with *Lamium amplexicaule* and other plants. Chickweed (*Stellaria media*), it was found, could be made to produce either ordinary or cleistogamic flowers by suitable illumination. In the wild state it is cleistogamic in bad weather. In *Melandrium album* it was observed that the corolla was the first organ to show a decrease with diminution of the light. From these experiments it follows that, for the normal development of a flower, a certain intensity of light is required; but this varies largely in different species. Low intensity of light results in reduced flowers, the reduction showing first of all in the corolla; in plants with a tendency to cleistogamy, flowers of this kind are produced. Hence we may look upon decrease of light, perhaps, as the primary cause of cleistogamy, calling forth incipient flowers of this type, upon which natural selection may come into play. Vöchting also observed, most markedly in *Mimulus Tilingii*, that the low degree of illumination tended to increase the vegetative activity of the plant. In *Mimulus* the axis of the inflorescence gave rise, instead of flowers, to numerous vegetative shoots. By suitable treatment, the flowers were prevented even from beginning development, and vegetative reproduction alone occurred. Cleistogamy has also been studied by Graebner, who considers that it may be brought about by other agents as well, *e.g.*, by temperature or the weakening action of fungi, etc., or, again, by an unsuitable relation of light to temperature (if one be raised, the other must also be raised, or abnormal floral development will occur). This view is also taken by the present writer, who has studied the behaviour of *Salvia verbenacea* and other plants.

It is thus evident that a study of the natural history of the flower from a physiological standpoint has already led to important results and may be expected to yield many more in the future. The present writer has studied the phenomena bearing on the various distributions of sex by the experimental method during the last four years, drawing therefrom the general conclusion that all these, as well as cleistogamy, are primarily due to the action upon the plant of external causes. Natural Selection apparently only begins to act later on, when the phenomenon in question has been to some extent produced by these causes.

In conclusion may be mentioned some lines on which it seems that profitable work may be done. Experimental investigation into the origin of such phenomena as the various forms of flowers in the same species is much to be desired; also full and thorough study of the flowers and insects of definite districts, especially in the tropics. Our own country remains still to be investigated in this respect. Isolated observations are of little value; the mechanisms of almost all the species of the British flora have been described—on continental plants. We need a thorough study of the whole flora of certain regions, having regard to the composition of the flora, the time of year, the insect visits, the vegetative reproduction of the plants, the exact sizes of their parts, and a comparison of the mechanism with that of the same plant as elsewhere observed. As a model of such work may be taken Macleod's last paper on the flowers of West Flanders. As another line of research, may be suggested the comparison of the same flower as regards size of parts, mechanism, visitors, etc., at different times of year, having careful regard to the weather, in order to obtain an insight into climatal effects upon the parts of the flower, the dichogamy, etc. Those who have access to a botanic garden may also do useful work in observing the mechanisms of exotic flowers, especially those belonging to the many natural orders hitherto untouched, though, owing to the absence of the proper insects, such observations will necessarily be one-sided. In this connection, finally, we may venture to recommend Knuth's short essay, "Ueber blütenbiologische Beobachtungen" (Kiel, 1893: Lipsius and Tischer, 1 mk.), in which is contained a good account of the present state of the flower-theory and the methods of observation in use for this investigation.

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IV.

Scorpions and their Geographical Distribution.

IT is a well-established fact that Scorpions have been in existence since the Middle Silurian era. But, unfortunately, almost all that we know of their geological history is furnished by a few specimens from beds of this age, and by a few more discovered in strata of the Coal period. It is also well known that the structural differences between the recent and the carboniferous fossil forms cannot be justifiably regarded in the light of an advance in organisation. In fact, as has already been more than once pointed out, these animals furnish an admirable example of a persistent type of life. From the persistence of structural characters, a persistence of habit may be inferred. At all events, there is little, if any, evidence that these animals, in the past days of their history, have ever gained a livelihood by means other than those employed at the present day. There is no reason for thinking that they have ever adopted an aquatic or arboreal mode of life, or have ever been dependent upon running or leaping powers for the capture of prey or avoidance of enemies; nor is there any foundation for the belief that any species has ever been helped in the struggle for existence by the assumption of any of those disguises of identity that are generally spoken of as protective colouration, or mimicry. That an abundance of time to become specialised into any number of strange forms has been granted them, must be admitted on all hands; but, perhaps, no fact connected with the existing species of Scorpions so forcibly strikes the student as the wonderful closeness of the connection between the different genera that have been established. There is, naturally, a considerable amount of structural variation, if two extremes be selected for comparison; yet the extremes are linked together by such a series of intermediate types that the division of the order into sharply-defined minor groups becomes a task of no small difficulty. Now, this is hardly what we should have looked for in a group of such vast antiquity. We should rather have expected to find the living population of Scorpions composed of a larger, or smaller, number of more or less isolated forms, the annectent types between which would have to be sought for in the records of their past geological history. But, considering that, for obvious reasons, there is practically no record of Scorpion-life between the Carboniferous times and our own day, it is, perhaps, not surprising that such small links as we require have not yet been found.

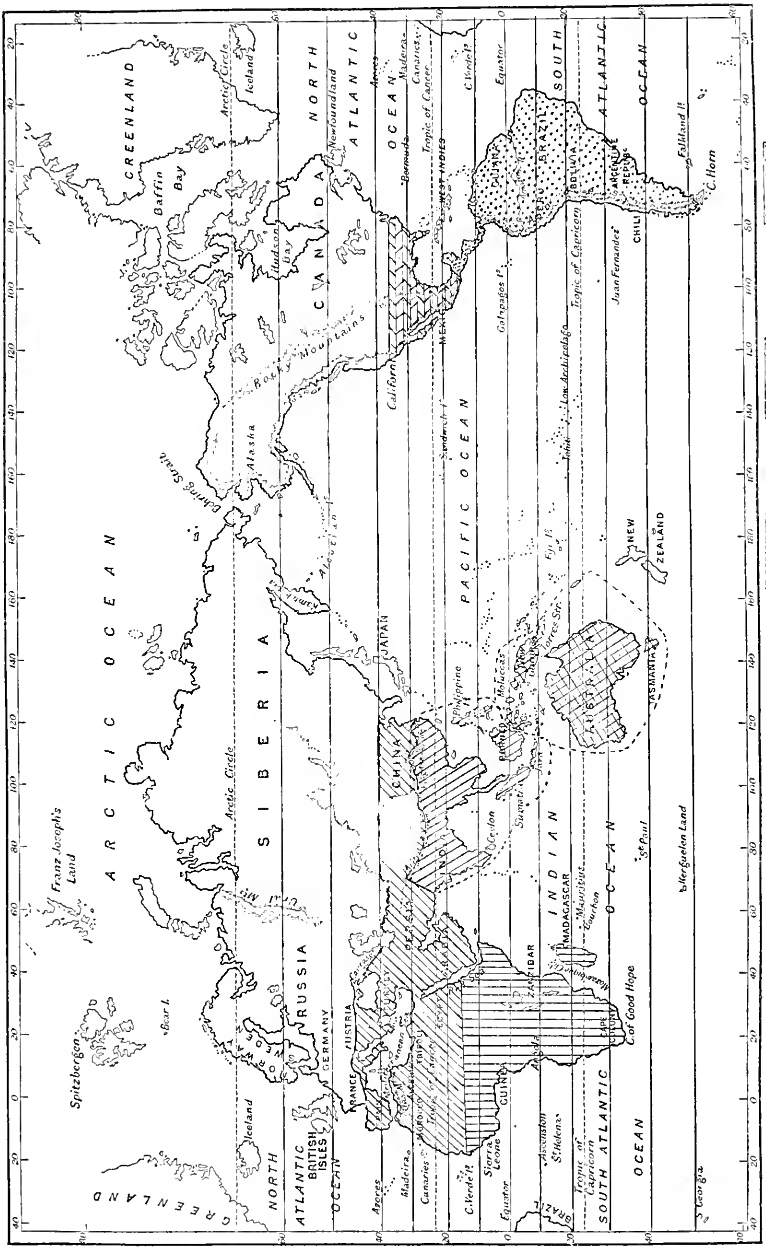
The relationship between the fossil and recent Scorpions has been summarised in the classification proposed some few years back by Dr. Thorell. According to this system, these animals are divisible into two great groups—the Apoxypodes, or those with pointed feet, including the Silurian *Palæophonus*, and the Dionychopodes for the Carboniferous Anthracoscorpii and the existing Neoscorpii, all of which have feet terminating in a couple of moveable claws. The chief distinctive feature between the two last-named divisions is the situation of the median eyes in the Anthracoscorpii close to the front border of the carapace, and in front of the lateral eyes. This archaic character, which is very noticeable in the Scorpion's relatives—*Thelyphonus*, *Phrynus*, and *Galeodes*—has not been retained by any existing genus of Scorpions; but, in the absence of evidence to the contrary, it seems justifiable to conclude that those recent forms in which the median ocular tubercle is in the anterior half of the carapace, approach the Anthracoscorpii more nearly than do those in which this tubercle is placed in or behind the middle of this plate. Judged by this test, the Scorpionidæ constitute the most specialised group; for in some of the genera of this family the eyes have moved back far past the middle of the carapace. In the Iuridæ, Buthidæ, Chactidæ, etc., on the contrary, the eyes are in the anterior half of the cephalothoracic shield.

Another test of specialisation seems to be furnished by the form of the sternum of the cephalothorax. In most Scorpions this plate is pentagonal; but in the majority of the Buthidæ it is reduced by lateral compression to a small longitudinally triangular sclerite, and in the Bothriuridæ by antero-posterior compression to a transversely-elongated plate. But that these two forms of the sternum are nothing but specialisations of the pentagonal type is shown by the fact that in the young of all Scorpions the pentagonal shape prevails.

One more apparent criterion of primitiveness may be mentioned. This is the presence in many of the Buthidæ of a spur upon the fifth segment of the last two pairs of limbs, this spur being seemingly homologous with a spur which has been figured by Thorell upon the corresponding segment of the legs in the Silurian *Palæophonus*. Moreover, it is important to note that among the genera of Buthidæ that possess this spur are those that have the sternum of the primitive pentagonal shape.

In the Buthidæ, then, and in no other group of Scorpions, we find genera that still retain the three archaic characters that have been mentioned, namely, the forward position of the median eyes, the pentagonal sternum, and the so-called tibial spurs. We would suggest, too, that the presence of a greater than the normal number of lateral ocelli in some of the Buthidæ may prove to be of interest in this connection. The usual number of these organs is three on each

Map of the World to Illustrate the Known Geographical Distribution of Recent Scorpions.



Regions:—Palæarctic. (= Mediterranean.) Ethiopian. Oriental. Australian. Nearctic. (= Sonoran.) Neotropical.

side; but in some of the Buthidæ there are as many as five, and the fact that these five may be observed in genera that are not especially related points to the conclusion that the ancestors of this family possessed this number; and this conclusion seems to be borne out by the circumstance that the nearest living ally of the Scorpions, namely, *Thelyphonus*, which we believe to be the most primitive of all the Epectinate Arachnida,[1] may also present five lateral ocelli on each side.

The conclusion that the Buthidæ are, on the whole, the most archaic of living Scorpions is borne out by a study of the geographical distribution of these animals; for, as will be seen in the sequel, this family is represented by peculiar genera in all the quarters of the globe where Scorpions exist.

The absence of proofs of their great antiquity, which was referred to in connection with the inter-relationships of the existing species of Scorpions, is also revealed no less remarkably by a study of their geographical distribution; for in this latter respect they show considerable resemblance to such a relatively recent group as the Mammalia. No doubt our knowledge of the recent species of this latter class is very much more complete than is our knowledge of the Arthropods in question; but so far as we have been able to ascertain, Wallace's map of the Zoological Regions of the world, if we eliminate the northern parts of the so-called Palæarctic and Nearctic Regions where Scorpions do not occur, is closely applicable to this group of animals. We may, therefore, without further words of preface, proceed to discuss the characteristic features of the various regions.

In the Palæarctic Region the northern limit of Scorpions in Europe and Western Asia appears in a general way to be defined by the mountain-chain of which the Pyrenees is the western and the Caucasus the eastern extremity. East of the Caspian they have not been recorded north of the 40th parallel, but they are known to occur at two places upon this line, namely, at Kashgar in Turkestan, and at Pekin in China. The two species from these localities are nearly allied to each other, and they unmistakably belong to the Mediterranean section of the genus *Buthus*. Furthermore, a species of *Buthus*, with distinct Palæarctic affinities, has recently been recorded from Shanghai. Consequently, we must conclude that the Mediterranean fauna extends from Spain and Algeria to the coast of China, with the probable omission of the table-land of Tibet. The southern limit of this area in China is, for want of data, uncertain; but since the Scorpions of Burma, Assam, and North India are totally different from those of Turkestan, Afghanistan, and Persia, we may

[1] Since, as Mr. Laurie has pointed out, the term Ctenophora, which I have recently assigned to the Scorpions as opposed to all other Arachnida which were called Lipoctena, is generally recognised as signifying a group of Cœlenterata, I wish to propose the terms Pectinifera and Epectinata as substitutes for the above.

safely adopt the boundaries that are usually recognised as separating the Palæarctic and Oriental Regions.

The exact limits between the Palæarctic and Ethiopian are also a little uncertain. Mr. Wallace draws the line of demarcation along the tropic of Cancer, and thus refers the northern half of Arabia to the former and the southern to the latter. But, with two exceptions, the Scorpions that occur at Aden, and at other parts of South Arabia, are either identical with Syrian and Egyptian forms, or are very nearly related to them. For instance, *Nebo*, which is met with at Aden and Muscat, is only known elsewhere from Syria and Egypt; *Hemiscorpius* has been obtained at Aden and Baghdad; *Buthus quinque-striatus*, a common Egyptian species, extends to Perim Island and South Arabia, and the Algerian and Egyptian *Prionurus australis* has been received from Muscat. On the other hand, the only Ethiopian types which are found in South Arabia are a species of *Scorpio* and *Parabuthus liosoma*, which ranges from Egypt to Masai-land. Clearly, therefore, the Mediterranean element in South Arabia far surpasses the Ethiopian, and the whole of this country must consequently be looked upon as part of the Palæarctic Region. In Africa it is impossible to draw a hard and fast line until more collecting has been done. We know nothing of the species which presumably inhabit the vast tract lying between Abyssinia on the east and Senegambia and Guinea on the west. On the west coast of the Red Sea, however, the Mediterranean element is represented at Massowah and at Zaila, in Somali-land, by a variety of the Spanish and North African *Buthus europæus*; but species of the essentially Ethiopian genus *Scorpio* extend into Nubia and Abyssinia. A similar partial overlapping of the two faunas occurs on the West Coast of North Africa, namely, in Senegambia, which is the northern limit of *Scorpio*, and the southern limit of *Buthus europæus* and *Prionurus australis*. We may, therefore, draw the line between these two regions along the 15th parallel or thereabouts.

The following is a list of the Palæarctic genera with the known range of each. Those that are peculiar to the region are marked with an asterisk:—**Heterometrus*, two species, North Africa, Syria; **Nebo*, two or three species, Syria, Egypt, and Aden; **Hemiscorpius*, Baghdad, Aden; **Iurus*, one species, Greece, Asia Minor, Egypt; **Belisarius*, one species, Pyrenees; **Euscorpius*, many species, Spain and Algeria to Asia Minor; **Prionurus*, two species, North Africa to Persia and Arabia; *Buthus*, many species, North Africa, South Europe, Persia to Pekin; **Butheolus*, two species, Sicily, Arabia, Persia; *Parabuthus*, one species, Egypt, Arabia.

The Ethiopian Region is very rich in Scorpions, and contains a large number of peculiar genera. It embraces Africa south of the 15th parallel, and Madagascar, the two areas representing distinct sub-regions. The African sub-region is peopled with Scorpionidæ, Ischnuridæ, and Buthidæ. The following is a list of the genera:—

(Scorpionidæ) *Scorpio*, about half a dozen species, Senegambia and the Congo to Abyssinia and Nyassa-land; **Miæphonus*, two species, Caffraria, Damara-land; **Œcopetrus*, two species, Damara-land, Mozambique; **Opisthophthalmus*, many species, Mozambique, Namaqua-land, Cape Colony; (Ischnuridæ) **Ischnurus*, several species, from Angola and Mozambique southwards; **Opisthocentrus*, four or five species, Congo, Transvaal, and Cape Colony; **Chiromachus*, one species, Mozambique; (Buthidæ) **Uroplectes*, several species, Nyassa-land and Cape Colony; **Lepreus*, many species, southwards from the Congo and Somali-land; *Archisometrus*, two species, Congo, Nyassa-land; **Babycurus*, several species, Old Calabar and Angola to Masai-land; *Parabuthus*, several species, Abyssinia, Benguela, Cape Colony; *Buthus*, a few species only, Senegambia and Abyssinia to Caffraria.

At the present time we unfortunately have no intimate knowledge of the Scorpions of Madagascar. Two peculiar genera of Buthidæ, however, namely *Grosphus* and *Tityobuthus*, occur, and two species ascribed to *Babycurus* have been recorded; there is also one peculiar species of *Opisthocentrus* known. The last two are African genera and the first two are essentially African in their affinities. It is, however, highly interesting to note the apparent absence from this continental island of almost all the large African genera of Scorpionidæ and Ischnuridæ. The differences between the genera of Buthidæ inhabiting Africa and Madagascar point to long separation between the two areas; while the absence from Madagascar of the Scorpionidæ seems to indicate that the latter made their way into Africa after the separation had been effected.

The Oriental Region offers some points of resemblance to the African portion of the Ethiopian; but on the whole the two faunas are very distinct. The following genera are known:—(Scorpionidæ) *Scorpio*, several species, India, Ceylon, Java; **Palamnæus*, about four species, Bengal to Borneo and the Philippines; (Ischnuridæ) **Iomachus*, one species, South India; *Hormurus*, one or two species, from Burma eastwards; (Iuridæ) **Scorpiops*, several species, North India, Burma; **Chærilus*, several species, Cashmere and Ceylon to Borneo; (Bothriuridæ) **Timogenes*, one species, Sumatra; (Buthidæ) *Buthus*, one species, India; *Isometrus*, two species, South India, Assam; *Archisometrus*, several species, India, Ceylon, and Burma eastwards; **Charmus* (*Heterocharmus*), three species, Ceylon. The region seems separable into two sub-regions, a western or Indian, containing Ceylon and the greater part of India, and an eastern or Indo-Malayan, extending from Cashmere along the Himalayas to Burma, and thence southwards and eastwards to Borneo and the Philippines. Characteristic of the Indian sub-region is the genus *Scorpio*, which in the Indo-Malayan sub-region has only two representatives, occurring in Sumatra and Java; the single Indian species of *Buthus*, too, does not appear to pass into Burma, while *Iomachus* and *Charmus* are not known from the east side of the Bay of Bengal. In the Indo-Malayan sub-region the genus *Scorpio* is almost entirely replaced by its near ally, *Palamnæus*, which ranges from Bengal to Borneo and the Philippines. *Hormurus australasiæ* and *Archisometrus mucronatus* have approximately the same range as *Palamnæus*, and are not known from India or Ceylon, while the genera *Scorpiops* and *Chærilus* extend from Cashmere into Assam, Burma, and Tenasserim. Here *Scorpiops*, of which one peculiar species has been recorded from the Deccan, reaches its limit; but *Chærilus*, which is also represented by a peculiar form in Ceylon, passes into Java, Sumatra, and Borneo. These two genera are of special interest, inasmuch as they are allied to the Palæarctic genera *Iurus* and *Euscorpius*, and thus indicate faunistic affinity between the Oriental and Palæarctic regions. A corresponding but rather closer affinity is indicated with the Ethiopian Region by the presence of *Scorpio* in India and Ceylon, and of *Archisometrus* over the whole Oriental Region.

The Australian Region is not easily separable from the Oriental where the two are nearly contiguous. It may be divided into two sub-regions, a northern insular portion or Austro-Malaya, and a southern continental portion or Australia. The following genera are represented:—(Ischnuridæ) *Hormurus*, several species, Celebes, Papua, Solomon Islands, New Caledonia, E. Australia; (Urodacidæ) **Urodacus*, several species, Australia; (Bothriuridæ) *Cercophonius*, one species, Australia; (Buthidæ) *Isometrus*, one species, E. Australia; *Archisometrus*, about three species, Celebes and Flores, Australia; **Isometroides*, two species, Australia. The Australian sub-region is recognisable from the Austro-Malayan by the presence of the genera *Urodacus*, *Cercophonius*, and *Isometroides*, which do not extend into the latter area. This Austro-Malayan sub-region is near akin to the Indo-Malayan. Two species, namely *Archisometrus mucronatus* and *Hormurus australasiæ*, are common to the two; and the characteristically Oriental genus *Chærilus* is represented by a single species in Celebes. But with the exception of *H. australasiæ*, the genus *Hormurus*, of which there is a peculiar species in New Caledonia, does not appear to cross Wallace's Line. There are no indigenous species of Scorpions in New Zealand and none, so far as has been ascertained, in the Pacific Islands.

In North America the northern limit of Scorpions seems to be situated between the 35th and 40th parallels. They thus belong to the Sonoran Province of Merriam. To the west of the Rockies these animals have been recorded from California and Utah; and to the east of this mountain chain they appear to extend into Kansas, Carolina, and Virginia. To the south, that is in Central America, the fauna seems to blend with that of the Neotropical. At all events, we have not sufficient data to enable us to define accurately the limits between the two regions.

Characteristic genera of the Sonoran Province are **Uroctonus* (*Anuroctonus*), three species, California, Utah, Virginia; **Hadrurus*, one species, Utah, California; **Vejovis*, several species, Carolina, Texas, and Utah; and *Centrurus*, two or three species, from Georgia, Florida, Texas, Kansas, and California. Of these *Uroctonus* does not appear to pass into Mexico; but *Hadrurus hirsutus* extends certainly as far as Jalapa, while *Vejovis* is represented by many species in various parts of Mexico, but does not, so far as is known to me, spread into Nicaragua or Costa Rica. Consequently, we must conclude that the greater part of Mexico belongs to the Sonoran Province. The genus *Centrurus*, which inhabits the southern States, seems to form part of the Neotropical fauna; for it is represented by several species inhabiting Central America, the West Indies, Colombia, etc. Similarly, *Diplocentrus* is common to the two regions, since it occurs in Texas, Mexico, the West Indies, and Brazil. But with these exceptions the Neotropical fauna of America, including Panama and all the countries to the south of it, as well as the West Indies, is very distinct from that of all other countries. The following genera are found:—(Diplocentridæ) *Diplocentrus*, two or three species, West Indies, Brazil; (Ischnuridæ) **Opisthacanthus* one species, Panama, Colombia; (Iuridæ) **Hadruroides*, four or five species, West Indies, Peru, Bolivia; **Caraboctonus*, one species, Chili, Brazil; (Chactidæ) **Broteas*, four species, Guiana, Brazil, La Plata; **Megacormus*, one species, Mexico; **Broteochactas*, three species, Guiana, Venezuela, Colombia; **Hadrurochactas*, one species, British Guiana; **Teuthraustes* two species, Eucador; **Chactas* and **Heterochactas*, about twelve species, Venezuela, Colombia, Ecuador, Peru; (Bothriuridæ) **Bothriurus*, six or eight species, Peru, Chili, Uruguay, South Brazil; **Brachistosternus*, three or four species, Peru, Chili, Argentine; **Mecocentrus*, one species, Brazil; **Phoniocercus*, one species, Brazil; **Thestylus*, one species, Brazil; **Centromachus*, one species, Chili; **Urophonius*, two species, Chili, Argentine, Uruguay; (Buthidæ) *Centrurus*, many species, West Indies, Colombia, Chili; **Heteroctenus*, two species, Hayti, Mexico, Brazil; **Tityus*, many species, Mexico, West Indies, Colombia, Brazil, Argentine; **Ananteris*, one species, Brazil.

These data show how very specialised is the Neotropical fauna. The Chactidæ are confined to the region, and, with the possible exception of *Cercophonius*, none of the Neotropical genera of Bothriuridæ are found elsewhere. Moreover, three out of the four genera of Buthidæ are peculiar; so, too, is the single genus of Ischnuridæ, while the remaining genus of Buthidæ occurs elsewhere only in the Sonoran Province of North America.

Nothing is known of the Scorpions of Patagonia. Darwin, however, tells us that they are found at least as far to the south as the 47th parallel. It is, of course, highly probable that the species of this country will prove to be nearly related to those of the Argentine Republic.

At present our limited knowledge makes it hardly possible to divide the Neotropical Region into sub-regions. In a general way, however, the northern parts of the area seem to be characterised by the presence of Chactidæ, and the southern by the presence of Bothriuridæ; and it is interesting to note that both of these groups are absent from the West Indies. There are, too, some further points of interest connected with these islands. For instance, the species known from the larger islands—*i.e.*, Cuba, Jamaica, Hayti, and Porto Rico—are, for the most part, also found on the mainland of Central or South America; while the species that have been obtained in the smaller islands to the south-east—*e.g.*, Montserrat, St. Lucia, St. Vincent, and Grenada—are peculiar forms of the Central and South American genera *Tityus* and *Diplocentrus*.

Some of the facts connected with the distribution of Scorpions set forth in the preceding paragraphs offer interesting points for further discussion.

It is to be observed, in the first place, that arms of the sea constitute barriers which these animals cannot pass; yet, although their means of dispersal are very limited, the antiquity of the group is so great that it has succeeded in distributing itself over all the contiguous land areas of the globe. In fact, as we have seen, these animals have been met with in all parts of the continents which have been explored, with the exception of the colder parts of the Northern Hemisphere, and in all continental islands with the single exception of New Zealand. But we know that in pre-Glacial Tertiary times they extended in Europe as far to the north as what is now the southern shore of the Baltic; and there cannot be much doubt, one would think, that their absence at the present day from all that area of the Northern Hemisphere which lies north of the 45th parallel of latitude is to be attributed to the recent glaciation of this part of the world.

But their absence from New Zealand is not to be so easily explained away. It is clear, however, that we have to account for the fact upon one of two hypotheses, namely, that they have never succeeded in reaching the country in question, or that they have been exterminated since arriving there.

The first hypothesis, however, seems hardly likely to be the true one, if there has ever been an uninterrupted and long-continued land-connection between New Zealand and the south-eastern parts of Asia by way of Australia or Austro-Malaya. But if, on the other hand, the connecting land was composed merely of islands, the intervening seas would probably have afforded an effectual barrier to their migration.

With regard to the hypothesis of extermination, it may be said that, so far as is known, there is nothing in the physical conditions of New Zealand antagonistic to Scorpion life, and it must be left to the geologists to decide whether there is any evidence in favour of the glaciation of this country which would account for the extermination of Scorpions, supposing they had ever succeeded in establishing themselves there. For myself, I am disposed to think that none of the recent groups of Scorpions have ever been represented in New Zealand; in which case it seems certain that the existing Scorpion population of Australia made its way, like the Mammalia, into the latter country after the isolation of New Zealand.

So, too, with Madagascar. The absence of nearly all the large Ethiopian forms from this island shows that the severance from the mainland took place before the typical African genera had appeared in the country. And the presence in Madagascar of genera of Buthidæ and Ischnuridæ, peculiar but with marked African affinities, points to the conclusion that, at the time of the connection with Africa, species of these two families were the principal if not the sole representatives of Scorpions in the Ethiopian Region.

A discussion of the fauna of Madagascar naturally leads us to inquire whether a study of the distribution of Scorpions affords any support to the hypothesis of a former direct connection between this island and the Oriental Region. But since there is no similarity between the species of the two areas, we may dismiss the subject by saying that the Scorpions do not furnish a particle of evidence that the union has ever been more complete than it is at present.

The absence of evidence in favour of Lemuria obviously suggests an examination of the question of the existence of Antarctica, to which many other groups bear witness. But here again all the evidence is on the negative side. For, firstly, there is the absence of Scorpions from New Zealand; secondly, total dissimilarity between the Scorpions of Madagascar and Australia, and of South Africa and South America; and, lastly, the almost complete want of resemblance between the Scorpions of Australia and those of South America. The one point of resemblance between these two countries is the presence in Australia of a genus of the Bothriuridæ, a family which is almost exclusively confined to the Neotropical area. This case has been cited by Mr. Forbes, in his interesting paper on the Chatham Islands, as an item of evidence in favour of Antarctica. But, since furnishing Mr. Forbes with the information that the Australian *Cercophonius squama* occurs also in Chili, I have found grounds for doubting the truth of the evidence upon which the information was based. If, however, it is so, the fact of its being the *same* species that occurs on these two shores of the South Pacific favours the view of artificial or fortuitous introduction; for apart from this one there is not a single species or even genus which is common to the Old and New Worlds. But whether or not the genus *Cercophonius* occurs in Australia and South America, we still have to account for the presence in the former country of a Scorpion belonging to a family which is typically South American. It is possible, of course, that this may be explained, as Mr. Forbes supposed, on the hypothesis of a southern land-connection between the two countries. But this is not the only theory that will account for the circumstance; for it is possible that the family to which the genera belong had once a wide extension in the Northern Hemisphere, and that although exterminated, for the most part, in the keener competition of more northern areas, some of the genera, like the Marsupial Mammals, have found places of refuge in the countries to which they are now restricted; and this supposition is borne out by the fact that a solitary representative of the family has been recently discovered in Sumatra.

It is necessary to bear in mind that the general absence of similarity between the Scorpions of the three southern extensions of land is not of the same value in disproving the former existence of Antarctica as is the absence of similarity between Madagascar and the Oriental Region in disproving the existence of Lemuria; for while it is clear that the Scorpions could have freely migrated across a land lying in the centre of the tropical Indian Ocean, it is equally clear that, unless there was a long-continued genial climate in the Antarctic Seas, they could never have succeeded in making their way even along the northern coast-line of the southern continent that Mr. Forbes has delineated.

A further modification of Sclater and Wallace's Zoö-geographical Map that has been suggested, and often adopted, is the union of the so-called Nearctic and Palæarctic into one region, for which the term Holarctic has been proposed; but a study of the distribution of Scorpions affords no support to this change, inasmuch as it shows that none of the genera extend from one region to the other, and even when the families are taken into consideration, it is found that the similarity between the Palæarctic and Nearctic is no greater than that between the Palæarctic and Oriental.

There still remain one or two apparent anomalies in the distribution of some of the families of Scorpions to be accounted for. The first and strangest of these, furnished by the Ischnuridæ, is the unquestionably close relationship that exists between the exclusively South African genus *Opisthocentrus* and the genus *Opisthacanthus*, which is restricted to Panama, Colombia, etc. A somewhat similar peculiarity is found in the case of the two known genera of the Diplocentridæ, namely, *Diplocentrus*, which is found in the Antilles and Central America, and *Nebo*, which occurs in Arabia, Egypt, and Syria. Again, coming further to the north, we find that in the Iuridæ the Levantine genus *Iurus* has one of its nearest allies in the Californian *Uroctonus*, and that the Neotropical group of the Chactidæ has a South European representative in *Euscorpius*.

These four cases, taken together, seem to me to point to the conclusion that, at one period, these families had a widely-extended range in the Northern Hemisphere, and were enabled thereby to pass from Eastern Asia into Western North America. And the one item of information we possess regarding comparatively recent fossil Scorpions is corroborative of this supposition. I refer to the case of a Scorpion described as a *Tityus* from the amber beds of the Baltic. From this we learn that, in pre-Miocene Tertiary times, Scorpions in Europe reached as far to the north as the 55th parallel, that is, to about the same latitude as the chain of islands which now connects Kamschatka with Alaska. Moreover, although the generic determination of this Scorpion cannot be unreservedly accepted, yet it is highly important to note that, at the present day, in the Old World the only Scorpions which could reasonably be identified as *Tityus* are found to the south of the tropic of Cancer. It seems, therefore, legitimate to conclude that in pre-Glacial Tertiary times the ancestors of our existing Old World tropical Scorpion fauna extended far enough to the north in the Europæo-Asiatic continent to pass freely along any land-connection with North America. But the advent of glacial conditions in later Tertiary times, and the consequent extermination of the Scorpions in the northern parts of the Northern Hemisphere, would soon put an end to the intercourse between the Asiatic and North American species; and these, under the changed conditions, might have become differentiated into the distinct types which inhabit these countries at the present day.

This supposition, then, of the former wide distribution in the Northern Hemisphere of the ancestors of the Ischnuridæ and other tropical or sub-tropical families, furnishes, it seems to me, the most satisfactory explanation of the resemblances and differences that are observable between the Scorpions of the Old and New Worlds. Moreover, the restriction of the Diplocentridæ and Ischnuridæ at the present time in South America to the northern parts of this region points to relatively recent immigration of these groups from North America. In fact, it seems probable that they made their way into the country at a time when it was occupied by ancestors of the existing Neotropical Bothriuridæ and Buthidæ; and this last conclusion points to the further one that these latter two families belong to an older type than the two before-mentioned groups, which are nearly related to the Scorpionidæ. This hypothesis, too, is borne out by the confinement of the Bothriuridæ in the Eastern Hemisphere to Sumatra and Australia, and by the fact that, although the Buthidæ are cosmopolitan in their range, yet peculiar genera of the family are found in South Africa, Madagascar, Ceylon, Australia, and South America.

R. I. POCOCK.

V.

Further Notes upon Habits of Insects.

IN a former review contributed to NATURAL SCIENCE (vol. iii., p. 267), I referred to Herr Verhoeff's researches into the habits of the social and solitary wasps and bees. This interesting subject has lately received further attention from a French observer, M. Paul Marchal, who (1, 2) gives details of the habits of two genera of the digging or fossorial wasps—*Bembex* and *Crabro*. He observed *Bembex rostrata* on coast sand-hills, and watched the operations of digging the nest and catching the prey to serve as food for the grubs. The prey of *Bembex* consists of species of *Eristalis*—large two-winged hovering-flies. M. Marchal collected a stock of these insects and, having attached the end of a silk thread to a leg of each, conveyed them to the haunts of the *Bembex*, where he let one fly, retaining the other end of the thread. The *Bembex* seized the *Eristalis* with great rapidity, held the fly back downwards beneath her body and pierced it with her sting. On releasing the fly from its captor, it was found to be quite motionless, except for feeble movements of the jaws and abdominal viscera, and in a few days it was dead and began to dry up. Fabre established the fact that *Bembex* brings a fresh fly each day to her progeny; hence there is no necessity that the life of the victim should be prolonged, as in the case of the prey of many sand-wasps.

On some occasions M. Marchal was surprised to find the *Bembices* engaged in furious and apparently aimless digging, giving the observer "l'impression d'être de véritables maniaques." His captive flies were neglected, or one put directly in front of the *Bembex* only caused the wasp to move away a few inches and recommence her strange pastime. This is clearly an aberration of the instinct of nest-making, and M. Marchal suggests that it may overcome the insect when, by reason of a high wind or otherwise, she is prevented from hunting.

Crabro cephalotes was observed to make her nest in an old felled walnut tree, by forming a tunnel curved like an irregular **3**, from which proceeded branches, some of them forked: at the end of these were the cells where the eggs were laid and the grubs hatched. Each cell was sealed with a plug of sawdust filling up its branch of the tunnel, after the wasp had placed in it from six to ten paralysed flies—mostly *Syrphi*. In carrying these into the nest, she was observed to walk on five or four legs, holding the prey beneath her by one or both legs of the intermediate pair. All her maternal care did not ensure the safety of her offspring from the attacks of a large ichneumon fly, *Ephialtes albicinctus*, which was found in the tunnel, and whose grub and pupa were found in the cocoons of the *Crabro*. The pupa (the limbs of which are, as is usual in hymenoptera, free) can turn itself over when disturbed.

In the paper in Natural Science already mentioned, I also referred to Dr. Sharp's researches upon stridulation in ants. M. Ch. Janet has (3) been working at the same subject, but, like the former observers mentioned by Dr. Sharp, he does not distinguish between the true stridulating organs and the ordinary sculpture of the segments. He mentions that a number of red ants (*Myrmica*) imprisoned between two pieces of glass fixed by cement, made a noise like the gentle boiling of water in a closed vessel, when their prison was held to the ear. The noise was specially audible when the ants were irritated by the observer blowing between the two pieces of glass.

In Natural Science for November last (vol. iii., p. 353), Mr. Rothera gave us an interesting paper on gall-producing insects, in which he brought forward arguments against the view that the formation of a gall is due to poison deposited with the egg in the plant by the parent insect. Dr. F. Heim, however, in a recent memoir (4), defends this view. His observations were not made upon any of the gall-flies (Cynipidæ), but upon a species of saw-fly (*Nematus salicis*, Jur.[1]), whose grubs pass their early stage within galls produced upon the leaves of willows. The female fly appears in May and makes a triangular cut close to one of the veins of the leaf; in this the eggs and poison are laid, and the gall is formed before the grub is hatched. It is evident, therefore, that the malformation cannot be due to any mechanical irritation by the larva, but from Mr. Rothera's article it appears that in such a case he would attribute it to some chemical irritant in the egg. The gall takes three or four weeks to attain its full size, by which time it appears as an ellipsoidal swelling, 1 cm. long, 5 mm. wide, and 5 mm. thick, of a paler green than the normal hue of the leaf, and with a somewhat purplish tint. Transverse sections showed the gall to have an epidermis with thickened cuticle, almost destitute of stomata; beneath this were cells containing a red colouring matter, shown by chemical tests to be a derivative of tannin, like the pigments found in fruits; the internal layer consisted of small cells, very rich in chlorophyll. The grub, when hatched, is of the usual saw-fly type and colourless, but becomes greenish by feeding. It undergoes no moult within the gall. After two or three weeks it makes a round opening in its habitation, by

[1] This insect is not *Nematus salicis*, L., whose grubs do not live in galls, but spend all their lives free on the leaves. I have not been able to trace the synonymy.

which, a few days later, it emerges, and passes the rest of its life, which lasts several weeks more, feeding freely upon the leaves of the tree. This is an observation of much interest, giving us a link between the habits of grubs like those of *N. salicis*, L., which feed openly all their lives, and those like *N. salicis-cinereæ* and *N. gallicola*, which do not come out of their galls till nearly ready to pupate. The pupal stage of the present species is passed in a cocoon buried in the ground. The brood of flies, consisting entirely of females, appears in August, and a parthenogenetic egg-laying ensues. The grubs of this second generation pass through a similar experience to those of the summer brood, and are full-fed by the time the leaves of their food-tree are ready to fall. The winter is passed by the insects underground as pupæ, and among the flies produced from these in the following spring a few males are found. Thus, as in so many other cases among insects, sexual and virgin reproduction alternate.

Dr. Heim concludes his memoir with some general considerations on galls, in which, as already mentioned, he defends the view that those structures are due to the action of poison injected by the parent insect. He compares the dense parenchyma of the gall of *Nematus* with the cell-proliferation which occurs in cancerous tissues in man, criticises M. Beyerinck's comparison of the structure of galls to that of shoots, and calls attention to the analogy between galls and fruits, suggesting that the action of the insect-poison on the leaf-tissues is comparable to that of a secretion of the pollen-tube upon the carpels of a fertilised flower.

Though the hymenoptera surpass all other insects in the interest of their habits, much is to be learnt from the other orders. Dr. A. Seitz has recently (5) collected a large number of noteworthy facts regarding the butterflies and moths, with special reference to their feeding in the larval and perfect stages. The first meal of a young caterpillar is well-known to be often its empty egg-shell; from this it turns to feed upon the leaves whereon its provident parent had laid her eggs. But in a few cases hatching takes place in winter or early spring, and the young larvæ have then to find a temporary food until their own special plant is available. For example, the caterpillars of some species of *Xanthia* and other noctuid moths feed at first upon willow-catkins. All who have tried to rear caterpillars know that, while those of some species will feed only on one particular species of plant, others will eat several species of the same genus or family, while others again are still less particular, some being able to feed on almost any green herb. That caterpillars, in this respect, have often very nice tastes there can be no doubt, and Dr. Seitz suggests further that the jaws of certain species are unable to bite leaves of different textures. It is curious to note how certain species change their food in different localities, a caterpillar confined to one plant in one place being less particular elsewhere. Individual aberrations in food are of special interest, in suggesting the starting point for a change in the race. When we consider the vast numbers of the lepidoptera, and the structural modifications which they have undergone, their generally faithful adherence to a vegetable diet (mostly leaves, rarely wood) is remarkable. The clothes-moths (Tineids) have invaded our dwellings and found a congenial food-stuff for their larvæ in our garments. A few small species of the same group (*Ephestia*) are reared in meal and other human food-stores, while the caterpillars of some pyralid moths (*Asopia*, *Aglossa*) feed upon kitchen refuse. Two species of crambid moths (*Aphomia sociella* and *Galleria melonella*) find a home in bee-hives, where their caterpillars feed upon the wax, while the waxy secretion from the body of the great American lantern-fly (*Fulgora candelaria*) serves both as shelter and food for the caterpillar of the moth *Epipyrops anomala*. Very few caterpillars have developed a thoroughly carnivorous habit. *Cosmia trapezina* feeds on oak and other leaves, but devours smaller caterpillars which happen to get in its way, and if shaken from the tree, eats other larvæ while climbing the trunk. *Xylina ornithopus* and a few other species are said to be always carnivorous when opportunity offers; the small looping caterpillar of a "pug"-moth (*Eupithecia coronata*) has been observed to eat a larva three times as big as itself. The caterpillars of *Orthosia pistacina* live together in peace while their food is moist, but devour each other when it dries up; this is true cannibalism—a term which should not be applied to the habit of preying on another species. Dr. Seitz remarks that in vertebrate animals also, thirst is more maddening than hunger. Cannibalism has been observed in a few other cases. Patagonia yields several examples of carnivorous caterpillars, as might be expected from the poverty of its flora. A few carnivorous caterpillars do not attack other caterpillars, but prey upon insects of different kinds; among these *Fenescia tarquinius*, which eats aphides, and *Erastria scitula*, which feeds upon scale insects, must be reckoned as benefactors to mankind.

The life-history of the latter moth has lately been worked out in detail by Dr. H. Rouzaud, and is described (6) by Professor V. Riley. It inhabits the shores of the Mediterranean, and its caterpillar devours the coccids upon various fruit-trees, specially the black-scale (*Lecanium oleæ*) of the olive. The moth, which is a small noctuid, the white markings on whose wings give it the appearance of a bird-dropping when at rest in the daytime, appears in May, and lays her eggs, singly and far apart, upon the trees infested by the coccids. When hatched, the young caterpillar selects a large female coccid, eats its way through the scale, and devours the insect beneath; having done this it makes its way to a fresh victim. As it increases in size it forms a case for itself made of the scales of its victims, excrement, etc., bound together by silk which it spins, and, protected by this covering, which closely resembles the smut-covered bark of the tree, it roams about during its later stages, devouring several coccids every day. The caterpillar is short and stumpy in shape, tapering towards the head, and recalling in appearance the maggots of some flies. Only the three hinder pairs of pro-legs are functional; those on the fifth and sixth abdominal segments are used for walking, the hindmost pair being attached to the case, which they keep in position. When full-fed, the caterpillar chooses a crevice in the bark or a fork between two branches, where it fixes its case, spins a cocoon, and pupates, having first taken the precaution to gnaw an aperture through which the moth can come out. So rapid is the transformation, that four or five broods follow each other during the summer. The execution upon the coccids must, therefore, be very great, and Professor Riley states that it is intended to import the moth into California, where it is hoped that it may prove as serviceable as the other predatory insects which have been introduced there to make war upon the destroyers of the fruit-trees.

After discussing carnivorous caterpillars, Dr. Seitz gives instances of the habit of nest-making which some caterpillars practise, living in colonies, with the web spun by their united labour as a protection. The influence of the food of the larva upon the colour and size of the imago is next considered. Some observers have thought that the sex of the moth is affected by the food of the caterpillar, poverty of nutriment producing males; but Dr. Seitz points out that the fact on which this rests—that some neglected larvæ of a batch pupating early produced males, and the rest, fed afterwards, females—is better explained by supposing a tendency to an earlier development of males, or proterandry (if a botanical term may be borrowed). There can be little doubt that the sex is irrevocably fixed in the egg. The difference of feeding by which bees can rear a worker or a queen at will is not, of course, an instance of determination of sex by food, as the worker is only an infertile female.

Dr. Seitz discusses also the causes which govern the time of development of a species, pointing out the advantage of rapid growth, when climatic conditions permit, in giving rise to several broods, and thus enormously increasing the number of individuals. The relation between caterpillar and imago, as regards size, is of considerable interest, the body of the latter being in some cases much smaller than that of the former, while in others the difference is less marked. In some moths we find a complete division of labour between the larval and perfect stages, the former being entirely devoted to feeding, the latter to reproduction. In such the mouth-organs of the moth, which lives but a few days, are vestigial. Dr. Seitz suggests that, as this condition exists in some of the most primitive families (Cossidæ, Hepialidæ), these may have come down to us unchanged from a period anterior to that of honey-bearing flowers. In some of the highest moth-families, however (Saturniidæ, Arctiidæ), we find the same state of things, and it seems more likely that in all cases it is a degradation and not a survival. A review of the habits of the butterflies and moths which do feed concludes Dr. Seitz's paper. He mentions various observations of these insects drinking water, or dew from leaves, and gives a list of the very unsavoury substances for which they sometimes forsake their normal food—honey. Blood from the wound of an animal is one of these not generally known. The advantages taken by collectors of such aberrant tastes are sufficiently familiar; it is sad to remember that gorgeous butterflies can be lured to capture by a bait of putrid meat, and moths by a mixture of treacle and intoxicating drink.

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GEO. H. CARPENTER.

SOME NEW BOOKS.

Mr. Bateson on Variation.

Materials for the Study of Variation, Treated with Especial Regard to Discontinuity in the Origin of Species. By William Bateson, M.A., Fellow of St. John's College, Cambridge. London: Macmillan & Co., 1894. Price 21s. nett.

Those who have been following the progress of the science of morphology in recent years must have noticed a change in its attitude and methods, a change to which Natural Science has repeatedly called attention. The details of Comparative Anatomy and Embryology are being investigated with continued enthusiasm, but there is a chastened spirit in the matter of basing huge generalisations upon particular facts. In the study of the cell and nucleus, and of the physical nature of protoplasm, results so novel and so interesting are being obtained, that no doubt we over-estimate greatly their theoretical importance. But the other results of microscopy certainly we do not exaggerate. The centre of gravity of morphological investigation is changing. Many are working at what Professor Lankester aptly called Bionomics, the study of organisms as they actually live; others are making experimental enquiries in teratology, in cross-breeding, on the ovum and spermatozoon, and Mr. Bateson, Professor Weldon, and others are studying variation in new ways. All these are matters which, in the first enthusiasm for studying anatomy and embryology in the new light of Darwinism, morphologists considered questions for the curious rather than for the scientific. But as Mr. Bateson insists in his preface, the problem of species has not been solved by anatomy and embryology, and we must turn to new ways for new lights. In discussing Mr. Bateson's book, I shall endeavour rather to give an account of it than to present in detail many objections to his method of argument. For whether or no it is on Mr. Bateson's lines that the problem of species will find solution, undoubtedly his ingenious and careful work should serve to stimulate many to a side of biological inquiry too long neglected. Let me, then, endeavour to present the main lines of his argument. The salient feature of life is that the forms of living things are diverse. Those who study groups may differ as to which characters are specific, but the naturalist and the man in the street are agreed that species are different kinds of animals not to be confounded. Species are what Mr. Bateson calls "discontinuous" in the main, although occasionally linking forms and doubtful cases occur. Next, it is obvious that specific forms fit, on the whole, the places in which they have to live. The third simple fact is that in the succession from parent to offspring variation occurs. Mr. Bateson assumes the doctrine of descent, or, as he puts it, that the specific differences between species and species have come about through, and are compounded of, the individual differences between parent and offspring. He assumes it because there is a balance of evidence in its favour, and because if it is not true we can get no further with the problem. According to Lamarck's solution of the problem of species, organisms make an appropriate structural and physiological response to the environment, and by the inheritance and accumulation of these, species arise. According to Darwin, in the struggle for existence, those of occurring variations which are in the direction of adaptation survive, the others do not. Cases of adaptation, as Lamarck understood it, are, says Mr. Bateson, significantly few, while Natural Selection is a true cause.

On the other hand, upon both theories specific diversity of form is dependent on diversity of environment, and apparently identical species live in most different environments, while apparently closely-allied but distinct species live under apparently identical conditions. In this Mr. Bateson sees an ultimate difficulty, insoluble by previously-existing facts and methods. His new method is to study variation. Mr. Bateson then dismisses the Recapitulation Theory as corroborating only the general theory of descent, and as inapplicable to the history of individual cases. He dismisses also the study of adaptation until such time as there be with it exact information about the actual amount of preservation caused by particular adaptations. He lays great stress on the familiar difficulty of accounting by Natural Selection for the incipient stages of adaptation, and finally suggests that a study of variation may reveal that the discontinuity of species arises from a discontinuity of variation. As he regards discontinuity in species as the chief difficulty, he proposes for the present to consider evidence only of discontinuity in variation. Next, Mr. Bateson proposes to consider chiefly variation with regard to symmetry. In almost every living thing pattern and symmetry are a striking feature, so much so that, if we understood pattern and symmetry, we should not be far from understanding organism. A great part of symmetry depends on repetition of parts, and for this Mr. Bateson employs the new term *merism.* Numerical and geometrical variation is of frequent occurrence. Mr. Bateson calls it meristic, and the evidence in this book deals almost entirely with it. It is of importance, first because differences in number and symmetry are frequently specific differences between organisms, and, therefore, because meristic change has occurred in evolution. It is found that meristic variation is very often discontinuous, in some cases of repetition always so. This, of course, suggests that the magnitude of the integral steps by which variation proceeds is often greater than most have supposed. *Substantive* variation. or variation in the actual quality of the elements of an organic structure, is in most cases to be distinguished carefully from *meristic* variation, although the two may occur in conjunction.

He sees in merism a general law of the organic world, and therefore dismisses all attempts to make metameric repetition an indication of community of descent—as, for instance, in seeking segmented invertebrates as the necessary ancestors of segmented vertebrates. Still more he repudiates the attempt to assign individual values to the members of a meristic series, as, for instance, the attempt to definitely compare and homologise the nerves in all the groups of vertebrates.

He draws an analogy between asexual reproduction and the production of a meristic series, and suggests that variation among the members of a meristic series may occur just as variation, although comparatively rarely, may occur among asexually-produced individuals. Similarly, he compares the relations between a paired metameric series to the relations between the first two segmentation spheres of an ovum, separation of which, as Driesch and E. B. Wilson have shown, causes, when complete, two individuals, when incomplete, a double monster.

To make plain what he means by discontinuity in variation, Mr. Bateson gives a number of instances of discontinuity in substantive variation. In the case of 583 mature male earwigs collected at the same time, in the same locality, it was found that the length of the forceps varied from two and a half to nine millimetres. In the most common cases of variation of this kind, it is found that, when a curve is drawn of which the ordinates represent the numbers of individuals, and the abscissæ the lengths, that the curve is a simple one, corresponding to what is called a curve of error. In other words, individuals with a mean length are the most common, individuals with extreme lengths, above and below the average, are most rare. In Mr. Bateson's earwigs there were two curves of error, two common kinds of earwigs. About 120 had a length of three and a half mm., about 90 of seven mm., and the numbers tapered off to the extremes and to the mean.

Sudden variations of colour are very common, and as these are generally from one colour directly to another colour without intermediate shades, it is clear that colour-variation may be discontinuous. Other common discontinuous variations are hairless mice or rats, bull-dog headed fish, and so forth. As typical examples of what he means by discontinuity in meristic variation, Mr. Bateson takes two cases. The first is where a flower—for instance a tulip—has all the parts in multiples of four, instead of in multiples of three. The change is complete, the division into four and the resulting symmetry is as perfect as the normal division into three. The second case is that of the tarsus of the leg of a blackbeetle. Usually this consists of five joints, but as a common variation the tarsus of one side may consist only of four. But in this case, as in the tulip, the new symmetry is complete. The four-jointed tarsus is of the usual length, and it is as perfectly shaped, and apparently as workmanlike a production, as the normal form. These two cases show what Mr. Bateson's extended observations clearly establish. Variations so massive as to be clearly discontinuous with the normal form, show for the most part no trace of monstrosity or irregularity, but are so clearly co-ordinated to their function, and to the general symmetry of the body, that only by actual knowledge can the variation be detected. If a number of examples of the variation were placed in the hands of an observer, who, though otherwise competent, were ignorant of the particular animals or plants, he would detect nothing unusual in the variations given him. Speaking generally, Mr. Bateson finds that what Galton called positions of organic stability occur in variations. Just as in species there is a mean form, on either side of which slight irregularities taper off, so in most variations there is a normal or mean form, round which slight irregularities of the variation cluster. This suggests to him that the discontinuity in species may be an expression of the discontinuity of variations. Of course he puts forward this view, not so much as an actual solution, as a direction in which the study of variation may profitably proceed. He suggests, in fact, that it is worth while enquiring whether the definiteness of animal and plant types be not due to the physical limitations of variation rather than to adaptation to environment. In connection with this, he draws attention to the obvious fact that as growth depends upon cell-division, many of the problems of organic structure may resolve themselves into problems of the physiology of division. Similarly, in questions of qualitative change, questions of what he calls substantive variation, many of the problems will resolve themselves ultimately into chemical problems. Chemical compounds are themselves discontinuous, and if the chemical nature of a substance be altered at all, it will be changed either inappreciably or completely.

After this introductory matter, which alone can be treated of at any length in a short account of Mr. Bateson's book, the author passes directly to the exposition of the large number of cases of meristic variation he has examined. These are arranged under various natural headings, and are described under consecutive numbers, so that future additions and references can be made very simply. It is impossible to exaggerate the skill and care with which this has been done, and there can be no question that a most excellent introduction to the study of variation has been written.

Although it is quite certain that a just appreciation of the value of the general conclusions Mr. Bateson foreshadows can be reached only after a long study, not only of Mr. Bateson's careful descriptions, but of actual specimens, a few of the many considerations suggested by the book may be set down. The more one studies his book, the more one is struck by the always present and occasionally avowed placing in juxtaposition of the discontinuity in species and the discontinuity in variation. In more than one place Mr. Bateson suggests definitely that the former finds its explanation in the latter. Most will agree that the author over-estimates the value of his suggestion. Take first the facts upon which the so-called discontinuity in species depend. Although, in many cases, it is merely an assumption of palæontologists that those animals which can be arranged in a structural series necessarily constitute a series in descent, yet in many cases—as, for instance, in Ammonites—series of descent upon almost undoubted evidence have been shown to exist; and these series show that the evolution of species took place, not *per saltum*, but by continuous modification. We do not expect to find complete records of continuous descent; but the imperfection of the record is necessarily so great, that unless descent by simply-graded modifications were the ordinary history, it would be almost inconceivable that so close simulation of such an occurrence as has been shown to exist could exist. Moreover, the palæontological record explains so many cases of geographical distribution, that it seems quite unnecessary to make so much difficulty about the present occurrence of most nearly-allied species in the same localities. Nothing has been established more certainly than that existing distribution depends upon so many slight changes in the immediate and in the remote past, that the present occurrence of species is absolutely no guide to their original habitats. Temporary geographical isolations of parts of species repeatedly occur, and as repeatedly disappear. We have much evidence that goes to show that the great land areas of the world have remained comparatively constant in position, but that there have been repeated changes from continents to archipelagoes and back again to continents. We have direct evidence as to the effect of geographical separation in producing divergence. Putting the two together, we have good reason to suppose that groups that have become divergent when separated, have been thrown together again. Anyone who is familiar with the physical changes of a country side in the very few years that cover the observations of one individual, must know of changes in the distribution of the most common animals and plants. This knowledge may not be, and probably is not, enough to solve the problem of the co-existence of different forms closely allied; but it is enough to give pause before finding in the co-existence of such species a problem that can be solved only by the assumption of a discontinuous origin.

But in drawing his contrast between the continuity of the environment and the discontinuity of species, Mr. Bateson attaches a curiously limited meaning to the term environment. It is quite true that in the same spring weather, in the same fields, and on the same flowers, lady-birds differing in striking but apparently unimportant details may be found, and side by side under the same stones dimorphic earwigs occur. No doubt such instances could be multiplied almost indefinitely wherever observers so careful as Mr. Bateson are at work. But can we deduce from such facts as these the necessity of abandoning continuity in the modification of species? If there is a struggle and a selection of the more favoured individuals, there are a thousand elusive factors in the environment that may be determining the existence of the animals. A slight difference in the power of resisting bacteria, a change in physiological habit that would write no mark upon the visible form of the creatures, and many another factor overlooked by us, might well be the determining cause of the animal's existence. These, no doubt, are all hypotheses, but it is not a hypothesis to say that we are too ignorant of the relations of any animal or plant to its environment to conclude that discontinuous forms of life arise or exist in a continuous environment, and therefore to seek explanation in discontinuous factors. When, moreover, one remembers that each animal or plant is an organic whole, and that selection of an invisible character must bring with it selection of many visible characters, it is plain enough that, although the characters which arrest our attention bear no intelligible relation to what we know of the environment, we need not abandon old methods and known causes to seek new and unknown causes.

Turning now to discontinuity in variation, it is to be noted that Mr. Bateson himself explains again and again that what he calls discontinuity is merely a necessary result of growth, or of chemical constitution. An embryonic cell divides, or it does not divide, and there results in the adult two organs or one organ, but not one and a half. A pigment is chemically altered, or it is not chemically altered, and there results a new colour, or the old colour, but not a series of intermediate shade. Such instances, however valuable as part of existing nature, do not, however, so much as touch the every-day instances of slight gradation and undoubtedly continuous variation that are to be observed in the shape and size of various parts. Moreover, as Mr. Bateson himself is careful to note, no adequate evidence is yet forthcoming with respect to the inheritance of discontinuous variations. In short, what Mr. Bateson has really done in his most interesting book is to collect and formulate a large amount of information about the laws of growth. He has shown clearly what naturalists are accustomed to neglect. The body of any animal or plant forms an organic whole. The various organs and structures are correlated together just as physiologists have shown that the various functions of the body are correlated together. In the case of physiological facts, there is as yet little guidance for us in attempting to understand how the correlations are affected. Mr. Bateson has shown how, in many cases, the structures that build up the symmetrical organism are correlated; he has brought out clearly the most striking fact that variations are not irregularities, but that they are as regular, and as harmonious, as the ordinary conditions of organisation. Indirectly, this will no doubt serve to explain the apparent discontinuity in species by showing that, as Mr. Bateson says, the integral stages by which variation proceeds are larger than we supposed. But it will also serve to make the apparent discontinuity less striking by directing our attention to the immense importance of the laws of growth in normal structures, as well as in abnormal ones. I do not think that his book so much suggests, as he supposes, that the discontinuity of species may be a consequence and an expression of the discontinuity of variation, but that the apparent discontinuity found both in variation and in species will seem less and less as we understand more the physical limitations by which the growth of organisms are determined.

P. C. M.

An English Botany Text-Book.

A Students' Text-Book of Botany. By S. H. Vines, M.A., D.Sc., F.R.S. (First half.) 8vo. Pp. x., 430, with 279 illustrations. London: Swan Sonnenschein & Co., 1894. Price 7s. 6d.

We have waited a long time for Dr. Vines' text-book, and, while welcoming the first portion, fervently echo the hope expressed by the publishers on the back of the cover, to wit, "that the remainder of the work, together with the Index, etc., will be ready for issue in the course of the year." The book has grown out of the author's English edition of Prantl's *Lehrbuch*, but growth has implied a change in form as well as increase in bulk, and to such an extent that "the present is essentially a new and distinct work," and, consequently, bears only Dr. Vines' name on its title-page. The older work, issued in 1880, contained 344 pages and 275 woodcuts; the first half of the new one contains nearly 100 pages more and 279 cuts; moreover, the scope of the book has been so extended that, while retaining all that has made it of value to beginners, it may also be useful to those engaged in the advanced study of the science.

A text-book is generally regarded as nourishment for the student who is feeding up for examination, or has a worthy desire to get a good general knowledge of botany before specialising in some one of its many branches. But it should have a wider use, as a tonic for specialists, and a corrective for the evils arising from work in a too confined space. Workers in different fields would be more in touch with each other if their knowledge of the general principles in the great divisions of morphology, physiology, and classification was kept fairly up-to-date; besides which, they would take a broader view of things, and make fewer blunders, while the value of their work would be enhanced accordingly. This puts a heavy responsibility on the shoulders of the text-book writer, and exposes him to universal criticism, but might also have the salutary effect of suppressing, if he is suppressible, the ever-recurring individual who, having realised a long-felt want, hastens to supply it with a compilation badly planned and feebly executed.

Dr. Vines' text-book is the first that modern botany has produced in this country. We have text-books, and good ones, like Sachs and Goebel, but they have been only translations of German works, native talent exhausting itself in the addition of a few foot-notes and a glossary at the end. It is matter for congratulation that originality in this line has not been utterly quenched. No botanist is so well fitted for the task as Dr. Vines, and the portion of the text-book already produced is admirable. It includes Part I., on Morphology; Part II., on the Intimate Structure of Plants (Anatomy and Histology); and that portion of Part III., the Classification of Plants, comprised under the old term Cryptogams including the groups Thallophyta, Bryophyta, and Pteridophyta. We notice at once a departure from the plan of the edition of Prantl, where the chapters on physiology followed, we think more naturally, those dealing with anatomy and histology.

Speaking of physiology we are reminded of the author's text-book on the subject, with which in one respect his more recent effort compares unfavourably. We mean in mode of expression. The "Physiology" was pleasant and comparatively easy reading, but the students' text-book is stiff, and bristles with technical terms, many of which will be new and strange even to the student who left off text-books less than seven years ago. This is most noticeable in the anatomical part. Thus, the plant unit is an *energid*, which becomes a cell only when invested with a cell-wall. An aggregate of energids, *e.g.*, the body of a *Vaucheria*, is a *coenocyte*, and *coenocytic* structure is thus contrasted with cellular; but we have also to distinguish the multinucleate cell, which from being uninucleate has become multinucleate by direct nuclear division, from the *syncyte*, a structure developed from already-formed cells by a more or less complete absorption of the separating walls, such as occurs in the development of vessels. The employment of the term *stele* for the tissues derived from the plerome entails a number of derivatives such as *polystely*, *schizostely*, *gamostelic*, *meristele*, etc., which will make the botanist to whom we have referred feel quite ancient.

We like the part on morphology best, and note especially the able way in which the more highly and more lowly organised plants are considered from one broad point of view. The extension of *root* and *fruit* into cellular plants, and a more general use of some other terms helps to break down the exclusive barrier which has too severely separated the larger groups. In treating of the leaf, the author adopts Bower's view of differentiation along a longitudinal axis, or *phyllopodium*, into *hypo*-, *meso*-, and *epi*-podium, the first forming the leaf-base, including the sheath, stipules, and pulvinus, the second the stalk, while the third is generally winged, forming the blade. When we consider the extremely close relation between the parts, and the frequent impossibility of accurate distinction, as well as the continuity of structure, these divisions seem somewhat arbitrary. A very admirable chapter is that on the cell, which forms a splendid introduction to the anatomical section. We notice, however, a slip on p. 112, where it is stated that "the proteid grain always contains a mass of mineral matter," a statement disproved by some work done in Dr. Vines' own laboratory at Cambridge.

The most noticeable features in the portion dealing with classification are the separation of *Isoëtes* from Salviniaceæ as a distinct order of Heterosporous Eusporangiate Filicinæ, and the well illustrated account of the embryogeny of the lycopods.

We sincerely hope that the "Students' Text-Book," by the production of which Dr. Vines has increased the obligation the botanical world already owes him, will not long remain incomplete.

British Glaciation.

Papers and Notes on the Glacial Geology of Great Britain and Ireland. By the late Henry Carvill Lewis, M.A , F.G.S. Edited from his unpublished MSS., with an introduction, by Henry W. Crosskey. Pp. lxxxi. and 469. 82 figures and 10 maps. London: Longmans, 1894. Price 21s.

Among all the vexed questions in British geology none has been the subject of more divergent theories, faddy speculations, and prolific literature of the type which Haeckel would call "phaulographic," than the interpretation of the series of sands and clays which are generally regarded as due to the action of some form of ice. The chaos has resulted from various reasons, among the chief of which are the facts that the sections are usually open temporarily so that only local workers can follow them, that comparatively few have the opportunity of studying ice in action at the present day, and that the subject has suffered from an extra crop of faddists and theorists. There is probably no branch of stratigraphical geology which requires that its students should have examined the deposits over such wide stretches of country, for they vary so greatly within very narrow limits. It was therefore highly desirable that some well-trained geologist should go over the whole of the ground, in order to collect data for an authoritative expression of opinion; English students were accordingly glad to welcome Professor H. Carvill Lewis when he entered upon this task. He brought to it very special qualifications; he was a man of untiring energy and remarkable keenness of observation; he was a petrographer as well as a physical geologist, so that he was able to recognise the erratics he had to study; he held, moreover, the great advantage of a training in the glaciation of America, where he had been able to examine enormous extents of glacial deposits in a region where the agency of floating marine ice could not be invoked. It was objected that he was a theorist, but this, after all, only meant that he was a man of ideas, and had the imagination necessary to enable him to interpret the descriptions of others, and allow for the misrepresentations due to inexperience, carelessness, and fads. The readiness which he always showed to abandon his old position as soon as facts rendered it untenable testified to his fairness and showed that he was not a man of blind prejudices. Hence, when the news spread that he had fallen a victim to the fell disease of typhoid fever at Manchester, just after he had landed for a fourth campaign in July, 1888, it was universally admitted that glacial geology had suffered an irreparable loss. And this was felt the more keenly by all who had come within the range of his personal influence, and knew the manly frankness, the contagious enthusiasm and energy, and the manifest sincerity which gave his character a singular fascination.

How much we have lost by the death of Professor Lewis, this volume helps us to realise; for it shows us what an amount of material he had collected, which now has to be published in a somewhat scrappy form. The work, however, is much better than some had expected, and for this we have to thank the editor. Much anxiety was felt when it was first announced that Professor Lewis's manuscripts had been left to Dr. Crosskey for him to edit, as this seemed like asking the Pope to edit Luther's tracts; for Dr. Crosskey had generally been regarded as one of the most conservative of the older school of glacial geologists and one of those most opposed to the views of Professor Lewis. Dr. Crosskey, however, did his task in a manner that deserves the highest admiration. He refused to "criticise," and confined his labours to those of arrangement, elucidation, and editing. This he has done, not only with a wide knowledge of the subject and a sound literary judgment, but with feelings of affectionate sympathy with his heretical young friend. He has contributed an admirable introduction of 49 pages, giving a sketch of the general results of Lewis's work, which shows how deep an influence the latter's views had had in England in a quarter where it was least expected.

When Professor Lewis came first to England the generally-accepted theory was that this country had twice been covered by a vast ice-sheet, and in the interval between these had been submerged to the depth of over 1,400 feet at the very least. One school occupied the extreme position of denying the influence of land-ice in any form, and explained the whole thing as due to icebergs drifting southward during a period of submergence; this view, however, was very restricted in its distribution, and there was an overwhelming majority for the orthodox side. A few men had advocated other views, notably J. G. Goodchild and T. Belt; they believed in one ice-age, denied any submergence, except locally to a very small amount, maintained the power of ice-sheets to raise boulders and frozen masses of shell-beds from lower to higher levels, and realised the effects of the differential movements that must occur in ice-sheets flowing over uneven surfaces. But these teachers had exerted barely any perceptible influence; their views was based on the complexity of the conditions of glaciation, whereas geologists preferred to regard these as very simple. Goodchild's remarkable paper on the "Glacial Geology of Edenside" appeared in 1875, but it was before its time and was practically ignored.

In opposition to the orthodox theory, Professor Lewis advocated the unity of the ice-age, at least until his discovery at Frankley Hill, and strenuously opposed the great submergence. He admitted that the north of England and Scotland had subsided for about 150 feet, and attributed all the deposits formed by water above this level to the action of either lakes or subglacial streams. The shells, he thought, worked their way up through the ice in frozen masses, just as boulders do through the Swiss glaciers. These views are expressed in the volume in five short papers. These are entitled, "Comparative Studies upon the Glaciation of North America, Great Britain, and Ireland"; "The Terminal Moraines of the Great Glaciers of England"; "On some Important Extra-Morainic Lakes in Central England, North America, and elsewhere, during the period of Maximum Glaciation, and on the Origin of Extra-Morainic Boulder Clay"; "The Supposed Three-fold Division of the Drift"; and "The Direction of Glaciation as ascertained by the form of the Striæ." These essays, however, he left only in abstract. Most of the volume consists of his field notes, and contains descriptions of sections and country in many parts of Ireland, England, and Wales. The districts that he knew best, and where he has added most to our knowledge, are the south-west of Ireland and northern Donegal, Shropshire,and South Lancashire; his description of the sections in these localities must prove of great service to English geologists.

One of the principal difficulties in using this part of the work is the varying meaning attached to the same term, and the frequent changes of position which were necessitated by increasing knowledge, and no one can read the volume without feeling what we have lost by the fact that Professor Lewis did not live to state his case finally and fully in the light of his latest conclusions. Many of the views expressed we know he modified the year before his death, and he had come to England to re-investigate the changes that were inevitable after his abandonment of his view of there being but a single glaciation.

But in spite of his early death he had lived to do much. He had unquestionably cleared the ground of many stumbling blocks.

He showed, for example—and Kendall's recent study of the sections exposed by the Manchester Ship Canal support it—that the old view of the three-fold classification of the drift into an upper and a lower boulder clay, separated by sands, is absolutely untenable; that even within very short distances this supposed sequence is often reversed, and we may get the boulder clay in the middle, with sands above and below. A second point of great importance was his insistence on the influence of water in depositing and arranging the glacial materials: it may act in the form of subglacial streams or lakes, which are either upon or in front of the glacier. Probably, however, Professor Lewis's most important contribution to British geology has been the practical annihilation of the theory of the submergence of England to the depth of 1,400 feet in an interglacial period. This theory he once characterised as "the most pernicious one ever propounded in geology" (p. 375), and against it he never ceased to wage war. That probably not one of the younger English geologists now believes this theory is, practically, entirely owing to the work of Professor Lewis. To have laid this bogey was itself a most brilliant achievement.

There are a few points, however, in which Professor Lewis seems to have overstated his case. Thus his law that "every glacier is bounded by a terminal moraine," is not likely to be generally accepted; it was founded at the time when it was confidently expected that the moraines of the Eastern States of America would be found to extend right across the Central Plain and unite with the old moraines of the Rockies. But now that it has been proved that this is not the case, and that the extra-morainic fringe is more extensive that was once thought, this view cannot be accepted as Professor Lewis stated it. A still more important point was his former denial of the existence of more than one glaciation, and his refusal to admit the action of land-ice for the Essex Boulder Clay, which was a natural corollary from the former. His examination, however, of the Frankley Hill sections convinced him that there have been two glaciations, and that his "terminal moraines" were all formed in the later. It is, therefore, highly probable that if he had examined some of the Essex sections after this, he would have accepted the Boulder Clay there as a true till belonging to the earlier glaciation; he would not then have attributed it to an extra-morainic lake, though the glacial gravels of this district are probably formed by some such agency. It is impossible to regard the scattered denuded remnants of the South Essex Boulder Clay as synchronous with the comparatively unweathered moraines of the Lake District and Wales. The acceptance of a double glaciation removes the most serious of the objections to Professor Lewis's hypothesis.

The volume is well printed, and has been most carefully edited. The explanations and notes of Dr. Crosskey and Mrs. Lewis, and a valuable appendix by Mr. Kendal, strengthen and remove doubts from Professor Lewis's position. The maps and sketches are clear and instructive, though some improvements might easily have been made in some of the former that would have made them more in accordance both with the facts and Professor Lewis's theories. Had a few such alterations been made, they would have been of more service. The only two serious regrets we feel are, that there is no index—the list of contents is, however, a full one—and that the volume has not been adorned with a portrait of its author.

J. W. G.

Science and Sport.

Big Game Shooting (Badminton Library). By Clive Phillipps-Wolley. With Contributions by Sir Samuel W. Baker, W. C. Oswell, F. J. Jackson, Warburton Pike, F. C. Selous, Lieut.-Colonel R. Heber Percy, Arnold Pike, Major Algernon C. Heber Percy, W. A. Baillie-Grohman, Sir Henry Pottinger, Bart., Earl of Kilmorey, Abel Chapman, Walter J. Buck, and St. George Littledale. 8vo. 2 vols., illustrated. London: Longmans & Co., 1893. Price 10/6 each vol.

That a book on Big Game Shooting, written professedly for the sportsman, should contain such a large amount of natural history, for the most part excellently written and well up-to-date, as the one before us, is a sign that sportsmen are taking a genuine interest in zoology, and that their sole aim is no longer the making of the biggest bag, or the securing the finest trophies. How heartily we welcome this change from the old state of affairs it is unnecessary to mention, but we hope the appearance of this most excellent work will aid in stimulating all the slayers of Big Game to use their unrivalled opportunities of adding to our knowledge of the habits and distribution of the animals they pursue. If we might add an additional plea, it would be that they would incur a further obligation on the part of the working naturalist if they would occasionally give us some notes on the life-histories of other little-known creatures, not coming under the title of Big Game, which they must frequently come across in the course of their wanderings. Such observations take but little time to record, and will often serve to fill up an idle hour in camp.

The large field covered by the work before us will be well seen from the titles of the chapters, which are as follows:—On Big Game Shooting generally, by C. P. Wolley; South Africa Fifty Years Ago, Second Expedition to South Africa, Later Visits to South Africa, and With Livingstone in South Africa, all by W. C. Oswell; East Africa—Battery, Dress, Camp-Gear, and Stores, Game Districts and Routes, The Caravan, Headman, Gun-bearers, etc., Hints on East Africa, Stalking, Driving, etc., the Elephant, the African Buffalo, the Lion, the Rhinoceros, the Hippopotamus, Ostriches and Giraffes, Antelopes, all by F. J. Jackson; the Lion in South Africa, by F. C. Selous; the Big Game of North America, the Caucasus, the Mountain Game of the Caucasus, all by C. P. Wolley; the Musk-Ox, by W. Pike; Arctic Hunting, by Arnold Pike; the Caucasian Aurochs, the *Ovis argali* of Mongolia, and the *Ovis poli* of the Pamir, by St. G. Littledale; the Chamois, and the Stag of the Alps, by W. A. Baillie-Grohman; the Scandinavian Elk, by Sir Henry Pottinger; European Big Game, by Major A. H. Percy and the Earl of Kilmorey; the Large Game of Spain and Portugal, by Abel Chapman and W. J. Buck; and Indian Shooting, by Lieut.-Col. R. H. Percy.

Among these chapters, especial interest attaches to the one by the late Mr. Oswell, on the condition of Africa, and the swarms of its big game half-a-century ago; although we can but recall with regret that such an excellent observer should have been one of those who assisted to no inconsiderable extent in the extermination of the so-called white rhinoceros. And here we take the opportunity of calling attention to the unrivalled excellence of the illustrations by Mr. Charles Whymper, with which the volume is embellished, some of these giving a better idea of what South Africa used to be in its palmy days as a big game country, than any others that have come under our notice. What more particularly strikes us is the fidelity to nature with which such small-sized photographs have been executed, the species of every animal portrayed being recognisable at the first glance.

Among the other chapters it is almost invidious to make a selection; but Mr. Jackson's chapter on the antelopes of East Africa, from a naturalist's point of view, strikes us as particularly good; while the one on the big game of India, by Colonel Percy, must certainly come in for a share of commendation. In a work like the present it is not likely that a naturalist would find much that is absolutely new to him; but there are many points that are worthy of his attention. In the first place, we believe it is not generally known that leopards inhabit the Caucasus, but if we are to credit the evidence recorded on page 43 of the second volume, it appears that we must admit this to be the case. Another point of interest is the opinion that the African elephant was never tamed by the Carthaginians, the coins with the effigy of this animal upon them having been struck long after Carthaginian times, and the animal even on these being a kind of mongrel. More probably the elephants which the Carthaginians undoubtedly possessed were imported Indian animals. The maximum height of the African elephant recorded in this work is 12 feet 2 inches, and the extraordinary numbers in which these giants formerly occurred in South Africa is graphically described on page 129 of the first volume. The subject of height reminds us that a maximum of 18 feet is assigned in this work to the giraffes although Mr. Bryden has assured us by letter that he has measured, a specimen of 19 feet. We confess that we should like further information on this subject; more especially as the apparently gigantic stuffed male from South Africa in the British Museum measures only 17 feet 4 inches.

In another work Mr. Selous has rather thrown cold water on the idea that the African buffalo is a ferocious animal, but in the volumes before us Mr. Jackson fully supports the view that the creature is decidedly an ugly customer to encounter. That the African rhinoceroses attack, as might have been supposed from the absence of front teeth, with their tremendous horns, is fully demonstrated; but it is perhaps less generally known that the Asiatic species use the lower tusks as their weapons of offence, in the same manner as a pig. The recorded occurrence of the Sitatunga antelope from Uganda is, if we mistake not, a new fact in distribution.

The foregoing references are sufficient to indicate the highly interesting nature of this most excellent treatise on Big Game, which we can heartily commend, not only to the attention of the sportsmen for whom it was primarily intended, but likewise to everyone interested in the habits and mode of life of these largest efforts of creation.

If we were in the mood for fault-finding, which we are not, we should discover but little to blame in the work as a whole. May we, however, suggest to the editor that in the next edition he should exercise his editorial powers a little more energetically, in order to prevent discrepancies. For instance, we find on page 76 of the second volume Mr. St. George Littledale lamenting that naturalists have not decided on the synonymy and number of species of the big Asiatic wild sheep; while on page 291 of the same volume Colonel Percy quotes at length Mr. Blanford's well-known and decisive observations on this interesting subject. Again, it would be well if the editor were to take into his council some zoologist of repute who would aid him in the thorny subject of nomenclature; and if this were done we should not in the second edition see the wild goat of Persia described and figured on page 52 of vol. ii. as *Hircus ægagrus*, although alluded to on page 321 by its proper title of *Capra ægagrus*. Neither should we find the saiga mentioned on page 44 of the same volume, and the chamois on page 176, under the generic name of *Antilope*.

These are, however, but trifling blemishes in a most excellent work, which will long be the standard on the subject of which it treats, and reflects credit alike on its editor and its contributors, as well as on the artists and publishers.

The Chemistry of Animals.

The Essentials of Chemical Physiology for the use of Students. By W. D. Halliburton, M.D., F.R.S., F.R.C.P., Professor of Physiology in King's College, London, etc., etc. Pp. 166. London: Longmans, Green & Co., 1893. Price 5s.

In the records of research and in advanced treatises the most certain and the newest discoveries are so held in solution that only an expert can detect them. But when a brilliant investigator and competent teacher like Dr. Halliburton writes a text-book for students, we expect to find that his mind has acted on the confused details of his science so as to precipitate and render obvious the most important truths. It requires small effort to see that Dr. Halliburton regards it as of the first importance to impress on students that in chemical physiology they are concerned with living organisms. Natural Science from time to time has called attention to the growth of what is called "Vitalism" in physiology, and here in that citadel of the mechanical school—the chemistry of the animal body—one finds the new doctrine entrenched. Consider what one was taught even a few years ago. The body was a collection of specialised organs, each organ with its own function or functions. The blood was a mechanical channel of connection between the organs. The food was taken into the alimentary canal and the various digestive juices acted upon it so that insoluble substances were turned into soluble. These latter passed by osmosis into the blood directly, or through the lacteals. By the blood they were handed on to the different organs, in each of which certain chemical processes went on. In the lungs oxygen diffused in, carbonic acid diffused out, and the reverse process took place in the tissues. Wherever a direct mechanical or chemical comparison could be made it was adopted as an explanation. Elaborate tables abounded, showing the transformation of so much food material into so many grammes of fat and glycogen and proteid; calculations were made showing the work to be expected from the oxidation of so much proteid and carbohydrate and the corresponding production of waste products.

Here all these matters are in the background, being replaced by the microscopic appearances of the cells and tissues; and the idea that all the processes are vital processes occurring in living protoplasm is insisted on. In digestion, no doubt, insoluble starches are turned into soluble sugars, insoluble proteids into soluble peptones; fats are emulsified and saponified. But these do not diffuse into the blood; they are "eaten" by the living cells of the alimentary canal, and these, neglecting diffusibility or indiffusibility, select what they want not even systematically but with varying caprices. Indeed if soluble peptone be injected into the blood, into which it used to be thought to soak, poisonous effects are produced and the animal may die. The epithelial cells of the alimentary canal protect us from these poisonous effects by turning back into insoluble proteids the peptones they absorb. Again, sugar injected into the blood passes into the lymph, but soon the percentage in the lymph is higher than the percentage in the blood—a result which cannot be explained by filtration or diffusion, and must be due to the "secretory activity" of the cells of the vessel walls. Even the vital action of the cells of the intestine does not alone perform the work of digestion. The process is aided by multitudes of bacteria that thrive where the antiseptic gastric juice has deen neutralised by the fluid from the pancreas.

Another striking "vitalistic" occurrence is the excretion of carbonic acid by the lungs. The tension of carbonic acid in the air in the alveoli of the lungs is much lower than the tension of carbonic acid in the veins. Hence it seems a simple physical process that carbonic acid should pass from the veins to the alveolar air. But the process goes on so far that when the venous blood has become arterial, the tension of the carbonic acid is lower in the blood than in the alveolar air. Here again secretory activity of the epithelium lining the pulmonary alveoli is called into account.

Some of the other changes from the physiological chemistry of our youth are equally striking. Thus, a large number of the so-called chemical processes depend on unorganised ferments; that is to say, on ferments possessing the characters of living things, except that they cannot be identified as separate organisms having shape, size, and so forth. Of these, some we know, others are more recent discoveries. Ptyalin of the saliva, pepsin and rennet of the stomach, trypsin, amylopsin, and steapsin of the pancreas, and the fibrin ferment in the white blood corpuscles, all are appeals from chemistry to vital action.

The organs and tissues of the body are bound together in much more than a mechanical fashion. Experimental evidence has shown that, in addition to its own special functions, each organ contributes in a vague way to the "general metabolism of the body." The expression of the fact is vague, but the fact is real and striking. Extirpation of the testes causes many well-known general changes in addition to the special change of impotency. And so extirpation of other organs brings about many general changes over the whole body in addition to loss of the special.

The special functions of organs are not the simple occurrences formerly believed in. For instance, urea is not formed in the kidneys, not even in the muscles, but in the liver; while, on the other hand, bile is not a digestive fluid but probably purely excretory.

We advise strongly those who are working in other branches of Biology to read Dr. Halliburton's clear and interesting little book. Many problems await their solution by the joint action of morphological and physiological considerations, and we recommend morphologists in particular to notice the paths along which the students of function are travelling.

It remains to be said that from the point of view of students Dr. Halliburton's book is admirable. The directions for practical work at the beginning of each section are explicit and simple; even dull students should require little further direction. The descriptions of apparatus are very clear, and if they are studied not directly from the figures in the book but with the apparatus in the laboratory, much time will be saved from the teaching of physics for the teaching of physiology.

THE FAUNA OF THE DEEP SEA. By S. J. Hickson, M.A., D.Sc. Modern Science Series. Pp. xvi., 169. London: Kegan Paul, Trench, Trubner & Co., 1894 Price 2s. 6d.

IN this interesting little book, which we are prevented by its title from calling superficial, Dr. Hickson deals in a readable and commendably brief way with recent enquiries into the nature and habits of animals living at great depths. The subject is alluring to everybody, and the "general reader" will, we imagine, not be disappointed with what Dr. Hickson has to offer him. The more seriously minded and expert reader will not of course expect a detailed discussion of the problems arising out of the facts. Nor would they indeed be entirely in place in a short epitome of this kind. Dr. Hickson begins his preface by saying, quite melodramatically, that "a time may come" when the bottom of the sea will be thoroughly known. At present it is as he justly, though hibernically, intimates a large *terra incognita*. Still a fair amount is known, and mainly, as everybody admits, through the results of the "Challenger" voyage. The uninstructed devourer of Mr. Hickson's pages will be struck with the satanic aspect of many of the deep-sea fishes. The piscine countenance is not formed for the presentation of beauty, but it is rarely that such malevolence is to be read there as in the case of these particular fishes. Moreover, the reader will also learn that the features are an index to the dispositions of their possessors. So ferociously carnivorous are some of these fish that they will without the least hesitation swallow a neighbour ever so much larger than themselves. Kindly nature, who in this quarter of the world is particularly "red in tooth and claw," has aided and abetted them in this course of action by endowing them with unusually extensile stomachs. Their voracity, however, is not always unpunished; for many other animals, which would be liable to fall victims to these cannibals, have put on an extensive armature of spines; anyone who consults the sumptuous plates of the "Challenger Monographs" will soon meet with figures of crustacea which are only to be compared with hedgehogs. Luckily there is a limit to this indiscriminate feeding off one another in the deep sea, or its fauna would by this time have arrived at the condition of the crew of the "Nancy Bell." Some years ago Dr. Moebius wrote a paper entitled "Wo kommt dann die Nährung der Tiefseefauna aus?" in which it was sought to prove that the animals of the abysses chiefly depended upon the surface waters for their food-supply. From them there falls a constant and abundant rain of the dead bodies of minute surface-creatures such as Diatoms and Foraminifera, which are snapped up by the animals at the bottom. In reviewing the facts concerning the deep-sea fauna with an eye to generalisations, one is struck by the contradictory nature of the evidence. The environment seems to have acted differently in various cases. For instance, the gills of the deep-sea fishes are shrunken and comparatively rudimentary. On the other hand, the very same cause has produced in other animals the reverse condition. Milne Edwards remarked upon the enormous development of accessory gills in his gigantic Isopod *Bathynomus*; and another Isopod belonging to the same family, *Anuropus*, has the last pair of abdominal appendages converted into gills. In some groups of animals the deep-sea representatives are shrunken and dwindled in size as compared with their shallow-water allies; in other groups the very largest members known hail from the deep-sea; *Bathynomus* is an instance of the latter statement. There is thus a good deal to do in the way of collating the abundant facts at our disposal, which will furnish in all probability good material for deciding on the merits of Natural Selection as opposed to environmental influence.

An Index to the Genera and Species of the Foraminifera. By Charles Davies Sherborn. Part I. (A to Non). From Smithsonian Miscellaneous Collections, vol. xxxvii. (No. 856). 8vo. Pp. ii., 240. Washington: Smithsonian Institution. 1893.

The Smithsonian Institution has often deserved well of the working naturalist by the publication of works troublesome to prepare and costly to print, appealing to no wide public, but invaluable to the few that are able to appreciate them. In no case will gratitude be more profound or more deserved than that which will come to the Institution in return for the issue of this Index. The labour involved in the production of such a work is sufficiently clear to anyone who casts his eye down one of its closely-printed pages, and is also evidenced by the fact that this, the first half, has taken nearly as long to print as the whole index took to prepare. The work is practically a systematic index to all the literature published on Foraminifera up to the end of 1889, and refers not merely to every published name, but to many names not properly published, to many published instances either not named or not referred to Foraminifera at all, and to other instances that have been erroneously placed in this group. The author does not profess to determine the synonymy of the different species, since this would introduce the element of personal opinion, which, even in the case of so approved an authority, might occasionally be erroneous. Almost the same end is, however, attained by the citation of previous opinions, and by the extraordinarily complete system of cross-references. The value of a work like the present is almost entirely dependent on the two qualities of accuracy and completeness. Those conversant with Mr. Sherborn's "Bibliography of the Foraminifera," a book of constant service to the librarian, the bibliographer, and the scientific writer, know that no one has a fuller acquaintance with the literature of his subject; while Woodward and Sherborn's "Catalogue of British Fossil Vertebrata" is sufficient testimony to the accuracy of the compiler.

We cannot dilate on this monument of enthusiastic industry, since it appeals to the specialist rather than to the general reader. But we would urge all who contemplate similar publications to take this as their model; and we hope that this example will lead many to imitate it for other classes of animals. Were all groups indexed in this manner, the labours of zoologists would be lightened of a grievous burden, and the wail of the synonym need no longer be heard in the land.

Other New Publications on the Foraminifera.

The samples of sea-bottom obtained by the German exploring ship "Gazelle" have been worked out by Dr. J. G. Egger, who has paid especial attention to the Foraminifera. Dr. Egger's monograph has recently been published in the Abhandlungen of the Bavarian Academy (vol. xviii.), and consists of 266 pages, illustrated by 21 quarto zincographs. These zincographs are sketchy, but serve their purpose admirably, because most of the forms have been described before. They are crowded with figures, and therefore present, for perhaps the first time, a valuable grouping of many allied forms in one picture. This is especially well seen in pl. x., devoted to the Lagenæ, and pl. xiii., devoted to the Globigerinæ, and helps the student to realise how intimately related all the so-called "species" are, and how difficult it is to attempt to draw specific distinctions when whole series of these lowly organisms are obtained. Fornasini has just published a paper on the Costa and Seguenza collections in the Naples Museum (*Mem. R. Accad. Sci. Ist. Bologna*, ser. 5, vol. iv.), which were collected from the Tertiary marls of Messina. His paper deals chiefly with the Nodosariæ and Cristellariæ, and the three beautiful plates of outline drawings leave nothing to be desired. Dervieux has also published in the *Boll. Soc. Geol. Ital.*, vol. xii., part 4, a paper on the Tertiary Nodosariæ of Piedmont, in which 64 forms are carefully described, and illustrated in one plate. There should be no difficulty now in identifying the numerous Tertiary forms of the genera, but students cannot be too strongly cautioned against describing supposed new varieties without the most patient study of existing literature, a study which, we think, is often neglected because of the trouble and time required.

The Study of Molluscs.

Introduction à l'Étude des Mollusques. Par Paul Pelseneer. 8vo. Pp. 216, figures. Reprinted [in advance] from the "Mémoires de la Société Royale Malacologique de Belgique, tom xxvii." (1892). Bruxelles: H. Lamertin, 1894. Price 6 francs.

Most works on elementary zoology are, as the author points out in his preface, behind the time, because it is not in the power of any single man to keep simultaneously abreast with the progress made in all the various branches of zoological science. Pending the time that such a work shall be produced, as the more advanced treatises often are, by the co-operation of specialists in the several groups, the student can frequently find much that he needs to know in monographs such as Graber's "Die Insekten," or Günther's "Introduction to the Study of Fishes," but no such work exists on the Mollusca, if we except Coupin's that appeared in 1892. This last is, however, more of a "cram book" than anything else, and was very much behind the time even when it was issued, so that it is hardly to be seriously reckoned with. Dr. Pelseneer's "Introduction," on the other hand, like all he attempts, is thorough, and though there are points on which we venture to differ from him, which are open to objection or criticism, there can be no doubt of its great value to all malacologists as a reference book, and as such it is cordially to be recommended. Indeed, we only wish that the systematic conchologists (the variety-mongers and mere collectors of shells may be left out of account as past praying for) could be induced to master some of the principles here so clearly set forth, since it could not fail to have a beneficial effect in widening their mental vision, and so rendering their labours more useful by imparting, to them at least, a tinge of true science.

This Introduction is framed, of course, on a zoological basis, and in some respects too exclusively so. The method of treatment is to give a succinct account, first of the Mollusca as a whole, and then of each class, or sub-class when that seems desirable, the sub-headings being:—(1) Morphology; (2) "Éthologie," which the author defines as the principal particulars concerning the conditions of existence, in other words, the habits and mode of life, for which "Bionomics" is a more appropriate term; (3) Bibliography; and (4) Systematic

Arrangement. The classes are taken in the following order:—Amphineura, Gastropoda, Scaphopoda, Lamellibranchiata, Cephalopoda.

The bibliography is only brought up to the commencement of 1892, and from internal evidence it would seem that the work itself does not contain, with the possibly sole exception to be presently referred to, any of the results of later researches; but for this the Société Royale Malacologique de Belgique, and not the author, must be held responsible, since it was prepared for their 1892 volume. Hence it comes that *Siphonaria*, which Haller showed in that year there were strong reasons for placing with the Opisthobranchiata, here still remains in Pulmonata. On the other hand, the internal nature of the shell of *Ephippodonta* only published, if we recollect rightly, last year in the *Proceedings of the Malacological Society of London*, has been included as an addendum under "Errata." In this last connection we miss, strange to say, all reference to Dall's remarkable *Chlamydoconcha* (1884), in which the bivalve shell is yet more completely concealed by the mantle.

On turning to the systematic part we speedily realise that Dr. Pelseneer is a "lumper," for which fact we are duly grateful; but while fully appreciating the worth of the main outlines of his classification and regretting that his phylogenetic tree has not been reproduced, we must, in some instances, differ from him *toto cœlo* in respect to the arrangement of his families. To take one example, what possible justification is there for the following sequence (pp. 96, 97):—Paludinidæ, Cyclophoridæ, Ampullariidæ, Littorinidæ, Cyclostomatidæ, Rissoidæ, Hydrobiidæ, Truncatellidæ, Valvatidæ, etc.? A minor point for regret is that some of the names are not those accepted by most conchologists on legitimate grounds of priority—*e.g.*, *Chenopus* instead of *Aporrhais*.

It could do no harm either to allude to the fossil groups—*e.g.*, Ammonea, Hippuritidæ—in their approximate position in the series, more especially since the Belemnitidæ and *Spirulirostra* are cited on p. 178, without, however, any mention of the fact that they are no longer living forms. A paragraph, too, might with advantage be devoted to the structure of the molluscan shell itself.

The work concludes with a "Table des Matières," which may be made to do duty as a table of classification for the main groups, and with an admirable index.

The above noted shortcomings in this most excellent volume are not adduced from any wish to detract from its value, or in any spirit of captious criticism; on the contrary, merely in order to point the almost obvious moral that not only is it impossible for any single writer to produce a satisfactory treatise on Zoology as a whole, but that it is not even in the power of a specialist, however eminent in his branch, to deal with it single-handed in such wise as to bring it level with the modern requirements of the general zoologist, a task which can only be performed with anything approaching true completeness by the concerted action of several workers drawn from the museum, the laboratory, and the ranks of the field naturalists. Granted, however, the single worker, no one could have performed the task better than Dr. Pelseneer, nor is the late Dr. P. J. Van Beneden's report on it one whit too strong when he says: "Tous ceux qui s'occupent de malacologie que ce soit au point de vue de l'anatomie, ou de la physiologie, ou même simplement de la Conchyliologie, y trouveront des renseignements d'une importance réelle." $(BV)^2$

OBITUARY.

WILLIAM PENGELLY.

BORN JANUARY 12, 1812. DIED MARCH 16, 1894.

ALTHOUGH Mr. Pengelly was for some sixty years a resident in Torquay, he was not a Devonshire man, his birthplace having been in the quiet little fishing town of East Looe, in Cornwall. It is not surprising that, with the surroundings of such a place, he should have acquired, as a lad, a strong attachment to the sea. Fortunately, however, the bent of his mind towards scientific studies led him to adopt the profession of a teacher, and while still a young man he established himself at Torquay. Here his enthusiasm for the acquisition of knowledge soon manifested itself in the activity which he displayed in developing the Mechanics' Institute; and a few years afterwards he suggested the formation of a local society for the study of Natural Science. It was, indeed, mainly due to Mr. Pengelly's energy that the autumn of 1844 witnessed the foundation of the Torquay Natural History Society. Over its early fortunes he exercised the most watchful care, and in 1851 he was induced to accept the office of Honorary Secretary, an office which he continued uninterruptedly to hold, to the unspeakable advantage of the Society, for not less than nine-and-thirty years. Under his guidance it became a scientific power in the county; year after year he lectured there, tincturing the locality with his own enthusiasm, and from the Society there ultimately sprang the Museum in Babbacombe Road, with its admirable local collections. In the reading-room attached to the Museum there fitly hangs an oil-painting of the man whose individuality is unmistakably stamped upon the entire institution—William Pengelly.

Everyone identifies Mr. Pengelly with the exploration of Kent's Cavern. To this cave he had been attracted soon after his settlement in Torquay; and as far back as 1846 he had assisted in its partial examination, as a member of a small and poorly-equipped Committee, appointed by the local Natural History Society. The work of this Committee tended to confirm the conclusions formed by MacEnery and afterwards by Godwin-Austen; but the age was far from being ripe for the reception of their views.

Twelve years passed, and a cavern in Devonian limestone was discovered at Windmill Hill, near Brixham. By this time scientific opinion was veering round to a more favourable quarter, and the

Royal and Geological Societies took immediate advantage of the discovery, by appointing and subsidising a Committee to explore exhaustively the untouched cave. On the shoulders of Mr. Pengelly fell practically all the work of supervision, but he had his reward in finding ample corroboration of his previous conclusions; for beneath the unbroken stalagmitic floor were brought to light relics of human handiwork in such intimate association with the remains of extinct mammalia as to place their contemporaneity beyond all cavil.

A change of attitude towards the great question of the geological range of Man having been thus effected, the eyes of many were again turned towards the depths of Kent's Cave, if haply they might yield fresh evidence bearing upon this subject. At the Bath meeting of the British Association in 1864, mainly by the influence of Sir Charles Lyell, who was then President, a powerful committee was appointed for the systematic exploration of the cavern; and of this committee—to borrow Professor Bonney's words—Mr. Pengelly was "the hands and the eyes, and, at least, a fair proportion of the compound brain." In fact, from the commencement of the work, on March 28, 1865, until its close, on June 19, 1880, Mr. Pengelly laboured with an untiring enthusiasm, which is attested by his long series of annual reports to the Association. One of the most important incidents in the course of this exploration was the confirmation—though not until the work had been continued for more than seven years—of MacEnery's discovery of the teeth of *Machærodus* in Kent's Cavern.

At the meetings of the British Association, Mr. Pengelly was always a welcome figure, whether in the Geological section or in the Anthropological department. Over the former he presided at the Plymouth meeting, in 1877, and over the latter at the Southport meeting, in 1883. On each occasion he discoursed, in his presidential address, on the Bone Caverns of Devonshire.

After the model of the British Association, Mr. Pengelly suggested the foundation of a Devonshire Association for the Advancement of Science, Literature, and Art. This was formed in 1862, and at the Barnstaple meeting, five years afterwards, Pengelly fitly occupied the presidential chair.

In order to settle the vexed question of the age of the Bovey beds, he undertook a systematic examination of these deposits, and in 1861 read before the Royal Society a valuable paper on "The Lignite and Clays of Bovey Tracey." At the same meeting, a communication was received from Dr. Oswald Heer, to whom the plant-remains had been submitted, "On the Fossil Flora of Bovey Tracey." These essays were reprinted, with a preface, as a monograph, in 1863; and although Mr. Starkie Gardner's subsequent studies of the Bovey flora have modified our opinion as to the age and origin of the deposits, Mr. Pengelly's work remains of great permanent value.

A fine collection of Devonian fossils from Devonshire and Cornwall, formed by Mr. Pengelly, was presented in 1860 by the Baroness

Burdett-Coutts to the Museum of the University of Oxford, in connection with the foundation of a geological scholarship, and is still known as "The Pengelly Collection." In 1863, Mr. Pengelly was elected a Fellow of the Royal Society, mainly in recognition of his work at Bovey and at Brixham; and in 1886 he received the Lyell Medal from the Geological Society—an award of singular fitness in so far as it commemorated the author of the "Antiquity of Man," who had been largely instrumental in securing the exploration of Kent's Cave. It is hoped that the memory of Mr. Pengelly may be suitably perpetuated, and to this end an influential Committee has been formed, including the President of the Royal Society, Professor Huxley, Sir John Lubbock, and Sir Douglas Galton, to consider a scheme for the provision of more Museum accommodation at Torquay.

Mr. Pengelly's scientific work was characterised by extreme honesty of purpose and thoroughness of execution; no amount of labour was considered too great for the elucidation of a detail which, to others, might seem insignificant. The work he undertook demanded accurate observation and sagacious inference rather than the gift of originality. Outside scientific circles Mr. Pengelly was at one time well known as a popular lecturer: his lectures were marked by much freedom of utterance and freshness of language, while they were certainly not lacking in one of the prime elements of success in public speaking—a touch of humour. To most people his geniality of presence was magnetic. In fact, many of us feel that, by Mr. Pengelly's death, we have lost one of the most clear-headed, quick-witted, and warm-hearted of friends.

F. W. R.

VERNON LOVETT CAMERON.

BORN 1844. DIED MARCH 26, 1894.

BY the death of Commander Cameron, owing to a fall from his horse at Leighton Buzzard on 26th March, we have lost another of the leaders of the "heroic age" of African exploration. He was born in 1844, and early entered the Royal Navy, and had his interest in African exploration roused while engaged in dhow-chasing off the East Coast of Africa. He was in Zanzibar when the Royal Geographical Society's Livingstone Relief Expedition broke down by the resignations of its successive leaders, Lieutenant Dawson, Lieutenant Henn, and Mr. New. He then proposed to organise another, and was commissioned by the Geographical Society to start to the relief of Livingstone, and then to solve the problem as to whether the Lualaba was really the head river of the Congo or the Nile. He left Bagamoyo early in 1873 with three other Europeans and a caravan of over 230 men. Though he succeeded in performing what was then the great feat of crossing Africa, the expedition was not a complete success. The caravan met Livingstone's body as it was being carried back to the coast, and thus the first object of the expedition was frustrated; but Cameron resolved to push on and accomplish the second. This he had to do single-handed, for Murphy resolved to return with Livingstone's men, while Moffat had died near the coast, and Dillon had shot himself in the delirium of fever. Cameron reached Tanganyika, and there made his principal contribution to African geography—the discovery that, *at the time of his visit*, the Lukuga was an outlet from the Lake to the west. He then reached the Lualaba and descended this to Nyangwe, a point previously reached by Livingstone. Here the natives forbade his advance, they refused him boats, and his men protested: so Cameron gave it up, and struck away to the south-west to the Lomani and across the head streams of the Kassabe to Benguela, which he reached in November, 1875. During the latter part of his march his astronomical observations enabled him to fix the positions with greater precision, but the great question as to whether the Lualaba belonged to the Nile or the Congo he left exactly where he found it. Stanley arrived a little later and had just the same opposition, and was in less advantageous circumstances; but he defied the natives, seized boats when he could not buy them, coerced his men, and accomplished his mission. A comparison has often been instituted between the methods of the two men, and Cameron's peaceful tact has often been commended in contrast with Stanley's forceful ways. But it must be remembered that they were both sent out to do a certain piece of work, and that while Cameron failed Stanley succeeded. In later years Cameron explored the "hinterland" of the Gold Coast and the Niger in 1882, and also the proposed railway route to India down the Euphrates Valley, in which scheme he was a devout believer. For some years he had settled down in England, his time being mainly occupied with his work as promoter and director of several commercial companies.

JOHN JENNER WEIR.

BORN AUGUST 9, 1822. DIED MARCH 23, 1894.

ANOTHER veteran entomologist has passed away. Mr. Weir died on 23rd March at the age of 71. He was principally known as a student of the Lepidoptera, numerous papers on which have appeared by him during the last thirty years. He was one of the earliest observers to remark the now well-known connection between the colours of caterpillars and their edibility by birds, a paper on this subject having been published by him in the *Trans. Ent. Soc.* for 1869 and 1870. Students of the British fauna will recall his work on the moths of Shetland, published in the *Entomologist*, on the editorial staff of which magazine he served up to his death. Melanism and other colour problems have received elucidation by his researches, which included vertebrates—specially birds—as well as insects. In the April number of the *Entomologist* is published also his last paper—

a discussion on some genera of Limnaine butterflies, with a description of a new species from Borneo, illustrated by a boldly-drawn figure. An autobiography, with portrait, appeared in the *British Naturalist* for July, 1893.

CHARLES EDOUARD BROWN-SÉQUARD.

Born April 8, 1817. Died April 1, 1894.

THIS eminent physiologist was the son of Edward Brown, of Philadelphia, and was born at Port Louis, in the Mauritius. His mother, from whom he derived his name, was a Frenchwoman. In 1838 he went to Paris to study medicine, received his doctorate in 1840, and proceeded at once to make those researches which have rendered his name famous. He held a post for a short while in London at the Hospital for Paralytics, and from 1864–1868 he held the Professorship of Pathology and Physiology at Harvard College, United States. In 1878, he succeeded Charles Bernard in the chair of experimental physiology at the School of Medicine at Paris. Among his best-known works may be cited his researches into the composition of the blood, animal heat, the spinal cord and its diseases, and the characters of the brain. He was the founder of the *Journal de la physiologie de l'homme et des animaux*, and was its editor from 1858–1863; he directed the *Archives de Physiologie Normale et Pathologique*, with Charcot and Valpian from 1868 onwards, and in 1873 he established a practice in New York, and, with Dr. Segrim, founded and edited the American Journal *Archives of Scientific and Practical Medicine and Surgery*. He was president of the Biological Society of France in 1887.

GEORGES POUCHET.

Born 1833. Died March, 1894.

GEORGES POUCHET was the son of Félix Archimede Pouchet, and was born at Rouen in 1833. He studied medicine at Paris, receiving his Doctorate in 1864. The year following he was appointed assistant-naturalist and chief of the anatomical department of the Musée d'Histoire Naturelle at Paris, a post he continued to hold until his death. In October, 1870, he became general secretary to the Prefecture of the Police, but soon returned to his natural history.

Pouchet published "De la pluralité des races humaines" (1858); "Précis d'histiologie humaine" (1863); "Colorations de l'épiderme" (1864); and numerous memoirs on the great ant-eater and other edentates.

THE deaths are also announced of:—Dr. William F. Poole, the well-known librarian of Chicago. Dr. Poole was in his seventy-third year, and had been librarian at Boston and Cincinnati before he went to Chicago to take charge of the Public Library. Since the fire of 1871 he has organised the Newberry Library in that city. Dr. Poole was President of the American Library Association for several years. His great work, "An Index to Periodical Literature," laid a debt upon readers difficult to estimate, and it is unquestionably one of the greatest bibliographic labours of any time.

Mr. Henry Bean Mackeson, who died at Hythe in March last, was in his eighty-third year. He was well known as an archæologist and geologist, and was the one to discover the great Saurian in the lower greensand of Hythe, which was described by Owen as *Dinodocus mackesoni.*

We also regret to record the death of John Bickerton Morgan, of Welshpool, one of the most promising geologists of the younger school. Mr. Morgan died of phthisis in March.

Among others who have passed away we notice the name of George Pycroft, of Richmond, Surrey, whose death occurred at Torquay on Good Friday. Mr. Pycroft was one of the original founders of the Devonshire Association for the advancement of science and art, his chief interests being centred in archæology and art. Mrs. Mary Hemenway, the Boston millionaire, who employed throughout life her knowledge, experience, and great wealth in inaugurating and fostering all matters relating to social and educational progress, scientific and historical research. She is best known as a friend to American archæology, and promoted and carried through the "Hemenway Exploring Expedition" in Arizona. Dr. F. Ulrich, Professor of Zoology in Hanover Polytechnic; Dr. S. A. Weiss, the well-known Professor of Botany at Prague; and Dr. Arthur Hill Hassall, the microscopist and analyst, who died on April 9 at his home at San Remo; also swell the heavy list which we regret to have to record this month.

NEWS OF UNIVERSITIES, MUSEUMS, AND SOCIETIES.

Mr. John C. Willis has left Cambridge for Glasgow, where he takes up the appointments of "Senior Assistant in Botany" at the University, and Lecturer in Botany at Queen Margaret's College. Mr. J. Elfreth Watkins, for nine years Curator of the Department of Transportation at the National Museum, Washington, has lately left for Chicago to take charge of the Department of Industrial Arts at the New Columbian Museum. It was Mr. Watkins who arranged the remarkable exhibit of the Pennsylvania Railroad at the World's Fair. Dr. O. Mattirolo has been appointed Extraordinary Professor of Botany and Director of the Botanic Garden at Bologna. Dr. F. Dahl has been appointed Professor of Zoology, and Dr. F. Shütt Professor of Botany, at Kiel University. Mr. Walter Garstang, M.A., who was recently elected to a Research Fellowship at Lincoln College, Oxford, has resigned his post on the Plymouth Staff of the Marine Biological Association, and will leave Plymouth towards the end of May. We understand that Mr. Garstang intends to devote himself to his Fellowship researches and to the early completion of an illustrated descriptive work upon the littoral zoology of the British Isles.

A short time ago the Berlin Aquarium built a Zoological Station at Rovigno, of which Dr. Hermes is Director. The internal arrangements are now so far completed that there is room for six students. Two tables are at the disposal of the German Government, two at that of the Prussian "Kultusministerium," and two at that of the Berlin Aquarium. Students may be of any nationality. We regret to learn, through the *American Naturalist*, that the Biological Laboratory founded at Milwaukee by Mr. Allis, has had to close in consequence of the hard times. The surplus copies of the five Annual Reports upon the Liverpool Marine Biological Station formerly on Puffin Island (1888 to 1892, the complete set) have been collated and bound up to form an 8vo volume of about 180 pages, illustrated with cuts and plates, and containing the original lithographed covers. Thirty copies of this volume are now offered at 3s. each nett (post free), and may be obtained from Mr. I. C. Thompson, 4 Lord Street, or Professor Herdman, University College, Liverpool.

The Director-General of the Geological Survey is arranging at the Museum of Practical Geology a series illustrative of the submarine deposits now forming off the coasts of the British Isles. This should prove of great value and interest to all naturalists.

Under the auspices of that useful body, the A. W. P. L. (for which see Natural Science, vol. iv., p. 254) some short courses of lectures on Natural History are being given in the Natural History Museum in the Cromwell Road. These courses are specially intended for children, and are followed by rambles in the Museum. The fee for a course of six lectures is ten shillings. As the Trustees of the British Museum provide one of their public galleries for a lecture-room, as well as screens, specimens, chairs, and the services of an attendant, it is to be hoped that the general public will benefit by this innovation, and that the A.W.P.L. will not be the only body to secure a commission on the receipts.

The Museums Association meet this year in Dublin during the last week in June, under the presidency of Dr. Valentine Ball, C.B., F.R.S. There is every promise of a successful meeting, as a strong local committee has been formed in Dublin, and we note that the council invite the attendance of members of Museum committees as well as curators. Further information may be obtained from H. M. Platnauer, Museum, York, or E. Howarth, Museum, Sheffield.

The Rutherford College, Newcastle-on-Tyne, which may be described, in the words of Lord Armstrong, as "a cheap working-man's college, designed chiefly for useful technical education, but intended, also, for the advancement of all pupils of excessive ability who aspire to professional life or to the attainment of academical honours," was formally opened by the Duke of York on April 5. This College, which is raised as a monument to the late Dr. J. H. Rutherford, who did so much for education among the masses, provides accommodation for 2,000 students. The Trustees have established some 30 scholarships, tenable for three years, ranging from £9 to £15 a year, and also an exhibition of £50 a year to the University of Cambridge. The building contains fine art, physical, chemical, biological, metallurgical, and engineering departments, with workshops, lecture theatre, library, and reading-room. The College is affiliated to London University, and associated with the Science and Art Department at South Kensington. A tower at one end of the building will be utilised as an astronomical observatory.

The date of the Robert Boyle lecture at Oxford is now definitely fixed for May 8. Professor Alexander Macalister's subject, "Some Points of Morphological Interest in Human Variations," is much "on the moment," as the newest journalism phrases it. At the conversazione of the Junior Scientific Club, on May 22, Captain Lugard will speak. We thought, by the way, the Robert Boyle lecture had been founded to remove lectures from the conversazione. Professor August Weismann, who is to deliver this year's Romanes lecture, arrived in England on April 10.

The Summer Educational Plans of Toynbee Hall, Whitechapel, contain the following alterations in the lecture list that we published last February (p. 156). Dr. Fison's subject is now "Light Waves and the Ether," while Mr. Parkyn talks on "The Tissues of the Body." On April 27, Mr. C. G. Moor begins a short course on "The Chemistry of Common Life," with practical laboratory classes. Dr. A. S. Gubb now takes a Sunday class in Physiology. The Natural History Society announces several excursions; its evening meetings are on the first Monday of each month.

The London Amateur Scientific Society appears to have ceased publishing, but in the form of meetings at the Memorial Hall, Farringdon Street, its activity still continues. The secretary is Mr. S. Pace, 252 Fulham Road. Papers have lately been read, "On the Ascent of Water in Trees," by L. A Boodle; "On the Occurrence of Gold in Eruptive Rocks from South Africa," by G. Holbrook; and "Some facts about Parasitism and kindred Phenomena in Plants," by Jesse Reeves. On April 27, F. A. Bather is announced to discuss the vexed question, "What is a Genus?"

The chief features of the report of the Zoological Society of London in the accounts for 1893 are an increase of £300 in cost of provisions, of £200 in menagerie expenses, and of £400 in the cost and carriage of animals. There is, fortunately, an increase of £1,600 in admissions to the Gardens, which assists in balancing the above-mentioned and other out-payments. The mortgage debt, which is steadily reduced £1,000 a year, now stands at only £2,000. The Society hold no stocks beyond the £2,000 Davis Fund Trust.

THE report of the Epsom College Natural History Society for the year ending Christmas, 1893, reaches 86 pages, and shows evidence of considerable activity Among the lectures delivered last year we note one by Mr. J. J. H. Teall, on Silica, one on the Puss moth, by Mr. O. H. Latter, and a third, on Captures of a Tow-net, by Dr. Hudson. Numerous excursions were made in the district round Epsom, a method of instruction upon which it is impossible to lay too much stress. Lists are given of the birds, plants, and lepidoptera of the district, with notes on their earliest observed occurrence. The system of giving a prize for the best lecture or essay, delivered by a member of the school during the year, is an excellent one, and tends to stimulate research and accuracy. Last year the prize was won by Mr. H. Mayo, for his paper on "Evolution." This year the subject selected for competition is "The Life and Work of Darwin." Might we suggest that subjects of more local and less cosmic interest would better bring out the scientific capabilities of our intelligent youth ?

FROM the Sixty-ninth Annual Report of the Norfolk and Norwich Museum we learn that the glass cases are almost completed. The departments of Ornithology, Mammalia, and Ethnology have been enriched by important additions, among which may be mentioned: a series of specimens from the bank of the Amazon; an adult skull of *Hippopotamus amphibius*; twenty-two specimens of birds of prey from Mr. J. H. Gurney; and numerous animals of local interest and rarity, including the adult female of the great Bustard (*Otis tarda*) referred to in Stevenson's "Birds of Norfolk" (vol. iii., p. 401), which now permits the exhibition in the Museum of an unequalled group of these birds. A full account of the Norfolk and Norwich Museum from the pen of Dr. Henry Woodward appeared in this Journal for November, 1892. The twenty-fifth annual meeting of the Norfolk and Norwich Naturalists' Society was held in the Museum, Norwich, on 27th March, the president (Mr. T. Southwell, F.Z.S.) in the chair. In reading his address, Mr. Southwell remarked upon the publication in the Society's *Transactions* of very valuable records of the local fauna and flora, and of the biographical memoirs of Norfolk naturalists, among the more interesting of which we recall those of C. B. Rose and Samuel Woodward. The series of letters from Gilbert White to Robert Marsham, of Stretton, were also referred to, as well as the endeavours of the Society to prevent the wanton destruction of rare and interesting birds that occasionally visited the country. The full strength of the Society is 226, and despite the heavy cost of printing the *Transactions*, it is now in a fairly prosperous condition. Mr. Southwell then gave a sketch of the avifauna of Norfolk, and the pastoral value of its soil. Dr. Charles Plowright was elected president in succession to Mr. Southwell, and Professor Collett and Mr. E. T. Newton were elected honorary members.

WE note the following papers in Publications of British Societies. The December number of *Timehri*, the journal of the Royal Agricultural and Commercial Society of British Guiana, contains a paper by the editor, Mr. Rodway, on the history of the Society for the first two years of its existence. The writer notes that the 18th March, 1894, was the fiftieth anniversary of the foundation of the Society. The excellent work of the Society in furthering the agricultural and commercial interests of the colony is touched upon, and attention is called to the importance of the Museum and Library, and the large collection of newspapers and magazines to be found in the reading room. No more interesting work can be done by the editor of a fifty years' old Colonial journal than to give a sketch of this kind, for the present generation are apt to forget the names of those who founded, and of those who carried successfully on, a Society which has stimulated such good work and provided so much entertainment for those whose interests lie in the development and advancement of their working field. Another paper of value in this number is that of the Rev. W. B. Ritchie, on "The First Thirty Years of Schools and Schoolmasters in British Guiana." The *Proceedings of the Dorset Natural History and Antiquarian Field Club*, for 1893, has been issued. Mr. Mansel-Pleydell's Presidential Address deals chiefly with the geological distribution of plants, and forms a useful synopsis of the subject. Mr. S. S. Buckman discusses the Inferior Oolite and its subdivision into zones; while the President adds a further note on the Dewlish "Elephant Bed," with photographic illustrations. The Rev. O. P. Cambridge continues his valuable reports on new and rare British spiders, and the Rev. R. P. Murray gives a coloured illustration of his new bramble, *Rubus durotrigum*, described two years ago in the *Journal of Botany*. The other papers are of archæological interest. The Royal Society of South Australia has issued the second part of vol. xvii. of its *Transactions*. The papers are mostly of a systematic nature, dealing with Galls, Rhopalocera, Heterocera, Coleoptera, and Tertiary Gasteropoda; but two papers by W. G. Stretton and Rev. D. Mackillop give a most interesting account of certain aboriginal tribes in the Northern Territory of S. Australia. One of the most useful branches of this flourishing Society is a committee for the protection of the native fauna and flora, many species of which are in great danger of extermination. Among the many interesting papers in the second number of the *Proceedings of the Malacological Society of London*, mention must be made of the useful paper on British Chitons, by Mr. E. R. Sykes; an excellent plate is given, and the student should now have little difficulty in identifying his finds. A similarly valuable paper has just been published by the Geologists' Association (*Proceedings*, vol. xviii., p. 190), by Mr. Smith Woodward, on "Sharks' Teeth from British Cretaceous Deposits." This paper is also well illustrated, and will enable many an amateur geologist to identify his Chalk finds without worrying a Museum curator. Dr. H. B. Guppy has a paper on the Temperature of Rivers in the last number of the *Proceedings of the Royal Physical Society of Edinburgh*. Only part i. has yet appeared, and deals with the daily changes and method of observation.

AT the twelfth annual meeting of the American Society of Naturalists, held at Yale University, December 27 and 28, 1893, a committee was appointed to appeal to Congress for the repeal of that tax upon knowledge which is embodied in the Customs duties on instruments of research. It was pointed out that these duties were not needed for the protection of the American manufacturer; for at least one American firm was ready to sell its goods at a price a little below that of the foreign manufacturers to those institutions that could already obtain duty-free prices, while for all others it added the extortionate 65 per cent. of the present tariff. In the interests of science we wish the committee every success. The American Society of Morphologists held its annual meeting at New Haven on December 28 and 29, 1893, while the American Physiological Society was holding its sixth annual meeting at the same time and place. These two Societies have entered a movement of closer co-operation among the leading American scientific Societies, headed by the Society of Naturalists. It is hoped that the Psychologists and Geologists will also join. Co-operation is admirable; but the immediate result appears to be the formation of something like a second American Association for the Advancement of Science.

IN the March issue of the *Botanical Gazette*, Mr. F. C. Coville, botanist to the U. S. Department of Agriculture, states that the Department has inaugurated a seed collection in connection with the National Herbarium, which is intended to include seeds of all the species of plants obtainable, especially weeds and forage plants The seeds, when not too large, will be placed in flat-bottomed specimen tubes, which will be labelled, and arranged systematically in covered trays made of binder's board. Fleshy fruits of native American plants will be put into similar bottles filled with a preserving liquid. Authentic herbarium specimens of plants raised from the seeds represented, or of plants from which the seeds were obtained, will accompany the collection whenever possible. The Division of Botany also proposes to undertake the testing of various seeds as to purity and germinative powers, for which purpose a laboratory will be fitted up and equipped after the most approved methods of American and European seed control stations. Physiological experiments connected with germination and development will be conducted both in the laboratory and the open air. Histological studies may ultimately be made of the structure of the seeds of American weeds and forage plants, partly with the view to elicit facts of taxonomic value. The entire work will be carried on with special regard to its economic importance, while the collection will be useful for reference. Mr. G. H. Hicks, recent instructor in Botany at the Michigan Agricultural College, has been placed in charge of the matter.

It will be remembered that, some time ago, the appropriation voted by Congress towards the United States Geological Survey was materially reduced. From Major Powell's annual report we glean the following results of this reduction. During the early part of the fiscal year the field parties engaged in geological work were entirely reorganised. A large reduction of the force employed in palæontological work was made necessary, and several former divisions were consolidated into one division, in charge of the chief palæontologist. The division of illustrations was dissolved at the opening of the year, and then re-organised, with a force of seven persons. The total expenditures of the survey for the year amounted to $423,022, against an appropriation of $430,073. It is interesting to note that, despite the reduction, much work, of great economic value to the nation, has been done on the running waters of the country. Steps are already being taken, it is stated, to use at least the smaller streams for water power and irrigation. A rough computation, based on the stream measurements and census figures, indicates, it is cited, that the running streams of the arid region, when all are used, will have a value of at least $600,000,000. Those who know the secret of the reduction of the grant will find food here for sweetly ironical reflections.

In November last we announced that Mr. W. F. E. Gurley had been appointed State Geologist of Illinois, and we feared that the palæontological work of the State would be entrusted to the well-known and prolific author of new specific names, Mr. S. A. Miller. Our worst anticipations have been realised. The Illinois State Museum of Natural History has published as its *Bulletin* no. 3 a "Description of some New Species of Invertebrates from the Palæozoic Rocks of Illinois and adjacent States" by those two writers. This appears equal to their previous work, and therefore needs no criticism. We merely wish to point out that fifty-eight new species are here described in a State publication, under the name of a State official; but that only four of the type specimens are in the State Museum, the remaining fifty-four being in the private cabinets of the two authors. "It requires neither information nor study to propose specific names" (p. 55); but the type specimens gain in pecuniary value even when the species are worthless.

Kansas University appears to have undertaken the work of a Geological Survey during 1893. Professor Erasmus Haworth organised a class of three who studied the stratigraphy of the south-eastern part of the State. Nearly 600 miles of sections were made and much other work accomplished, a report of which will be found in the *Kansas University Quarterly* for January, 1894. Enthusiastic students are always to be found among the young; this method supplies them with what they chiefly lack—organisation and experience.

The United States Government are fitting out an expedition to explore the region of the north magnetic pole. This spot, which lies on the western point of the Isle of Boothia Felix, near Cape Adelaide, has only been described once, when Ross's expedition discovered it, and a great deal of curiosity is felt as to whether it will have shifted at all during the last sixty-five years.

CORRESPONDENCE.

A Whale Fight in 1240.

In reference to Mr. R. Lydekker's account of a whale fight in the South Atlantic, printed at p. 173, it may be of interest to quote the account of a whale fight which occurred in 1240, probably near the mouth of the Thames, as given by Matthew Paris, the chronicler of St. Albans, in his *English History*.

A.D. 1240.—"*A Remarkable Battle amongst the Fishes of the Sea.*—Although other great and unheard-of wonders happened in this year, we have thought it worth our while to mention in this work one more remarkable than the rest. As it is the nature of the sea to vomit up on dry land the dead bodies thrown into it, about eleven Whales, besides other marine monsters, were cast up on the sea coast of England dead, as if they had been injured in some kind of struggle, not, however, by the attacks or skill of man. The sailors and old people, dwelling near the coast, who had seen the wonders of the deep when following their vocation in the vast waters, and trafficing to distant countries, declared that there had been an unusual battle amongst the fishes, beasts and monsters of the deep, which by wounding and gnawing each other, had caused death to several; and those which had been killed had been cast ashore. One of the fishes, a monster of prodigious size, made its way into the Thames, and with difficulty passed uninjured between the pillars of the bridge; it was carried as far as a manor of the king's called Mortlake, where it was followed by a number of sailors, and at length killed, after a great deal of trouble by innumerable blows of spears."

Dunstable. Worthington G. Smith.

An Ammonite Problem Solved (?)

With reference to our note with this title (p. 245), Mr. S. S. Buckman points out to us that a distinction should be drawn between "beds which only yield worn and imperfect specimens," and "beds which afford specimens in a complete state of preservation, the shell-sculpture remarkably sharp, and the delicate mouth-processes complete." In the former cases "distribution is readily granted"; but in the latter "it is reasonable to conclude that there has not been much distribution after death."

While admitting some such caution, we may, nevertheless, suggest that the shell of *Spirula* is a sufficiently delicate structure, and that distribution by flotation would not really expose the shells to many casualties.

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NOTES AND COMMENTS.

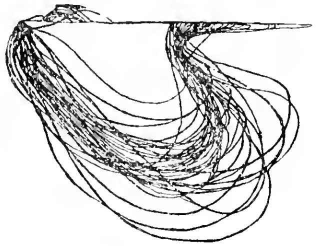
Composite Generic Fundamenta.

THE *American Geologist* for April contains a note by Mr. J. M. Clarke, which is of such interest in connection with subjects lately discussed in our own pages, that we take the liberty of quoting it at length :—

"Some remarks on 'Mathematical Biology' in the February number of Natural Science, and the suggestion made by Bather in his recent work on the 'Crinoidea of Gotland,' that Galton's method of composite portraiture might be employed to ascertain a specific type from which variations in various degrees could be reckoned, recalled to me some germane experiments in which I was interested some eight years ago, and which indicate that there is even a possibility among narrowly restricted, up-to-date genera, of educing, by a series of comparative measurements and successive overlays, a sort of generic *fundamentum*. I take the liberty of citing and illustrating a single instance of this among the fossils, the case being a simple one and involving the search for the standard in one element of variation only, namely, *outline*; but whatever may be done with a single specific character, in this manner, is equally possible of all the others.

"In volume v., pt. 1, of the Palæontology of New York are described 57 species of the lamellibranch genus *Leptodesma*, two of which are ascribed to the horizon of the Hamilton group, and 55 to the fauna of the overlying Chemung beds. *Leptodesma* is an aviculoid genus with smooth and convex valves, and the shells upon which these observations are based are preserved plump and without disturbance of the marginal outline. The genus in some of the higher beds of the Chemung group is enormously prolific, so that the perception and identification of these 55 specific values is a puzzle to which the identification of Jurassic Ammonites or recent Unios is but play. Nevertheless, no more instructive series of variations of a single generic type has ever been described among

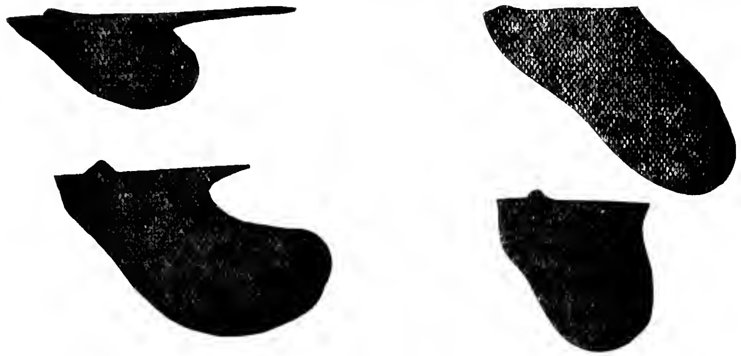
Palæozoic fossils. The first onset at such a group is certain to lay the student low with acute brain-fag, and leave upon his mind a hazy conviction that all the alleged species are pretty much one and the same thing. The beauty of the series and the persistence of its variations or species dawns upon the mind gradually but invincibly. Having attained this point in the study of the original specimens of these fossils, the attempt was made by the process of superposition to ascertain a standard or radicle outline for the entire generic group. In the making of this composite figure, which is here reproduced, it was, of course, necessary to fix upon two points or one dimension as a base to which all the elements could be reduced or elevated: just as in composite portraiture, the eyes, or some other indices, of all faces in the composite must be coincident. In this case the standard to which all have been made to conform has been the distance between the anterior cardinal extremity and the deepest posterior incurvature of the valve; a purely arbitrary dimension; probably any other would serve as well.



"The figure represents superposed outlines of the left valve of 36 of these species of *Leptodesma*. It will be observed that notable differences of outline in the components of this figure are obscured by the coincidence of the lines for a greater or less portion of their length, while the ruling outline or type stands out conspicuously like a coarsely shaded drawing of the valve. Of all the component outlines this interwoven valve approaches nearest to that of *L. rogersi*, as shown in the adjoining figure. It will naturally be understood that *L. rogersi* enters into this combination no more than the other 35 species, nor are there other shells whose outline is so nearly similar to that of *L. rogersi* as to produce a succession of parallel lines, which thus become intensified. The depth and predominance of the *L. rogersi* outline is wholly due to the coincidence of parts of outlines of species which vary greatly in this respect, as witness the four silhouettes of elements in this composition, shown on page 403.

"As already remarked, what is here done for the outline of the valves can be done with equal facility for convexity or other specific variations, either by this method of superposition or by the expression of such differences by a series of co-ordinates or mathematical curves.

"One interesting fact in regard to the type or *fundamentum* expressed in this composite is that *L. rogersi* (the silhouette of which, here given, is of exaggerated size) is the temporal precursor of the cometary outburst of *Leptodesma* in the Chemung faunas, and is one of the two species occurring in the Hamilton faunas beneath.



"I am disposed to believe that whenever this method is practicable it will be found of real usefulness not only to biologists in general, but to the palæontologist in particular, especially in the determination of specific standards or *fundamenta*, as suggested by Bather. Its successful application implies, first of all, abundant data. With that prerequisite provided for, profitable comparisons could be instituted between species of distant faunas supposed to be identical, or which, though perhaps identical, may be masquerading under different names; and between such species in successive faunas of the same region. As a case in point, the brachiopod species *Athyris* or *Seminula subtilita* Hall would serve; an abundant and remarkably variable shell from the upper Carboniferous. In the lower Carboniferous limestones occurs an allied form, *A. subquadrata*, and it has been confidently asserted that neither species passes into the geological horizon of the other. Yet the two are greatly alike and each appears under many variations of outline and contour. Assuming that the two are alike in internal structure, which I believe to be essentially true, a series of composites might determine whether or not the variations of the two so-called species reduce to similar *fundamenta*, and if they do I should be inclined to regard this as rational evidence of specific identity. Again, the geological value of this method might be tested in such a case as that recently adduced by Professor Prosser, who argues that an extensive series of rocks in central and eastern New York, which appear to be permeated with Hamilton fossils, are not of the age of the Hamilton group, but represent a later geological stage, and that the fossils have, in a considerable degree, undergone modifications from their typical expression in the true Hamilton fauna. As the quality of these variations is hardly palpable under ordinary circumstances, and has not been satisfactorily expressed in words, it ought to appear in composites based upon sufficient data; and should there prove to be differences in the *fundamenta* of specific variations, from the true Hamilton fauna, and of those from the alleged but contested Hamilton fauna above, the argument from such evidence would be entitled to serious consideration."

Organic Equilibrium.

In our last number, the review of Mr. Bateson's book on Variation gave occasion for some remarks on continuity and discontinuity in species. It will be remembered that the guiding idea of that book is that a species may change from one specific type to another by a sudden jump, or, as Mr. Bateson phrases it, by a discontinuous variation. In the words of Francis Galton, the species passes from one position of organic stability to another. It may therefore be interesting to remind our readers that similar ideas were long ago put forward by two American biologists, who, however, went even further in supposing a sudden passage of more than one species from one genus to another. E. D. Cope in 1868 discussed the Origin of Genera (*Proc. Acad. Nat. Sci. Philadelphia*), and showed, as he believed, that genera were grades of organisation, entered upon by more than one species at a time, and often entered upon with some suddenness. He explained these metamorphoses of species by a reference to metamorphoses or periods of rapid development in the life of individuals. When such periods corresponded with the period of reproduction, then the offspring would, he considered, be more liable to variation. When the metamorphosis of the individual was subsequent to reproduction, the offspring, and therefore the species, would remain unchanged; but when the metamorphosis occurred before the period of reproduction, the characters would be transmitted to the offspring, and the species would enter on a new phase. Cope compared these points of change to those critical points of temperature at which sudden changes take place in the molecular constitution of matter, and he applied to them the term "expression-points." Carefully examined, however, Cope's principle of "Acceleration" is seen to be essentially the same as what is now called the "Law of Earlier Inheritance"; and those who believe that the latter "Law" expresses the process of evolution of species and genera, certainly do not believe in any sudden change.

W. H. Dall, writing in the *American Naturalist* for March, 1877, similarly ascribes such supposed sudden changes "to the action of a law of development which finds expression in the paradox that the same species may belong to different genera." That sudden leaps may be due to the gradual accumulation of minute differences, he exemplifies as follows:—"In a sloping gutter of a paved street not too cleanly swept every one will have noticed on a sudden shower how small particles of earth and other materials will sometimes act as a dam, producing a puddle, which, relieved by partial draining, may for a time remain in *statu quo*. A time comes, however, when the gradually-accumulated pressure suddenly sweeps the dam before it for a short distance, until another similar one is formed, the pool again appears for a time to remain unchanged, and so on indefinitely. Now the modern idea of a species may be stated to be a greater or lesser number of similar individual organisms in which for the time being the majority of characters are in a condition of more or less stable equilibrium, and which have the power to transmit these characters to their progeny with a tendency to maintain this equilibrium. This tendency may be, in some cases, sufficiently strong to resist for a considerable period the changes which a gradual modification of the environment may tend to bring about. When the latter has reached a pitch which renders the resistance no longer effectual, it is conceivable that a sudden change may take place in the arrangement of the constitution of the organism, adapting it once more to its surroundings, when the tendency to equilibrium may reassert itself in the minor characteristics, and they may, as it were, crystallise once more in a form not dissimilar in its specific results to that which was recognisable in the earlier generic type. If among a certain assemblage of individuals constituting a species, the tendency to maintain the specific equilibrium be (as it should be *à priori*) transmitted to the progeny in different degrees of intensity, a gradual separation might take place between those with a stronger tendency to equilibrium and those with less. Here natural selection would come in. Those yielding as above to the pressure of the environment would necessarily become better adapted to it (or perish) and with their changed generic structure might be able to persist. On the other hand, those with the broader base, so to speak, with the inherited tendency to remain unshaken by the modifications of the environment, may be conceived as through this tendency to be and to remain less injuriously affected by adverse circumstances, and consequently might still endure. In short, natural selection in the one case would find its fulcrum in the tendency to easy adjustment of characters; and in the other case in the inherited persistency in equilibrium rendering its possessor more or less indifferent to the injurious elements of the environment. The intermediate individuals by the hypothesis would be those least-fitted to persist in any case and hence liable to be rapidly eliminated. Then we should have parallel series of species in two or even more genera existing simultaneously."

Induced Variation.

How far the variation of organisms can or does take place in response to change of environment is one of those questions that the biologist is bound to answer before he can solve the problem of species. A determined attempt to answer this question has, we all know, been made for many years by Professor E. B. Poulton, in his experiments on caterpillars. At the Royal Society's conversazione, on

May 2, that investigator exhibited some living specimens of the larva of the Lappet-moth (*Gastropacha quercifolia*). Under usual conditions these caterpillars are of a rather dark brown colour, with a few whitish spots down the sides; some may be darker, and some lighter than the others. The specimens exhibited, however, which had all been reared from the same batch of eggs, had been divided into two lots, and, during the early stages of growth, one lot had been surrounded by black twigs, and the other lot by lichen-covered twigs, the food being the same in both cases. So impressionable were the youthful caterpillars, that all the former lot had become nearly black, with the white spots very few and small, while the latter lot were lighter than usual in colour and had the white spots large and numerous. Subsequent transference of a light caterpillar to the black twigs, or *vice versâ*, had had no effect upon its colouring; the response to environment took place only during infancy. In the course of a lantern demonstration, Mr. Poulton described many other experiments having similar results, and expressed his opinion that the young caterpillar did actually possess considerable sensibility and power of adaptation to the colour of its surroundings. This sounded like flat Lamarckism, but only for a moment. There was a limitation to be noted; there was no response to such colours as the caterpillar did not ordinarily come in contact with in a state of nature; or, if any effect was produced, it was only in the direction of some variation natural to the animal, and useful to it under certain natural circumstances. For this reason, and because all variations that do occur are clearly protective, the lecturer concluded that this marvellous power of individual adaptation to environment had been acquired through the ordinary processes of natural selection. And that is at all events sound Darwinism. Whether the experiments are yet sufficiently conclusive, will however be doubted by many entomologists.

A most interesting example of this individual adaptation, regularly occurring amid natural surroundings, has recently been added to the beautiful series exhibited in the central hall at the British Museum (Natural History). In the forest of Maramanga, which is in Madagascar, about 65 miles east of Antananarivo, there lives a Homopterous insect, which men (scientific men) call *Flatoides dealbatus*. When this insect settles, as is its habit, on the bark of the forest trees, it becomes almost imperceptible; for each specimen, though differing slightly from its neighbour, bears, when its wings are closed, a most striking resemblance either to plain bark, or to bark covered with green moss or grey lichen. This, as the Museum label with true scientific caution expresses it, is "a fact which seems well calculated to afford them protection." Madagascar has also furnished the Museum with the curious beetle, *Lithinus nigrocristatus*, whose black and white or yellowish colour and black hairs render it almost indistinguishable from the lichen-covered twigs among which it lives.

Some sceptics say that birds must be very foolish creatures to be deceived by certain so-called protective resemblance; but the birds in Madagascar must be very old birds indeed if they often get a meal off either of these marvellous examples of mimicry.

The Ways of the White Ant.

An example of individual adaptation of somewhat different nature was also to be seen at the *soirée* of the Royal Society, in the case of Termite ants exhibited by Dr. D. Sharp. We have already alluded to the recent work of Grassi and Sandias on the two European species of this family (Natural Science, vol. iv., p. 312), a work that has stimulated afresh our curiosity as to the social economy and the physiology of the white ants. As has been partly explained by Dr. Cunningham in our own pages (vol. iv., p. 287), Grassi has arrived at the conclusion that the various forms making up the species of a Termes are produced at will by the community from similar individuals of an "undifferentiated" nature. His statements, in fact, amount to this, that the continuation of the species being confided by the community to a single pair, the produce of this couple is made into the various castes required by the community by means of processes of special feeding. Should the community require a new royal pair, they apply to a certain number of individuals a course of feeding by which the reproductive organs are brought into full development and functional activity, while the external parts of the body remain permanently in the pre-adult state. To such individuals the name "neoteinic,"[1] or "permanently adolescent," has been applied. Their number is afterwards reduced by the community to a single pair.

Dr. Sharp's exhibit included some 10 or 12 species of *Termites* that had been collected at Singapore by Mr. G. D. Haviland, and each species was represented by many of its various forms and most of the stages of individual development. In the nest of one species Mr. Haviland had found about 10 neoteinic pairs, leading to the belief that in this species also an economy prevails similar to that in *Termes lucifugus*, as described by Grassi. This Singapore collection, which contains a large number of specimens, all in a perfect state of preservation, has been presented by Mr. Haviland to the Museum of Cambridge University.

Botany; British and Foreign.

The May issue of the *Journal of Botany* contains descriptions of some of the new plants recently collected by Dr. J. W. Gregory in

[1] For explanation of term "neoteinic," see Kollmann, *Verh. Ges. Basel*, vii., 1883, p. 391; also Camerano, *Bull. Soc. Ent. Ital*, 1885, p. 89, and *Atti Acc. Torino*, xix, p. 84

East Tropical Africa. Mr. Spencer Moore describes a number of Acanthaceæ, including a new genus, and Mr. E. G. Baker a new tree *Senecio*. There is considerable difference in size between our common groundsel (*Senecio vulgaris*) and the new giant which Dr. Gregory discovered growing on the rocky sides of valleys at an elevation of 13,000 to 14,000 feet on the south-west side of Mount Kenia. The woolly leaves of the latter are over a foot in length, and the stem grows to a height of 25 to 30 feet, attaining a diameter of a foot or more. This interesting plant is closely allied to one found by Mr. H. H. Johnston on Mount Kilima-njaro, and described by Professor Oliver a few years ago. Another tree *Senecio* occurs on the Abyssinian Mountains, and one in the Cameroons.

British botanists are not neglected, for in the same number several new native brambles are described. First, one by the Rev. W. H. Purchas, who admits that "It is certainly very undesirable to add to the already lengthened list of British brambles, unless very good cause can be shown for doing so; but" his plant "is so readily distinguishable from other forms, and is so plentiful and characteristic" in its locality "that it would be inconsistent with the treatment accorded to the rest of the genus to leave it without recognition as a well-marked variety." The plant in question was referred by Professor Babington and Dr. Focke, to a known species, *Rubus rosaceus*, but the Rev. W. R. Linton, who has enjoyed the best opportunities of studying it, from living in the same neighbourhood, "has made it increasingly evident" that "its strongest affinities are with the Caesian group." "Accordingly, the Rev. W. Moyle Rogers, who last year saw it growing," "considers that it should be placed under *Rubus dumetorum* as a named variety." Finally, however, the two other reverend gentlemen put their heads together and make a new *species*, *Rubus rubicundus*.

In order to let us down gently and relieve the monotony, the editor thoughtfully inserts the note on the new *Senecio* between Mr. Purchas's description and a paper entitled "Three New Bramble Forms," by the Rev. Augustin Ley, in which a new species from Herefordshire and two new varieties are described.

The genus *Rubus* is a fruitful one for investigation, the species of the British Isles having already supplied matter for no less than five papers in the journal for the present year. It is, however, interesting to note the apologetic tone in which new species are generally introduced. Thus, the Rev. W. Moyle Rogers, before proceeding to perpetrate three in the February number, remarks: "We must, I think, be anxious, all of us, to keep down and, where it may be possible, reduce the number of our *Rubi* 'species'." One cannot help thinking that these worthy clergymen have either not realised the fact of individual variation, or are so impressed with the origin of species by evolution, that in an excess of zeal they name them before they have actually arisen.

Death Valley.

Under the title "Botany of the Death Valley Expedition," the U.S. Department of Agriculture have recently issued a bulky report, prepared by Mr. F. V. Coville, botanist to the expedition, and now head of the division of Botany. Death Valley, bounded on the east by the Funeral Mountains and westward by the Panamints, lies on the Nevada side of California, and forms part of the vast more or less desert region broken by short mountain ranges, which extends between the Rocky Mountains and the Sierra Nevada. In and about this cheerful region, Mr. Coville and his assistants spent more than six months of 1891, collecting plants and making observations on their habitat and environment. An idea of the nature of the country may be gathered from the following description:—"January 19 we broke camp, and set out for Death Valley by the old borax road. The excessive dryness of the region was evidenced by the fact that the pencil marks on a roadside grave-board, which had been twelve years exposed to atmospheric effects, still appeared clear and fresh, the surface of the wood retaining its natural appearance. We passed the night in Long Valley, and in the morning continued down the cañon, emerging into Death Valley near the south end of its alkali-flat. On either side were high mountains and between them the narrow valley, not more than ten miles wide. In the bottom of the valley was the snow-white stretch of salt and alkali, and to the northward, perhaps fifty miles away, mountains, valleys, and salt-flat vanished in haze. Creosote bush had been characteristic of all our route until we neared the salt-flat; but here, under the influence of clay and alkali, it gave way to greasewood (*Atriplex polycarpa*), that in turn to salt grass (*Distichlis spicata*), and the last to a shrub related to the pickle-weed." Beyond this there was no vegetation whatever.

The report, which occupies nearly 300 pages, is an example of what such reports should be, and an illustration of what can be done by a collector who is at the same time a proficient botanist. Besides an exhaustive catalogue of species, including descriptions of 42 novelties, and a tabulated list of specimens arranged in the order of collecting numbers, with date of collection, locality, and altitude, the author gives a valuable account of the distribution of plants in South-eastern California, and of the relationships of the mountain flora of the Sierra Nevada, and of that of Death Valley, and also discusses at some length the characteristics and adaptations of the desert flora. In a humid climate dew is an important source of moisture, but the weather-observer recorded no dew in Death Valley, and the several months' observations of desert conditions and phenomena have led to the conclusion that a very important proportion, perhaps in some cases all, of the summer water-supply of certain desert-shrubs is conserved in the soil as capillary moisture derived from local rainfall. The tree Yucca (*Y. arborescens*) is the nearest approach to the real tree that the desert affords, often attaining 18 feet in height, but this is confined to the high altitudes. It is in the shrubby vegetation that the arid character is most reflected. The largest of the shrubs, the creosote-bush (*Larrea tridentata*) commonly grows to from three to five feet, while the height of most desert species ranges from this down to a foot. The struggle for continued existence is not with each other, as in a humid climate, since from scarcity of moisture each individual is separated by several yards from its neighbours, but against physical forces alone. A rounded form is the result of this spacing out, as, surrounded on all sides by light, the plants develop equally in every direction. No creeping or cone-shaped shrub is known in the desert.

An important principle in plant-life is the absorption of moisture from the soil by the roots, its conduction along the stem, and its transpiration from the leaf-surface; hence the study of desert plants reveals various adaptations for striking a living balance between absorption and loss of moisture. One device is great root development; thus the roots of the mesquite (*Prosopis juliflora*), a tree characteristic of desert areas with a moist subsoil, grow to enormous lengths; one was seen which reached more than 16 yards. As, however, during the season of drought the largest amount of water that can be absorbed is comparatively small, the greatest modifications are found in the stem and foliage. The size, form, and thickness of the leaves are most concerned. Thus, of forty-one shrubs examined, only four had leaves whose single-surface area exceeded a square centimetre. In some cases the leaves fall soon after the cessation of the spring rains, but in most they remain for the greater part of the summer, and to reduce loss of water to a minimum, have their surfaces protected by a resinous excretion or a covering of dry hairs. The creosote bush, for instance, owes its name to the resinous covering, in appearance like shellac, of its leaves and small twigs.

The twenty-one excellent plates of new species will serve to illustrate some of these points, and the large map at the end of the volume on which the route is indicated is also a valuable addition.

THE HATCHING OF THE OCTOPUS.

THAT an *Octopus* should be given to sit upon its eggs for the purpose of hatching them, like any barn-door hen, savours at first of the ludicrous, even though the instance of the female Argonaut which carries, if it does not incubate its eggs in its "boat," be borne in mind. More curious still is it that the habit was first observed and recorded by that astute old-time philosopher Aristotle, but subsequently forgotten till the discovery the other day in Lower California, by M. Diguet, of a new species of *Octopus*, which sets to work in a very systematic fashion, brought the circumstance once more to light. Aristotle remarked that the *Octopus* sits as soon as all its eggs are laid, and in the same spot in which they are deposited—the crack of a rock or the interior of an empty shell—and he further notes that they do not feed while sitting, so that they become quite thin.

The marked peculiarity concerning the new species, which is described by MM. Perrier and Rochebrune (*Comptes Rendus*, vol. cxviii., p. 770) under the name of *Octopus digueti*, appears to be that it habitually spawns in empty bivalve shells (*Cytherea*, *Pecten*, etc.), lining the interior of the two valves with its eggs, and itself occupying the intervening space. Whether it merely remains in this situation during incubation, or whether, hermit-crab-wise, it makes its abode in empty shells a matter of permanent policy, does not transpire; but MM. Perrier and Rochebrune, judging from their concluding remarks, evidently incline to the latter idea. In fact, this habit is merely a specialisation of the ordinary habit possessed by these shell-less Cephalopoda of protecting their soft bodies by inserting them in foreign shells, rock crevices, old tins, or whatever first presents itself.

Nerves of Molluscs.

A long and apparently most careful paper on the histology and organology of the nervous centres of Gastropoda as exemplified in the genera *Helix*, *Arion*, *Zonites*, and *Limax*, from the pen of M. B. de Nabias, has just appeared in the *Actes de la Société Linnéenne de Bordeaux* (vol. xlvii., pp. 11-202, 5 pls.).

As the author justly remarks, the microscopic structure of the nervous system of the Gastropoda—indeed he might have said of Mollusca generally—is almost totally neglected, attention being devoted solely to the external topography. Mr. Nabias' researches show that there exist two sorts of nervous cells in the nervous centres. First, ganglionic cells properly so called, of variable size, that occur in the subœsophagian centres, in the visceral ganglia, and in the posterior portion of the brain, where they are disposed radially round the central fibrillary mass. The larger cells are near the periphery, the medium-sized and smaller ones in closer proximity to the central mass. Secondly, small spherical cells of uniform size, only met with in the anterior region of the brain (Protocerebron), in the terminal ganglia of the tentacles (both upper and lower) and the ganglion of the external labial nerve, which must be considered as the gustatory nerve.

The number of cerebral nerves, amounting to nine pairs, are constant for the five genera. M. Nabias distinguishes three regions in the cerebral ganglion—protocerebron, mesocerebron and post-cerebron—for the last of which the term metacerebron would have been preferable.

Nullipores.

It is already well-known that the small calcareous marine Algæ, commonly termed "Nullipores," sometimes form great deposits of massive limestone among rocks of the Tertiary and perhaps the latest Cretaceous periods. Hitherto, however, only insignificant remains of these organisms seem to have been recognised in strata of earlier date. Geologists will, therefore, peruse with much interest the paper by Dr. Alexander Brown on *Solenopora*, published in the April and May numbers of the *Geological Magazine*. *Solenopora* is a problematical calcareous organism of varying size, ranging from the dimensions of a pea to those of an orange, and of irregular shape; and it occurs abundantly in the Ordovician (Lower Silurian) rocks, where it sometimes forms great beds of limestone. Dr. Brown attempts to prove that its structure is cellular, not tubular as previously supposed, and that there are occasionally appearances which can only be compared with the "tetrasporangia" and "conceptacles" of recent corallines. It is thus extremely likely that the problematic fossil in question will prove to be a nullipore, and in that case the range of these minute organisms as rock-builders is extended backwards to early Palæozoic times.

An International Catalogue of Scientific Publications.

In the *Bulletin de l'Académie Royale de Belgique* for April 7, M. Mourlon has a paper on the formation of an International bureau for Bibliography. He refers to the scheme read before the Academy on December 4 last by M. F. Van der Haeghen, for the compilation of a General Catalogue of the contents of public libraries, and proceeds to quote a letter received from the Royal Society of London, dated March 22, 1894, and signed by the secretaries, Professor M. Foster, Lord Rayleigh, and Sir J. Lister.

This letter, which we presume has been sent to other Societies besides the Royal Academy of Belgium, announces the proposed preparation of a Catalogue of all "scientific publications, whether appearing in periodicals or independently," and goes on to say that, as such a "Catalogue is far beyond the power and means of any single Society," the "Royal Society have appointed a Committee to inquire into and report upon *the feasibility of such a catalogue being compiled through international co-operation*." "The Catalogue should commence with papers published on or after January 1, 1900."

This excellent suggestion has been made many times before, and we are glad to hear that the Royal Society of London is taking some practical steps in the matter. But we are curious to learn the names of those forming the committee, that there may be some guarantee of special knowledge in the decisions arrived at. That the Royal Society failed to attain reasonable completeness in their "Catalogue of Scientific Papers" is generally felt, and in their letter referred to this is definitely acknowledged. But the reasons therein given for this failure are lamentably feeble, for they say that this incompleteness is "owing to the omission of the titles of papers published in periodicals of little importance, or not easy of access." Now, in the first place, it is not for compilers of catalogues to judge whether a periodical is, or is not, of "little importance." The importance of an article, or of a note for that matter, is decided by its importance to the individual who wishes to consult it; it cannot be valued by the clerk who transcribes. In the second place it is the experience of most of those who have to consult periodicals, that they can find in one or other of the great libraries in London practically everything they wish to consult. Judging by our own experience of the "Catalogue of Scientific Papers," published by the Royal Society, the rich collections of scientific serials at Bloomsbury, and the still richer collections stored in the Natural History Museum at South Kensington, could not have been consulted very carefully by the compilers.

Turning to foreign publications of the same nature, we find that the more convenient "Bibliotheca Historico-Naturalis" of Engelmann (1846), the "Bibliotheca Zoologica" of Carus and Engelmann (1860), with the continuation now publishing under the editorship of Taschenberg, reaches a far higher level of completeness in the special subject with which these volumes are concerned. The reason for this is seen in the fact that the German compilers have a special knowledge of the subject upon which they work, and take infinitely more pains to render their work perfect. Only a year or so ago Dr. Taschenberg himself paid a special visit to this country to consult the rarer English publications in order to minimise, as far as possible, the number of omissions.

These catalogues, if they are to be compiled at all, should not suffer from the neglect of periodicals "of little importance or not easy of access," and we sincerely hope that the Royal Society of London, if it attempts the publication of a Catalogue such as it proposes, will use the experience gained by their acknowledged failure, will model their work on Engelmann, Carus, and Taschenberg, both in completeness and size, and make their part of the proposed Catalogue worthy of the subject, and of the money which must be spent upon it.

Records of Scientific Literature.

We have often referred in these pages to those books known as Records of Scientific Literature, which have for object the assistance of the systematic scientist, by cataloguing and arranging the vast flood of papers and books published during the year on scientific subjects. It is our intention, in an early number of Natural Science, to bring together a list of the more important of these valuable time-savers, to show, in the first place, what has been and is being done in this direction, and, in the second place, to bring before the notice of would-be compilers, the importance of some international action as proposed by the Royal Society in the letter referred to above, in order to save the duplication of work, and the extravagant expenditure of energy and money, which result from the numerous independent publications all tending to the same end. The most striking illustration of the waste in this direction is perhaps seen in the fact that no less than three recognised publications are issued year by year dealing with zoological literature, viz., the *Zoological Record*; the *Zoologischer Jahresbericht*; and the *Zoologischer Anzeiger*. In Geology the case is not at present so bad, for D'Agincourt's *Annuaire* is the only publication embracing, or rather attempting to embrace, the geological literature of the whole world. There are, however, numerous other geological records of local interest, as Blake's *Annals of British Geology*, Nikitin's *Russkaya Gheologicheskaya Biblioteka*, and the *Bibliografia Geologica Italiana* of the Italian Survey. As it has been proved more than once that the scientific public will not support these works, despite their enormous value, it behoves all those interested in the cataloguing of scientific literature, to consider any scheme whereby the necessary catalogue can be produced without the doleful interruptions due to non-support, incompleteness, unpunctuality, or neglect, which have characterised these publications in the past.

Boulders as Sources of Error.

In *Nature* for May 3, Professor McKenny Hughes has an interesting letter on the above subject. He points out that a quantity of rubbish of all descriptions is taken by barges down the lower Thames and spread on the adjoining lands. Thence it is carried on "with road scrapings, fragments of every kind of road metal; with soil turned out in digging foundations, specimens of all the materials used for building; with the contents of middens, and every variety of object of domestic use and ornament." He himself has seen pieces of Napoleonite on the surface in North Kent! Then, with regard to the soils washed out of a cliff of boulder clay, although in the majority of cases there is no doubt as to their origin, Professor Hughes points out that there is another serious source of error, of which he gives a good example.

"A Norwegian vessel, carrying timber from Christiansund to Boston, in Lincolnshire, ran aground and became a total wreck off Old Hunstanton last winter. I saw her in January. The vessel looked sound enough to a landsman's eye; but she was dismasted and gutted, and the salvage was on the sand dunes close by. About her a pool of varying breadth had been formed by the swirl of the water round the hull. The currents had been deflected by various circumstances here and there, as especially where a quantity of ballast had been thrown out. This consisted of large boulders of various kinds of gneiss and porphyry, and the weighty pile looked as if it were little affected by the currents of the incoming and receding tides.

"In April, I visited the spot again, excepting to find that the boulders had been driven along the shore by the fierce storms which had raged along that coast since my previous visit, and intending to make note of their dispersal and the distance to which they had travelled. I found, however, that the keel and a portion of the lower part of the wreck remained, and that the surrounding pool was greatly deepened and extended. Through the deep clear water I saw the heap of ballast, which had been undermined and was settling down into the depths, being already far below the level of the surrounding sand. When the last of the timber shall have yielded to the axe and the waves, the sand will soon level up the hole caused by the scour round the obstructing mass, and this heap of Scandinavian boulders will lie buried in the sand till some exceptional storm shall shift the banks, and expose them again, and perhaps transport them along the shore.

"Had this vessel been thrown on a hard rocky shore instead, the ballast would have started at once with the other boulders on the shore, and been scattered, according to size and form, along the coast. As it was, however, these have got buried deep in sand, and preserved till, perhaps, the habit of using such boulders for ballast shall have been given up, and then, washed out by the accidents of weather, of coast destruction, and of shifting sand, they will appear among the fallen fragments of a boulder-clay cliff, and be appealed to in proof of its origin.

"How many ships with Scandinavian ballast have been wrecked along our eastern coast ever since the time of the Vikings? How many hundred tons of such boulders are still travelling round our shores?"

At a meeting of the Geologists' Association of London, on May 4, Mr. W. W. Watts read a paper on behalf of Mr. A. C. G. Cameron, "On some boulders of chalk in the Boulder-clay of Huntingdonshire." These masses were of large size, and were evidently torn from the original mass, and were in no way "reconstructed" chalk. It was pointed out that one of these masses was considerably more than half-a-mile long, about a quarter of a mile wide, and of unascertained thickness. Upon it, the greater part of the village of Catworth was built, the inhabitants of which derived an abundant supply of water from wells sunk into the mass, this commodity being difficult to obtain by those living on the surrounding surface of boulder-clay. Such a block of chalk as this raises similar interesting questions to the travelled blocks of Professor Hughes. But in this case we cannot invoke the Vikings. As was pointed out at the meeting of the Association, it is difficult to imagine the ice-force necessary to tear away from the parent rock so prodigious a mass of chalk, leaving out of the question the quantity of ice necessary to lift and transport such a mass bodily over the country.

The Sutherland Gold-fields.

It seems likely that the Sutherland gold-diggings will be re-opened in a few months after having been abandoned for twenty-five years.

The facts known about the mode of occurrence and source of this gold appear to be few and elementary. All the gold obtained was alluvial, and the diggings were along three streams—the Kildonan, Suisgill, and Kinbrace burns. These are tributaries, on the eastern side, of the Helmsdale River, which drains a considerable area in N.E. Sutherland. Gold was also found in small rills on the western side, and, as might be expected, in the main river.

The diggings were in terraces of coarse, sandy gravel which skirt the streams, and in the present detritus of their beds, the rock-pockets being the richest. Whether gold was ever found in the parent rock seems uncertain. It may exist finely disseminated in it, and does not appear to be derived from vein-quartz. The country drained by the three burns consists of quartz- and mica-schists traversed by granites, and belonging to that Eastern Highland series over the age and origin of which so much mystery still hangs.

It is not likely that speculation concerning the source of the gold will be very fruitful until many more localities have been searched, and until much more is known of the distribution of the rock-groups in East Sutherland. This we may look for before very long, as the Geological Survey is now at work there. Then, perhaps, some connection between the occurrence of the gold and the nature of the rocks may be found, and light may be thrown on a subject which, though not very important (at least at present) from an economic point of view, has always a certain scientific interest.

We are pleased to note that the Government of Western Australia has decided to reserve a large tract of public land in the colony as a "National Park" for the preservation of the native fauna and flora. At the suggestion of Mr. Bernard H. Woodward, curator of the Government Museum, an area of 160,000 acres has been selected on the Darling Range, between the Albany and Bunbury roads, mid-way between Bannister and Pinjarrah, and within a reasonable distance of Perth. It is one of the most picturesque parts of the range, having many serrated mountain peaks, and being exceedingly wild and rugged. It is said to be exactly the site required for the preservation of the kangaroo, with other marsupials, and the emu, of which there are still a certain number left upon it.

I.

Cell-Division.

PART II.

IN the number of NATURAL SCIENCE for January of this year an attempt was made to give a more or less up-to-date account of the karyokinetic method of cell-division. The present article proposes to discuss the phenomenon briefly in its bearing upon reproduction and the segmentation of the ovum, and also to pay some attention to points of theoretical interest in the same connection. Before doing so, however, it will be advisable to consider that other form of nuclear division, viz., Amitosis, or direct division, to which reference was made at the conclusion of the former article. This course is almost necessitated by the fact that recent observations tend to show that amitosis sometimes occurs where theoretical considerations would naturally lead one to expect karyokinesis. If the accuracy of these observations be allowed, it would seem that much that has been written on the significance of karyokinetic division in the transmission of hereditary substance must be reconsidered, if not laid aside as no longer compatible with attested facts.

Amitosis, and its Relation to Mitosis or Karyokinesis.

Amitosis has been stated by many observers to occur normally both in unicellular organisms and in the tissues of higher animals and plants.

Firstly, as regards its occurrence in the Protozoa. The student of nuclear division in these animals must draw a sharp line of demarcation between those forms which possess both a macro- and micro-nucleus, *e.g.*, *Paramœcium*, and those which, like the common amoeba, possess only one. In the former instances, the macro-nucleus invariably divides amitotically. Can the same be said of the single nucleus of the latter? Flemming, Ziegler (18), and those who seek to show that amitotic division is invariably a sign of the degeneration of the nucleus that exhibits it, maintain that in those forms which have only one nucleus the division is always accompanied by karyokinesis. Hence, if it can be proved undoubtedly that amitotic division may take place in such forms as *Amoeba*, it follows that the view of those authors must be disregarded, at any rate in so far as it applies to the Protozoa. It is somewhat surprising that little careful investigation of this latter point has as yet been made.

Secondly, as regards the occurrence of amitosis in the Metazoa. Although a few authorities still doubt its existence, it seems clear that, if we are not to disregard a large number of observations, amitotic division of nuclei does actually take place. This fact was first insisted on by Flemming, and the subject has been carefully worked out by Ziegler and others. These observers have shown, in the first place, that nuclei which divide directly are always of relatively enormous size, a condition probably the result of unusually intense secreting or assimilating processes going on within them. For instance, the ovarian cells of many insects act as conveyers of nutriment to the growing ovum. These cells possess large nuclei, which have been observed to break up directly into two or more pieces, although there is no corresponding division of the body of the cell as a whole. Again, the brood-pouches of certain molluscs are lined by cells which pour into them a nutritive fluid. These cells have large, irregularly-shaped nuclei, which undergo rapid amitotic division preparatory to disintegration. Further, it has been shown that the cells lining the mid-gut of insects have the function of gland-cells. They are continually being given off from the inner surface of the gut, and new cells are formed from underneath to supply the place of the old ones. These young cells are formed, in the first instance, by karyokinetic division, but as soon as they become functionally active, their nuclei swell up and divide directly into several pieces. Soon afterwards the cell dies and is thrown off. To take one more instance, this time from the Mammalia, it has been noticed that amitotic division characterises the nuclei of the epithelial cells in the uterine wall preparatory to parturition. Lastly, amitosis is of frequent occurrence in the cells of pathological growths of all kinds. In all these examples it must be noticed that, although nuclear division takes place, there is no corresponding division of the cell-body, and, further, that amitosis is a characteristic of nuclei that have taken on a special function, leading to the speedy death and disintegration of the cell.

It is, however, by no means true that amitosis is never accompanied by cell-division, or that it is always followed by nuclear degeneration and a stopping of cell multiplication. In the spermatogenesis of many animals, it appears that the sperm-mother-cells divide amitotically up to a certain point, after which karyokinesis marks their further division into spermatoblasts. In the development of the spermatozoa of *Branchipus*, Moore (14) has shown that some of the primitive genital cells break down to form a fluid, in which lie the spermatozoa produced by the remainder. The former are the product of repeated amitotic division, the latter of karyokinetic. But the more striking instances of fragmentation of the nucleus are met with in the fertilised ova of many animals. Henking, among others, has made careful investigations on insect ova (10), and in a large number of cases has shown that the first segmentation nucleus may entirely disappear, and all trace of chromatic or achromatic substance vanish. The chromosomes appear to break up into minute granules, and to become scattered throughout the protoplasm of the ovum, where, by fusion, they apparently, later on, form the "free" or "yolk" nuclei. It must, however, be noticed that no trace of division into blastomeres is to be found till normal karyokinetic division sets in. The chromatin of the first nuclear spindle appears to be the result of a fusion of some of these nuclear granules. There appears, moreover, to be, in insects at any rate, every condition between a regular karyokinetic division of the first segmentation nucleus and an irregular fragmentation of the same. The limits of this article forbid further examination of the evidence in favour of the fragmentation of the nucleus, but it should be mentioned that in the spore-formation of many Protozoa a similar breaking-up of the nucleus takes place, without any trace of karyokinesis. Hickson has, in a recent paper (11), reviewed the literature on the subject, besides giving details of his own observations, and the conclusions he draws appear to be the most probable at the present state of our knowledge. They are :—

1. Fragmentation of the nucleus is a normal method of nuclear division, and is not always a sign of pathological change, or, indeed, of anything abnormal.

2. In many of the instances in which the nucleus is supposed to disappear, there is, as a matter of fact, minute fragmentation of its component parts.

3. Fragmentation of the nucleus is never followed by any kind of corresponding division in the body of the ovum.

It is certain that no hard and fast line can be drawn between mitosis and amitosis, since many recorded observations prove how the one passes almost imperceptibly into the other. There remains, however, the question as to which of the two is the more primitive. To give an answer in the least degree probable is a matter of considerable difficulty, if not of impossibility. In the first place, it is almost necessary to postulate the past existence of non-nucleate organisms, even if it cannot be allowed that there are any such living at the present day. It is equally essential to assume that they must have reproduced themselves in some way or other, either by dividing into equal halves, or by breaking up into irregular pieces. Hence, before the nucleus was developed, there were already forces residing in the cell-substance, tending either to pull it into equal halves or into many pieces. After the appearance of the nucleus in those individuals which had normally multiplied in the former manner, regular karyokinesis would take place, while in the latter case fragmentation of the nucleus could have been the only possible cause. The latter method appears to have become rarer and rarer in the Metazoa, probably because the nucleus took on a more definite plan of structure, necessitating an exact division of each of its component parts. It is difficult to imagine such a complicated process as karyokinesis arising suddenly in a small nucleated mass of "Urschleim," or primordial protoplasm. It would seem more natural to imagine the nucleus dividing irregularly at first, which division gradually became more and more precise as the importance of the nucleus as an element in the cell increased. It cannot be considered, however, that amitosis, when it occurs in the Metazoa, is a reversion to a primitive condition. There can be little doubt that it is an acquired process, dependent on some special change in the nucleus or cytoplasm.

The Relations of Nuclear Division to Reproduction and Segmentation.

It is well known that the essential process of fertilisation is the conjugation or "fusion" of the head of the spermatozoon, with the nucleus of the ovum. In order to understand the nature of the phenomenon, it is necessary to study the part played by each of the two elements concerned. The head of the spermatozoon, or sperm-nucleus, is practically a mass of chromatin, with nothing resembling the achromatic network of a resting nucleus. The body, or middle piece, is the centrosome, the nature of which was fully discussed in the first part of this article. The tail consists merely of vibratile protoplasm, and either drops off while the spermatozoon is still in the periphery of the ovum, or may persist for a while in the substance of the egg, eventually becoming detached from the head and finally absorbed. The head itself, after penetrating into the egg, may either (*a*) be transformed immediately into a resting nucleus with membrane and achromatic network, a condition it maintains throughout, or (*b*) having first passed into a resting condition, later on its chromatic elements may become collected to form one or more chromosomes, but always a definite number for every species, while the achromatic elements and the membrane simultaneously disappear.

In *Ascaris megalocephala*, the classical object for research on nuclear structures, the sperm-nucleus always possesses a certain number of large chromosomes in the form of threads or rods. The whole process of fertilisation has been most minutely studied by Van Beneden, Boveri, Carnoy, and others. The egg-nucleus is precisely similar in appearance, and in the number of chromosomes it contains, to the sperm-nucleus. To reach this condition, it has had to undergo important changes and losses, caused by the so-called "reducing division," or extrusion of the polar bodies. The significance of these structures has been interpreted in many different ways, some of which will be briefly touched upon later. It is enough at this point to call attention to the fact that, by a reduction in the amount of chromatin it originally possessed, the egg-nucleus has come to exactly resemble in all outward features the metamorphosed head of the spermatozoon. Passing on now to the actual process of fertilisation, Van Beneden has observed that, in one species of *Ascaris*, both the egg- and sperm-nuclei (male and female pronuclei), contain a single varicose chromatin thread. As they approach one another, the thread in each divides transversely into two halves, both of which become looped and again divide, this time by longitudinal splitting, into four apparently identical pieces. The two nuclei then come into close contact, and the eight threads, from male and from female, arrange themselves in the equatorial plane of a spindle, which has by this time been formed by the activity of the centrosome brought into the ovum by the spermatozoon. The threads gradually travel towards the poles of the spindle, and a separation is effected between them in such a way that each of the daughter-nuclei is formed out of four chromosomes, two derived from the female and two from the male. Constrictions now appear, dividing the ovum into two blastomeres, the nuclei of which have by this time passed into a resting condition. It will be seen from the foregoing account that there is no true fusion of the chromosomes of the two pronuclei, but only a mingling together of their substance. Indeed, the notion that in the fertilisation of any ovum the two nuclei actually fuse to form one, or that any part of them do so, is gradually being given up.

There still remain to be considered those cases in which the two nuclei copulate while in a typically resting state. The process of fertilisation in the leech *Nephelis*, which the present writer has had the opportunity of studying, affords a good case in point. Both pronuclei are in a state of perfect rest during the whole time; all that appears to happen is the breaking down of the two membranes of the adjacent nuclei at the point of contact, allowing a mingling of the chromatic and achromatic elements, which results in the formation of a single large nucleus. This also remains some time in a state of rest before it proceeds to karyokinetic division.

It would seem, therefore, necessary to distinguish those cases in which the two pronuclei fuse, so as to give rise immediately to a nuclear figure, from those in which copulation takes place between two resting pronuclei to form a single nucleus in the same condition. What the significance of these two modifications may be is not clearly understood.

Nuclear Division in Relation to Points of Theoretical Importance.

Since the nuclear matter is so obviously concerned in the process of fertilisation, it is legitimate to hold that the nucleus is the seat of the hereditary substance which the parent transmits to its offspring. Strasburger and O. Hertwig were among the first to advocate this view, and it has now come to be generally accepted that only the chromatin of the nucleus is the bearer of the hereditary tendencies. This view is supported by the fact that paternal characters can be inherited just as well as maternal, although the amount of protoplasm in the two germ-cells is greatly disproportionate.

Further, the persistent part of the spermatozoon is practically nothing more than a mass of chromatin and a centrosome. The latter is, without doubt, merely an organ for division, although one author has recently tried to show that the centrosome is the bearer of parental qualities to the entire exclusion of the chromatin substance. If it be granted, therefore, that the chromatin is the bearer of the hereditary tendencies, it is of the greatest importance to trace out the changes which the chromatin of the egg- and sperm-nuclei undergo preparatory to copulation.

Mention has already been made of the "reducing division" of the nuclear matter of the egg-cell by means of the polar bodies. These structures have been noticed for some considerable time, and there has been much speculation as to their real nature. The following are some of the more important suggestions which have been made in order to explain their presence:—

1. The earlier authors considered them to be excretory products which the ovum had to get rid of.

2. Kölliker regarded them as a means of rendering the egg-nucleus the same size as the sperm-nucleus.

3. Flemming thought they represented a parthenogenetic mode of development possessed by the ova of earlier ancestors.

4. Hertwig and Boveri look upon the formation of the polar bodies as nothing more than unequal cell-division, strictly comparable to what happens in the formation of the spermatozoon. Boveri has constructed two diagrams, reproduced here, to illustrate this point (3), and has invented a new nomenclature for the germ-cells in the various stages of their development. From an inspection of these diagrams it will be seen that the first polar body corresponds to a sperm-mother-cell, while the second corresponds to a spermatozoon. While the diagrams illustrate strictly the number of divisions which the ovocyte I. and spermatocyte I. undergo, viz., two, there are more series of cell-divisions than represented in the upper part of the diagram for the zone of germination. These diagrams will be subsequently referred to in considering the fate of the chromosomes in the reducing division.

5. Minot and Balfour, as is well-known, regarded the polar bodies as representing outcast male elements, and postulated a somewhat similar process taking place in the formation of the spermatozoon, by which corresponding female elements were got rid of. Thus, these two authors considered the primary germ-cells to be essentially hermaphrodite.

6. Weismann sees quite a different significance in the polar bodies. According to his earlier view, nuclear matter presents two modifications, viz., germ-plasm and histogenic nucleoplasm. The former is only found in the germ-cell, and is the hereditary substance passed on from parent to offspring. The latter is the element which determines the nature and directs the growth of the cell which contains it.

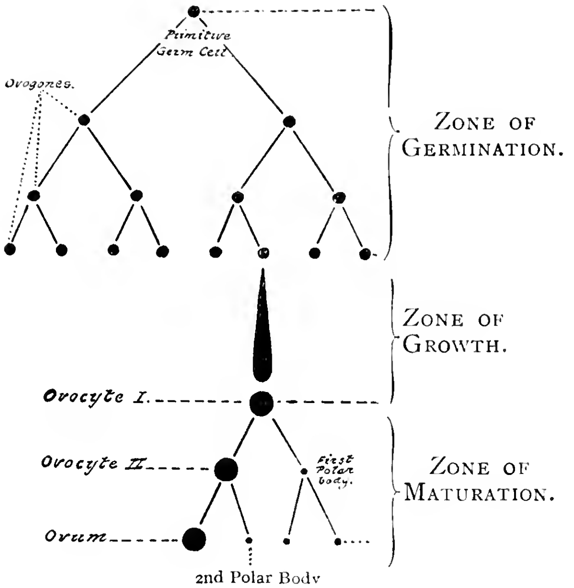
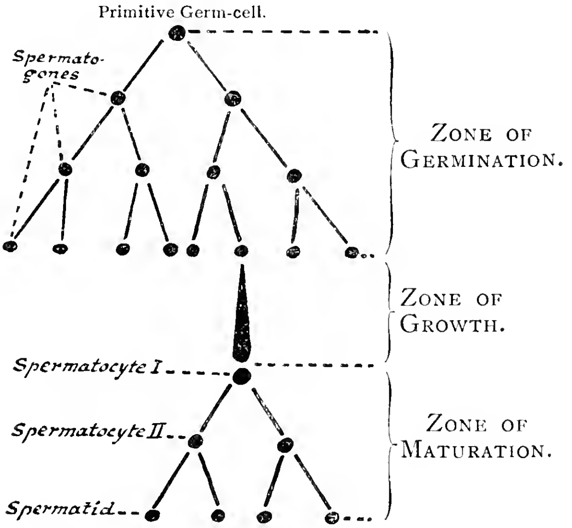


Diagram Showing the Development of the Egg-Cells in Ascaris megalocephala (*after Boveri*).



Spermatocyte I. = Sperm-grandmother-cell.
Spermatocyte II. = Sperm-mother-cell.
Spermatid = Spermatozoon.

Diagram Showing the Development of the Sperm Cells in Ascaris megalocephala (*after Boveri*).

Thus, the nucleus of a nerve-cell would contain a different kind of histogenic plasm from that of a gland- or muscle-cell. As soon as the ovum has arrived at maturity, its own histogenic plasm has become superfluous, and is therefore got rid of in the shape of polar bodies. When, however, it became known that, whereas in sexually reproducing ova two polar bodies were extruded, in those which developed parthenogenetically there was never more than one,[1] Weismann was forced to attach another meaning to the second polar body. This he did by suggesting that it was a means of keeping the number of ancestral units in germ-plasm from increasing; were there not some such method the germ-plasm would be doubled at every fertilisation, and soon grow too large to be contained in the nucleus. It is possible that this idea was based on certain erroneous observations as to the exact method of nuclear division in the formation of the second polar body. The point is far too complex to be entered upon here, but it has been adequately discussed, and criticised by Boveri (3) and others.

After the publication of Hertwig's (10) admirable researches on the spermatogenesis of *Ascaris*, Weismann considerably modified his views. It was shown, or at any rate Weismann has gathered from Hertwig's work, that the youngest sperm-mother-cells possess nuclei which are characterised in the active stage by the presence of four chromosomes. These cells (spermatogones, to use Boveri's nomenclature) increase by ordinary karyokinetic division, *i.e.*, longitudinal splitting of their chromosomes up to a certain point. When this is reached, the cells cease to multiply, but grow considerably in size, and their nuclei pass into the resting condition. On again becoming active, the nuclei are seen to possess not four rods as heretofore but eight. At this point the reducing division sets in. Each cell (spermatocyte I.) divides into two (spermatocyte II.), each of which again divides, forming two daughter-cells, which are the true spermatozoa (Spermatids) (*see* diagram). It must be noticed, however, that in both these latter divisions there is no longitudinal splitting of the chromosomes, but half the number of rods pass into the daughter-nuclei. Since there are two reducing divisions, it will be seen that each spermatozoon eventually comes to possess two rods, *i.e.*, half the number contained by the original spermatogone. The process in the formation of the ovum is exactly similar to the above, the sole difference being that, whereas in the male cells the reducing division of the spermatocyte I. gives rise to four equal spermatozoa, that of the ovocyte I. gives rise to three polar bodies[2] and the ovum, of which only the last is functionally active. Therefore, the ovum before the extrusion of the polar bodies is the homologue of the sperm-grandmother-cell or spermatocyte I.

[1] Blochmann, however, has described two polar bodies in the parthenogenetic ova of *Apis* and *Liparis*, and Brauer has shown that the same is the case in the parthenogenetic eggs of *Branchipus* and *Artemia*.

[2] The first polar body divides into two, making three in all.

This reducing division has excited great attention among biologists, and scarcely a week passes without some new contribution to the already extensive literature on the subject. It is only possible here to give the briefest mention of the view that Weismann now holds. This author considers the nuclear chromatin rods, or "idants," to be composed of individual masses of ancestral plasms, or "ids," each of which could, if it alone dominated the ovum, control the whole course of development, and give rise to a complete individual of the species. The doubling of the idants before the reducing division is a means of increasing the number of possible combinations among the ids, and of thereby ensuring that as many spermatozoa as possible shall possess the hereditary tendencies balanced in different proportions. By this means, which equally well applies to the ovum, the organism resulting from the union of two individuals may differ markedly from its parents, or, in other words, may exhibit considerable variation from the specific type.

Before leaving the subject of the reducing division, it should be noticed that a similar process occurs in the Protozoa. Maupas has shown that the micro-nucleus of the Ciliata, which alone takes any part in conjugation, undergoes as many as three reducing divisions before it is ready for action. In some lowly-organised plants (Desmidiacea) reducing division takes place after two individuals have fused to form a zygote.

Lastly, Boveri has carefully traced the method ot nuclear-division in the segmenting ovum of *Ascaris*, and finds that large masses of chromatin may be extruded bodily from the cells. Further, he has discovered that the ovum divides, at its first segmentation, into a somatic-cell and a germ-cell. The difference between them is marked by the way their nuclei divide. Whereas the former cell and its descendants divide in a more or less rough and ready manner (though always karyokinetically), and masses of chromatin are extruded bodily from the cell, the latter divides, with the exactest halving of its rods, into two, one of which halves repeats the division of its parent, while the other segments in a manner similar to the somatic cells. Thus, up to a certain point in ontogeny, there is in the embryo, at any given period, one cell which is a product of perfect karyokinetic division. Beyond this stage all the descendants of this cell divide similarly to it, and give rise to the germ-cells. Thus there is a perfect continuity of the nuclear matter from the two-celled stage in development up to the ripe sexual elements of the adult. Boveri's results are, therefore, a striking proof of Weismann's theory of the continuity of the germ-plasm, as far as outward form goes.

The above account deals with some of the main points in which cell-, and more particularly nuclear, division are of importance, as regards both the actual process of fertilisation and development. It is naturally impossible to give any clear idea of Weismann's elaborate theories based on nuclear structure and the changes it undergoes; but it was felt that it would be equally undesirable to entirely pass over all theoretical speculations. Without some connecting idea, the facts themselves lose much of their interest, and biologists must of necessity pay close attention to such work as Weismann's, even if they have to find subsequently that some new discovery renders that work no longer tenable as affording an adequate explanation of the facts as they stand. Though to some minds Weismann's doctrines may extend into the regions of transcendental science, yet his works, and those of the Hertwigs, Boveri, and other eminent cytologists, have brought home to all an immense and varied field of possible research, the results of which may in the future, as they have done in the past, profoundly modify the position of Biological Science.

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II.

Can the Sexes in Ammonites be Distinguished?

ALL living Cephalopoda known to us have the sexes separate; no hermaphrodite species has been discovered. It is therefore natural to suppose that the extinct Ammonites were similarly unisexual, some specimens being male, others female. If this be admitted, it becomes of some importance to ascertain whether the difference of sex affected the hard as well as the soft parts of the animal, and, conversely, whether certain differences of form that distinguish individuals may not be of sexual rather than of varietal or specific nature. Clearly it would be wrong to give separate specific names to individuals whose only difference was that of sex.

The opinion that such secondary sexual characters are manifested in Ammonite shells has long been maintained by many eminent authorities, notably among French palæontologists. The first to suggest it seems to have been Ducrotay de Blainville, in his "Prodrome d'une monographie d'Ammonites," Paris, 1840. "Unknown," he said, "though the Ammonite animal be, yet analogy drawn from what we know of the Nautilus does not allow us to doubt that the sexes were separate in different individuals. The females, then, must have had the ventral side more swollen by the ovaries replete with eggs at a certain period. Hence the shell and its aperture must have betrayed these differences by a size and swelling in the former and a relative width in the latter, both greater in female individuals than in those of the male sex, since the semen of the males could never reach such a development as the fertilised ova of the females." De Blainville was followed by d'Orbigny and many other palæontologists. Pierre Reynès, in the Monograph cut short by his untimely death (1879), strongly upholds the distinction of the sexes, saying—"The difference in the dimensions of shells equally ornamented seems to be one of the most convincing proofs. Among individuals, some are slight and of compressed shape, while the whorls of others are broad; we think that the first are the males and the second the females. . . . It results from the comparison of a certain number of individuals of the same species that, without any doubt, among Ammonites, the compressed forms are almost always accompanied by swollen forms, and that these two forms are constantly associated. The ornamentation and septa are identical; the individuals only differ in the involution and width of their whorls. Anyone making a general study of Ammonites can easily convince himself that the majority of species have two distinct forms, and can prove this whenever the material is sufficiently plentiful. To what cause can this difference of thickness be attributed if not to sex? Ornament is often more pronounced in one sex than in the other, although identical in general arrangement. The ribs and tubercles are then more marked and their number is less; in this case the furrows have a greater depth (*A. bifrons*, *Murchisonæ*, *Martiusii* [*sic*], *Truellei*, *Duncani*, etc.). In other species the ornament is in no way changed, the whorls preserve their ordinary proportions, and are not modified in any of their parts."

That differences, not of specific importance, do exist between individual shells, will not be denied by anyone who has studied large collections of Ammonoidea; and these differences may be due to sex, with at least as much probability as to any other cause. The smaller size of the male is certainly paralleled among recent Cephalopoda, *e.g.*, *Sepia*, *Sepiola*, *Loligo*, *Argonauta*. For the views enunciated by Reynès and the other palæontologists mentioned above, something might perhaps be said within small limits; but modern research has done much to disprove them. First, the supposed males and females are found to be not always contemporaneous when the strata are critically examined. Next, the thick and thin forms of a "species" are replaced in modern collections by a great number of forms in all degrees of compression, and these forms do not exhibit that strict agreement in details of ornamentation, etc., which we should expect to find after reading the accounts of these authors. Finally, it has yet to be proved that the thicker forms did actually possess body-chambers of larger capacity than their thinner relatives. It would be so, of course, if the length remained the same; but our investigations rather indicate that the length varies with the degree of compression, so as to maintain, among relatives, the same size of body-chamber in proportion to the whole shell. For instance, in *Stephanoceras* the body-chamber varies in length from about half a whorl in the thick forms (the supposed females) to very nearly two whorls in the thin forms (the supposed males). If the "female" had to enlarge her body-chamber for the accommodation of the eggs, it is obvious that her body-chamber ought to be larger in proportion to the whole shell than is the body-chamber of the "male," who was not called upon to provide this extra house-room.

Recent writers on the subject have therefore gone upon another tack. In their over-anxiety to obey the behest "cherchez la femme!" two well-known French authors have set themselves to prove that the two sexes in the Ammonites differ not only in compression, but in ornamentation, in shape, in size, in septation, and in the processes at the shell-aperture.

First comes Munier-Chalmas, who, in the *Compte rendu de la Société géologique de France* (no. 14, p. 170, 1892), explains his views on the subject. He considers that the males among Ammonites are represented by certain "scaphitoid" forms, as he calls them, which are distinguished by the following characters:—1. The last whorl is more or less bent back (*réfracté*). 2. The edge of the shell aperture (*péristome*) is furnished with a double process—one auricle on each side —(*apophyse jugale*). 3. The size is relatively small. 4. The evolution of the septa is rapidly arrested.

As types of these *Scaphites*-like Ammonites, Munier-Chalmas indicates the following genera with which we are already acquainted:— *Œcotraustes*, Waagen; *Œcoptychius*, Neumayr; *Sutneria*, Zittel; while he himself adds, as new genera, *Cadomoceras*, of which the type-species is *Ammonites cadomensis*, d'Orb.; *Horioceras*, with type-species *A. baugieri*, d'Orb.; and *Creniceras* which has for type *A. renggeri*, d'Orb. The species belonging to these forms are considered by Munier-Chalmas to be the males of other species, which are females. Thus, *Œcotraustes genicularis*, Waagen, is assigned as male to *Oppelia subradiata* (Sow.); *Horioceras baugieri* (d'Orb.) is made to ally himself with *Distichoceras* (n.g.) *bipartitum* (Zieten); and so on. Why, if these species really are males, generic names, none too happily invented should be given to them, it is not easy to understand. Surely, among Ammonites, as among higher orders of beings, husband and wife should be known by the same name.

This author also treats of the group of Ammonites allied to *A. humphriesianus*, under the name *Cœloceras*. This genus he divides into males, distinguished by an "apophyse jugale," and called *Normannites*; and females, which have no such "apophyse" and are called *Cadomites*. Thus he links the following males and females:—

Cœloceras	(*Normannites*)	*bigoti*	to	*C.*	(*Cadomites*)	*bigoti.*
,,	,,	*sauzei*	to	,,	,,	*polyschides.*
,,	,,	*braikenridgii*	to	,,	,,	*subcoronatum.*
,,	,,	*linguiferum*	to	,,	,,	*daubenyi.*

The example set by Munier-Chalmas has recently been followed by E. Haug, in a paper on "Ammonites des Etages moyennes" (*Bull. Soc. Géol. France*, 3^{e} ser., t. xx., p. 298). This author has applied the same criteria to the genus *Sonninia*, and has come to the conclusion (p. 300) that the normal *Sonniniæ* are the females, and that the group of *Sonninia sulcata*, which contains forms not unlike *Ammonites cycloides*, consists of males. He admits that the species of females far outnumber those of males, but expresses a hope that the missing husbands will eventually be found.

Let us now consider how far these somewhat extreme views, which if true would lead to great complications, are consistent with already known facts.

An objection that might strike even the casual reader of these papers is that all the Lias and much of the Inferior Oolite had been passed through before any of these so-called males appeared; for the earliest are those which Haug finds among the *Sonniniæ*. In the Ammonite fauna of the Lias we have as yet only been able to notice one species possessing the characters supposed by Munier-Chalmas and Haug to denote the male sex. That species is *Ammonites accipitris*, J. Buckman, which, as it occurs with *Ammonites oxynotus*, would be considered as the male of that species. Now *Ammonites accipitris* is, unfortunately for this hypothesis, a very rare form, which seems only to have been found in this country, and in one restricted locality. *Ammonites oxynotus*, however, is common enough on the Continent, where it must have lived in a state of single blessedness. But as for the rest of the Liassic Ammonites, where are the males? Or are we to suppose that the two sexes were exactly alike, and that secondary sexual characters were a comparatively latter-day Jurassic invention?

Objections such as these suggest the enquiry whether there may not be some other explanation of the appearances that the French authors are so ready to ascribe to sexuality. As that remarkably Heavenly Twin, Angelica Hamilton-Wells, reminds us, "so unwholesomely is the imagination of a man affected by ideas of sex."

Now the characters that Munier-Chalmas has hit upon as "masculine" are in great measure those which appear in the different Ammonite-stocks or lines of descent when they draw near the period of their extinction. They are, to a large extent, characters such as we have learned to associate with the old age of a race, when it is in a sense retrogressive. May we not then suppose that these so-called males are in reality the final expressions of the various races to which they belong? At all events, *Cadomoceras*, *Œcotraustes*, and *Œcoptychius* seem explicable as such retrogressive forms; but *Normannites* is admittedly a difficulty.

The sexual hypothesis, however, is one about which it would be foolish to dogmatise; it deserves full consideration. Munier-Chalmas and Haug say that they have many males yet unfigured; and this statement is borne out by other collections, so far as the Oolitic rocks are concerned. It must be remembered that our knowledge of the Ammonite fauna is as yet very imperfect, large though the number of described species appears to be. Some of the Jurassic rocks have been done very scant justice to, and their treasures are still unknown to Ammonite literature.

Apart, however, from any special hypothesis, there is one consideration that may profitably be brought to the notice of those who endeavour to discover signs of sex in the extinct Cephalopods. They may be recommended to enquire whether such signs are to be found in the living species of *Nautilus*, and if so, what those signs are. Of course *Nautilus* is not an Ammonite, does not even belong to the same Order of Cephalopoda; still there can be very little doubt that the situation of the animal with regard to the shell was much the same in the Ammonites, and that any effect produced in the Ammonite shell by sexual difference would probably also be found in that of *Nautilus*.

Owing to the somewhat curious fact, which may of course be mere coincidence, that the large majority of specimens of *Nautilus* examined by eminent naturalists have been of the female sex, not much has been said upon this subject by zoologists. J. D. Macdonald, however, in his account of the anatomy of *Nautilus umbilicatus* (*Phil. Trans.*, 1855, p. 277), has a sentence which, though its logic is obscure, certainly bears on this question. He writes: "The specimen of *N. umbilicatus* examined proved to be a female, a fact which may serve to modify the views of those who, adopting the ingenious speculations of d'Orbigny with reference to the sexes of the Ammonites as indicated by the characters of their shells, apply them also to the several kinds of *Nautili* known." He appears to be alluding to the belief that the species known as *N. umbilicatus* was nothing more than the male of *N. pompilius*. Still the fact that it was really a true species, though it might upset that particular belief, would not conflict with the idea that there might be some differences between the shells of the two sexes.

An attempt to demonstrate some such difference was made in the same year by J. Van der Hoeven (*Verh. d. kon. Nederl. Akad. van Wetensch.*), who had at last obtained a male *Nautilus pompilius*. After describing various external sexual characters of the animal, he proceeds:—"It seems to me moreover as not improbable that in the shape of the hood there is a sexual distinction, and that this, when of the same average length, is about two centimetres shorter in the male individual. With this is also connected a distinction in the shape of the shell; in the male individual this is broader and more globose at the aperture, more laterally compressed in the female animal. Also the edge of the aperture of the shell in the male animal is, as it seems to me, more strongly sinuous; in the female animal more regular." It will be noted that these points of difference, assuming them to be correct, by no means agree with the suppositions of de Blainville, d'Orbigny and others with regard to Ammonites; and in such a case surely no one will venture to exclaim "So much the worse for the *Nautilus!*" Moreover, if one may judge from the drawings by A. G. Bourne which adorn Professor E. Ray Lankester's article on Mollusca in the "Encyclopædia Britannica," both the male animal and its shell are proportionately broader than the female. It is indeed by no means necessary to suppose, as did the older writers, that the swelling of the female organs involves a widening of the shell. The shell of the body-chamber must necessarily have been formed before the development of the ova, and any pressure caused by the enlargement of the soft parts must act on the soft parts themselves quite as much as on the shell. Since, however, the shell is hard and unyielding, the obvious result of such pressure is merely to push the animal forward so that it obtains space by lengthening rather than by widening the body-chamber.

Some caution is, however, to be exercised before accepting the views which Van der Hoeven based upon the evidence of a single specimen. Differences such as he points out do certainly exist between *Nautilus* shells; but a careful examination inclines one to regard them as due to difference of age rather than of sex. As *N. pompilius* grows older, the sides of the shell-aperture begin to swell outwards, so that the width of the aperture is greater towards the inner or dorsal region of the whorl; and this produces a sinuosity in the margin, which continues to increase with age up to a certain point. May it not then be that Van der Hoeven was deceived by just the same kind of characters in the individual species as we believe Munier-Chalmas and Haug to have been deceived by in the race?

To sum up the case in language that has often been objected to in this Journal, and with which its readers cannot, therefore, be wholly unfamiliar,—we suggest that the characters in question are auxologic or bioplastic rather than sexual, being in some cases phylo-gerontic, in others merely ephebic or gerontic, and we conclude that sexual dimorphism has yet to be proved for Ammonite-shells.

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III.

The Palæarctic and Nearctic Regions compared as regards the Families and Genera of their Mammalia and Birds.

IN a paper read before the Cambridge Natural Science Club on March 12 (and printed in *Nature* of April 26, 1894), I discussed the question of the nature and uses of Zoological Regions, and arrived at the conclusion that, in order to secure the maximum of utility, it is essential to have only one set of regions for all groups of land animals; and, further, that the six regions established by Dr. P. L. Sclater are the most natural and convenient, and are best adapted to facilitate the comparative study of distribution, which is the main purpose for which Zoological Regions, as distinct from the ordinary geographical divisions of the globe, have been established.

These regions were at first generally adopted; but of late years many eminent naturalists, both in America and Europe, have proposed other divisions, though hardly any two of these agree with each other. The most important modification, and that which has been adopted by several zoologists both as regards mammals and birds, is to unite the Palæarctic and Nearctic Regions so as to form one new region, coextensive with the extratropical Northern Hemisphere. This new region, which has been termed the Holarctic, is said to be more nearly equal to the other regions as regards peculiar genera and families, and, therefore, to form part of a more natural and harmonious series than if we treat the two component parts as separate regions. It is this one question only that I propose to discuss in the present paper: whether the Palæarctic and Nearctic Regions, as defined by Sclater, present so many resemblances and so few differences that they can be reasonably considered to form one region as homogeneous as are most of the other regions.

The reason why so much difference of opinion exists on this point, when the very same facts are before all the enquirers, seems to be that they treat the facts in different ways. In the first place, it seems to me that far too much stress is laid upon the comparatively small number of absolutely peculiar genera or families in the two temperate regions. That may, or may not, be a reasonable ground for deciding that the regions in question are not of equal rank with some other regions; but it cannot justify the union of the two areas unless it can be shown that they are to a large extent homogeneous—that, in fact, the resemblances are more numerous and more important than the differences. In the areas we are discussing, however, this is decidedly not the case, since the facts clearly show that the differences very far surpass the resemblances—that the former are, in fact, fundamental, and are far greater than can be found in the separate halves of any of the other regions, unless they are so divided as to be very unequal in area or to present very great differences in climate. But the Palæarctic and Nearctic Regions are, roughly speaking, equal in area, while they both exhibit the very same range of climate. Any difference that exists between them must, therefore, be due to more fundamental causes; and the most fundamental cause is, that in each case the existing fauna is descended from an ancient, equally distinct, fauna, modified in different ways by immigration from adjacent areas.

In dealing with any question of this kind, it is very important that the genera and family groups adopted shall be the same as far as possible throughout the whole area. In order to ensure this, I have, for mammalia, adopted those of Flower and Lydekker in their "Mammals Living and Extinct." In the case of the birds, I am indebted to my friend Mr. H. E. Dresser, both for completing his "List of European Birds" so as to include those of the whole Palæarctic region, and also for so harmonising his genera with those of the "A. O. U. Check List of North American Birds," as to combine the whole into a single series. As Mr. Dresser has made a study of North American birds as well as of those of the Palæarctic Region with which his name is more especially associated, the result is probably as fair and unbiased, for the comparison in question, as can be arrived at. In the case of both regions, I have rejected all those genera in which a single species only just enters the region from the adjacent region to which it properly belongs. Here, again, there is, of course, room for difference of opinion; but the doubtful cases are not sufficiently numerous to introduce any important uncertainty in the result.

For both mammals and birds I adopt the same system of presenting the facts which, after much consideration and many trials, seems to me to be the best. The families and genera are arranged in three columns—the first giving those which are Palæarctic but not Nearctic; the third those that are Nearctic but not Palæarctic; the middle column giving those which are common to the two regions—so that by combining this with either of the others we obtain the entire fauna of that region. The results are then summarised in other tables and briefly discussed. We begin with the mammals:—

Mammals of the Palæarctic and Nearctic Regions.

PALÆARCTIC.	BOTH REGIONS.	NEARCTIC.
	Bats.	
Rhinolophidæ :		
1. Rhinolophus.		
Vespertilionidæ :	*Vespertilionidæ* :	*Vespertilionidæ* :
2. Synotus.	1. Plecotus.	1. Antrozous.
3. Harpyiocephalus.	2. Vesperugo.	2. Nycticejus.
	3. Vespertilio.	3. Atalapha.
	Emballonuridæ :	*Phyllostomidæ* :
	4. Nyctinomus.	4. Macrotus.
	Insectivora.	
Erinaceidæ :		
4. Erinaceus.		
Soricidæ :	*Soricidæ* :	*Soricidæ* :
5. Crossopus.	5. Sorex.	5. Neosorex.
6. Crocidura.		6. Blarina.
7. Diplomesodon.		
8. Anurosorex.		
9. Nectogale.		
Talpidæ :	*Talpidæ* :	*Talpidæ* :
10. Myogale.	6. Urotrichus.	7. Scalops.
11. Talpa.		8. Scapanus.
		9. Condylura.
	Carnivora.	
Viverridæ :	*Felidæ* :	*Procyonidæ* :
12. Genetta.	7. Felis.	10. Procyon.
13. Herpestes.		11. Bassaris.
Hyænidæ :	*Canidæ* :	
14. Hyæna.	8. Canis.	
	Ursidæ :	
	9. Ursus.	
Mustelidæ :	*Mustelidæ* :	*Mustelidæ* :
15. Meles.	10. Lutra.	12. Latax.
	11. Mustela.	13. Mephitis.
	12. Gulo.	14. Taxidea.
	Trichechidæ :	*Otariidæ* :
	13. Trichechus.	15. Otaria.
Phocidæ :	*Phocidæ* :	*Phocidæ* :
16. Halichærus.	14. Phoca.	16. Macrorhinus.
17. Monachus.	15. Cystophora	
	Ungulata.	
Suidæ :		*Dicotylidæ* :
18. Sus.		17. Dicotyles.
Cervidæ :	*Cervidæ* :	*Cervidæ* :
19. Moschus.	16. Cervus.	18. Cariacus.
	17. Rangifer.	
	18. Alces.	
		Antilocapridæ :
		19. Antilocapra.

PALÆARCTIC.	BOTH REGIONS.	NEARCTIC.
	UNGULATA.—*continued.*	
Bovidæ :	*Bovidæ* :	*Bovidæ* :
20. Saiga.	19. Ovis.	20. Haplocerus.
21. Pantholops.	20. Bos.	21. Ovibos.
22. Gazella.		
23. Addax.		
24. Rupicapra.		
25. Budorcas.		
26. Capra.		
Equidæ :		
27. Equus.		
	RODENTIA.	
	Sciuridæ :	*Sciuridæ* :
	21. Sciurus.	22. Cynomys.
	22. Tamias.	
	23. Sciuropterus.	
	24. Arctomys.	
	25. Spermophilus.	
Myoxidæ :	*Castoridæ* :	*Haploodontidæ* :
28. Myoxus.	26. Castor.	23. Haploodon.
29. Eliomys.		
30. Muscardinus.		
Muridæ :	*Muridæ* :	*Muridæ* :
31. Gerbillus.	27. Arvicola.	24. Hesperomys.
32. Cricetus.	28. Myodes.	25. Sigmodon.
33. Ellobius.	29. Cuniculus.	26. Ochetodon.
34. Siphneus.		27. Neotoma.
35. Mus.		28. Phenacomys.
36. Acanthomys.		29. Synaptomys.
		30. Fiber.
		31. Neofiber.
Spalacidæ :		
37. Spalax.		
38. Rhizomys.		
		Geomyidæ :
		32. Geomys.
		33. Thomomys.
		34. Diplodomys.
		35. Perognathus.
		36. Heteromys.
Dipodidæ :		*Dipodidæ* :
39. Sminthus.		37. Zapus.
40. Dipus.		
41. Alactaga.		
42. Platyceromys.		
Hystricidæ :		*Hystricidæ* :
43. Hystrix.		38. Erethizon.
	Lagomyidæ :	
	30. Lagomys.	
	Leporidæ :	
	31. Lepus.	
	MARSUPIALIA.	
		Didelphidæ :
		39. Didelphys.

Looking through the preceding lists, we find a remarkable divergence in the characteristic groups of the two regions. Out of fifteen genera of Insectivora, only two are common to both regions; an amount of difference which, if it occurred among larger and better known animals, would produce a striking effect of diversity. In the Carnivora there is a much smaller proportion of peculiar genera, but this is to some extent counterbalanced by each region possessing two families absent from the other. Ungulata, again, show considerable diversity, the Palæarctic Region possessing ten genera and the Nearctic five which are not found in the other. Only five genera are common to both, and of these five, two, Rangifer and Alces, are arctic, while two others, Ovis and Bos, have one species each in the Nearctic Region against about thirteen between them in the Palæarctic. The Rodents, again, have only eleven genera common to both regions, while the Palæarctic has sixteen and the Nearctic seventeen which are not found in the other region.

The following summary will enable us to see the total amount of similarity and difference:—

SUMMARY OF DISTRIBUTION.

Orders.		Families.			Genera.		
	No. of Genera.	*Palæarctic.*	*Both.*	*Nearctic.*	*Palæarctic.*	*Both.*	*Nearctic.*
Cheiroptera ..	11	1	2	1	3	4	4
Insectivora ..	15	1	2	0	8	2	5
Carnivora	22	2	6	2	6	9	7
Ungulata	20	2	2	2	10	5	5
Rodentia	44	2	7	2	16	11	17
Marsupialia ..	1	0	0	1	0	0	1
	—	—	—	—	—	—	—
		8	19	8	43	31	39
Total Genera ..	113	—	—	—	74	—	70
Total Families ..		27		27			

Here we see that in both the regions the number of genera *not* found in the other largely exceed those common to both, the proportion of the total genera thus limited being 58 per cent. in the Palæarctic, and 56 per cent. in the Nearctic Region; while in each case out of a total of 27 families no less than 8 are so limited. If we compare this amount of diversity with that between the Ethiopian and Oriental Regions, we shall find that, while as regards genera it is somewhat less, as regards families it is considerably greater. In the Oriental Region out of a total of about 72 families of mammals only 8 are not Ethiopian; while in the Ethiopian region out of about 74 families only 10 are not Oriental. No doubt these two regions are those which most resemble each other, and they have been united by some naturalists, but they are now generally admitted to be sufficiently distinct to be classed as separate regions. Great weight has, however, always been given to the possession of peculiar families; and for the same reason the fact that nearly one-third of the families in the

Palæarctic and Nearctic regions respectively are *not* found in the other, indicates a fundamental diversity that renders their union into one region quite inadmissible.

We will now tabulate the birds, in which the amount of diversity is much larger as regards genera, and equally as large as regards families:—

LAND BIRDS OF THE PALÆARCTIC AND NEARCTIC REGIONS.

PALÆARCTIC.	BOTH.	NEARCTIC.
Turdidæ:	*Turdidæ*:	*Turdidæ*:
1. Monticola (4 sp.)	1. Turdus (21.5)	1. Merula (2)
2. Myiophoneus (1)	2. Sialia (1) (= Grandala (3)	2. Hesperocichla (1)
3. Saxicola (20)	3. Regulus (4.3)	3. Polioptila (3)
4. Pratincola (7)		4. Myadestes (1)
5. Ruticilla (15)		
6. Hodgsonius (1)		
7. Chimarrhornis (1)		
8. Cyanecula (2)		
9. Erithacus (4)		
10. Calliope (3)		
11. Cossypha (1)		
12. Nemura (1)		
13. Daulias (2)		
14. Sylvia (18)		
15. Melizophilus (2)		
16. Phylloscopus (19)		
17. Hypolais (8)		
18. Ædon (2)		
19. Acrocephalus (10)		
20. Lusciniola (10)		
21. Locustella (8)		
22. Cettia (4)		
23. Cisticola (1)		
24. Drymoeca (1)		
25. Scotocerca (2)		
26. Argya (3)		
27. Rhopophilus (3)		
28. Babax (1)		
29. Pterorhinus (1)		
30. Trochalopteron (2)		
	Cinclidæ:	
	4. Cinclus (4.1)	
Accentoridæ:		
31. Accentor (11)		
Panuridæ:		
32. Panurus (1)		
Paridæ:	*Paridæ*:	*Paridæ*:
33. Leptopœcilus (2)	5. Parus (26.6)	5. Chamæa (12) (sub. fam.)
34. Lophobasileus (1)	6. Lophophanes (3.4)	
35. Suthora (1)	7. Acredula (7) = Psaltriparus (13)	
36. Ægithalus (4)		
	Sittidæ:	
	8. Sitta (8.4)	

PALÆARCTIC.	BOTH.	NEARCTIC.
Certhiidæ:	*Certhiidæ*:	
37. Tichodroma (1)	9. Certhia (2.1)	
	Troglodytidæ:	*Troglodytidæ*:
	10. Troglodytes (6.3)	6. Cistothorus (2)
		7. Thryothorus (3)
		8. Catherpes (1)
Motacillidæ:	*Motacillidæ*:	9. Salpinctes (2)
38. Motacilla (16)	11. Anthus (14.2)	10. Harporhynchus (8)
39. Limodromus (1)		11. Galeoscoptes (1)
		12. Mimus (1)
		13. Oroscoptes (1)
Crateropodidæ ?		*Mniotiltidæ*:
40. Zosterops (2)		14. Mniotilta (1)
Oriolidæ:		15. Protonotaria (1)
41. Oriolus (2)		16. Helenaia (1)
		17. Helmitherus (1)
		18. Helminthophila (8)
		19. Compsothlypis (2)
		20. Dendroica (24)
		21. Sciurus (3)
		22. Geothlypis (6)
		23. Icteria (1)
		24. Sylvania (3)
		25. Setophaga (2)
		26. Cardellina (1)
Muscicapidæ:	*Laniidæ*:	*Vireonidæ*:
42. Muscicapa (6)	12. Lanius (22.2)	27. Vireo (12)
43. Hemichelidon (1)	*Ampelidæ*:	*Ampelidæ*:
44. Alseonax (1)	13. Ampelis (2.2)	28 Phainopepla (1)
45. Xanthopygia (3)		
Hirundinidæ:	*Hirundinidæ*:	*Hirundinidæ*:
46. Chelidon (3)	14. Hirundo (3) (= Chelidon (1)	29. Progne (1)
		30. Petrochelidon (1)
	15. Cotile (3) (= Clivicola (1)	31. Tachyniceta (2)
		32. Stelgidopteryx (1)
		Tanagridæ:
		33. Piranga (4)
Fringillidæ:	*Fringillidæ*:	*Fringillidæ*:
47. Carduelis (2)	16. Chrysomitrus (2) = Spinus (4)	34. Rhyncophanes (1)
48. Serinus (4)		35. Poocetes (1)
49. Chloris (3)	17. Coccothraustes (1.1)	36. Ammodramus (11)
50. Passer (8)	18. Linota (7) = Acanthis (2)	37. Chondestes (1)
51. Eophona (2)		38. Zonotrichia (6)
52. Pycnorhamphus (1)	19. Carpodacus (10.4)	39. Spizella (7)
53. Petronia (2)	20. Pinicola (1.1)	40. Junco (7)
54. Montifringilla (7)	21. Loxia (5.2)	41. Amphispiza (2)
55. Fringilla (6)	22. Plectrophanes (2) = Calcarius and Plectrophenax (5)	42. Peucæa (5)
56. Fringalauda (1)		43. Melospiza (4)
57. Bucanetes (4)		44. Passerella (1)
58. Uragus (2)	23. Leucosticte (5.3)	45. Pipilo (6)
59. Pyrrhula (7)		46. Cardinalis (1)
60. Urocynchramus (1)		47. Habia (2)
61. Emberiza (32)		48. Guiraca (1)

PALÆARCTIC.	BOTH.	NEARCTIC
		Fringillidæ—(continued) :
		49. Passerina (4)
		50. Spiza (1)
		51. Calamospiza (1)
		Icteridæ :
		52. Dolichonyx (1)
		53. Molothrus (1)
		54. Xanthocephalus (1)
		55. Agelaius (3)
		56. Sturnella (1)
		57. Icterus (6)
		58. Scolecophagus (2)
		59. Quiscalus (3)
Alaudidæ :	*Alaudidæ* :	
62. Certhilauda (2)	24. Otocorys (4.1)	
63. Galerita (3)		
64. Alauda (3)		
65. Ammomanes (2)		
66. Calandrella (6)		
67. Melanoscorypha (6)		
68. Rhamphocorys (1)		
Sturnidæ :		
69. Sturnus (4)		
70. Pastor (1)		
71. Poliopsar (1)		
72. Sturnia (2)		
Corvidæ :	*Corvidæ* :	*Corvidæ* :
73. Podoces (4)	25. Nucifraga (1) =	60. Cyanocitta (2)
74. Pyrrhocorax (2)	Picicorvus (1)	61. Aphelocoma (3)
75. Garrulus (9)	26. Perisoreus (1.2)	62. Cyanocephalus (1)
76. Cyanopica (2)	27. Pica (2.2)	
	28. Corvus (11.5)	
		Tyrannidæ :
		63. Milvulus (1)
		64. Tyrannus (4)
		65. Myiodynastes (1)
		66. Myiarchus (3)
		67. Sayornis (3)
		68. Contopus (4)
		69. Empidonax (7)
		70. Pyrocephalus (1)
		71. Ornithion (1)
Cypselidæ :	*Cypselidæ* :	*Cypselidæ* :
77. Acanthyllis (1)	29. Cypselus (7) =	72. Cypseloides (1)
	Micropus (1)	73. Chætura (2)
Caprimulgidæ :		*Caprimulgidæ* :
78. Caprimulgus (4)		74. Autrostomus (2)
		75. Phalænoptilus (1)
		76. Chordeiles 1)

PALÆARCTIC.	BOTH.	NEARCTIC.
		Trochilidæ :
		77. Eugenes (1)
		78. Cœligena (1)
		79. Trochilus (8)
		80. Iache (1)
Picidæ :	*Picidæ* :	*Picidæ* :
79. Dryocopus (2)	30. Picus (18) = Dryobates (5)	81. Campephilus (1)
80. Gecinus (6)	31. Picoides (1.2)	82. Xenopicus (1)
81. Ingipicus (3)		83. Sphyrapicus (3)
82. Jynx (1)		84. Ceophlæus (1)
		85. Melanerpes (5)
		86. Colaptes (4)
Alcedinidæ :	*Alcedinidæ* :	
83. Alcedo (1)	32. Ceryle (2.2)	
84. Halcyon (2)		
Coraciadæ :		
85. Coracias (2)		
Meropidæ :		
86. Merops (3)		
Upupidæ :		
87. Upupa (1)		
Cuculidæ :		*Cuculidæ* :
88. Cuculus (4)		87. Coccyzus (2)
89. Hierococcyx (2)		88. Geococcyx (1)
90. Coccystes (1)		89. Crotophaga (1)
		Psittacidæ :
		90. Conurus (1)
	Strigidæ :	
	33. Strix (1.1)	
Bubonidæ :	*Bubonidæ* :	*Bubonidæ* :
91. Ninox (1)	34. Asio (1.2)	91. Speotypo (1)
92. Athene (3)	35. Syrnium (4) = Ulula (3)	92. Micrathene (1)
	36. Nyctea (1.1)	
	37. Surnia (2.1)	
	38. Nyctala (1.2)	
	39. Scops (4) = Megascops (2)	
	40. Bubo (4.1)	
	41. Glaucidium (1.1)	
Vulturidæ :		*Cathartidæ* :
93. Gyps (2)		93. Pseudogryphus (1)
94. Vultur (1)		94. Cathartes (1)
95. Neophron (1)		95. Catharista (1)
96. Gypaetus (1)		
Falconidæ :	*Falconidæ* :	*Falconidæ* :
97. Circaetus (1)	42. Circus (6.1)	96. Elanoides (1)
98. Nisaetus (2)	43. Buteo (5.7)	97. Ictinia (1)
99. Milvus (4)	44. Archibuteo (2.2)	98. Parabuteo (1)
100. Pernis (1)	45. Aquila (7.1)	99. Urubutinga (1)
	46. Haliætus (3.1)	100. Polyborus (2)

PALÆARCTIC.	BOTH.	NEARCTIC
	Falconidæ—(continued):	
	47. Astur (2.1)	
	48. Accipiter (4.2)	
	49. Elanus (1.1)	
	50. Falco (17.8)	
	51. Pandion (1.1)	
Columbidæ:	*Columbidæ*:	*Columbidæ*:
101. Turtur (8)	52. Columba (14.3)	101. Ectopistes (1)
		102. Zenaidura (1)
		103. Columbigallina (1)
		104. Scardafella (1)
Pteroclidæ:		
102. Pterocles (6)		
103. Syrrhaptes (2)		
Phasianidæ:		*Phasianidæ*:
104. Phasianus (17)		105. Meleagris (1
105. Pucrasia (2)		
106. Chrysolophus (2)		
107. Crossoptilon (5)		
108. Lophophorus (1)		
109. Ithaginis (3)		
110. Caccabis (5)		
111. Francolinus (2)		
112. Perdix (4)		
113. Coturnix (2)		
114. Tetraophasis (2)		
115. Tetraogallus (5)		
Tetraonidæ:	*Tetraonidæ*:	*Tetraonidæ*:
116. Tetrastes (3)	53. Lagopus (5.4)	106. Colinus (3)
117. Tetrao (5)	54. Canachites (2) = Dendragapus (3)	107. Oreortyx (2)
		108. Callipepla (3)
		109. Cyrtonyx (1)
		110. Bonasa (1)
		111. Tympanuchus (2)
		112. Pediocetes (1)
		113. Centrocercus (1)
Turnicidæ:		
118. Turnix (3)		

By merely glancing over these lists we see at once how greatly the genera in either the first or third column exceeds those in the middle column. This tells us that the speciality of each region in relation to the other is very much greater than their similarity. In order, however, to bring out these differences and resemblances more clearly, and to show what they imply, the facts are summarised in the following table of the families, giving the distribution of their genera and species in the same order as in the preceding lists:—

Families of North Temperate Land Birds with their distribution as regards the Palæarctic and Nearctic Regions.[1]

Total Genera.	Families.	Palæarctic only. Genera.	Palæarctic only. Species.	Both Regions. Genera.	Both Regions. Species.	Nearctic only. Genera.	Nearctic only. Species.
37	Turdidæ	30	185	3	0	4	18
1	Cinclidæ	—	4	1	0	—	1
1	Accentoridæ ..	1	11				
1	Panuridæ.. ..	1	1				
8	Paridæ	4	44	3	0	1	14
1	Sittidæ	—	8	1	0	—	4
2	Certhiidæ ..	1	3	1	0	—	1
9	Troglodytidæ ..	—	6	1	0	8	22
3	Motacillidæ ..	2	31	1	0	—	2
13	Mniotiltidæ ..					13	54
1	Vireonidæ ..					1	12
1	Crateropodidæ ? ..	1	2				
1	Oriolidæ	1	2				
1	Laniidæ	—	22	1	0	—	2
2	Ampelidæ ..	—	1	1	1	1	2
4	Muscicapidæ ..	4	11				
7	Hirundinidæ ..	1	9	2	1	4	7
1	Tanagridæ ..					1	4
41	Fringillidæ ..	15	110	8	5	18	79
8	Icteridæ ..					8	18
8	Alaudidæ ..	7	26	1	1	—	1
4	Sturnidæ ..	4	8				
11	Corvidæ ..	4	30	4	2	3	14
9	Tyrannidæ ..					9	25
4	Cypselidæ ..	1	8	1	0	2	4
4	Caprimulgidæ ..	1	4	—	—	3	4
4	Trochilidæ ..					4	11
12	Picidæ	4	31	2	0	6	22
3	Alcedinidæ ..	2	5	1	0	—	2
1	Coraciadæ ..	1	2				
1	Meropidæ ..	1	3				
1	Upupidæ ..	1	1				
6	Cuculidæ ..	3	7	—	—	3	4
1	Psittacidæ ..					1	1
1	Strigidæ ..	—	1	1	0	—	1
12	Bubonidæ ..	2	18	8	4	2	11
4	Vulturidæ ..	4	5				
3	Cathartidæ ..					3	3
19	Falconidæ ..	4	51	10	5	5	26
6	Columbidæ ..	1	22	1	0	4	7
2	Pteroclidæ ..	2	8				
13	Phasianidæ ..	12	50	—	—	1	1
12	Tetraonidæ ..	2	14	2	1	8	20
1	Turnicidæ ..	1	3				
285	(44 Families.)	118	747	54	20	113	397
Total in each Region ..		172	767			167	417

[1] It must be noted that the numbers in the "Species" columns represent the *species* which are absent from the other region, *not* the number of species contained in the "genera" of the preceding column, which are the genera absent from the other region.

The following statement, giving statistics derived from the preceding lists, will complete the information necessary for a comparative view of the relations of the Palæarctic and Nearctic Regions as regards their land-birds :—

The Palæarctic Region has 36 families of land-birds.
Of these, 12 families are not in the Nearctic Region.
These 12 families comprise 22 genera and 57 species.

The Nearctic Region has 32 families of land-birds.
Of these, 8 families are not in the Palæarctic Region.
These 8 families comprise 40 genera and 128 species.

The 118 Palæarctic genera which are not Nearctic comprise 472 species.
The 113 Nearctic genera which are not Palæarctic comprise 282 species.

The preceding lists and figures enable us to obtain a very complete view of the amount of difference that exists between the avifaunas of the Palæarctic and Nearctic Regions.

Considering first the Family groups, we find that in the one case **one-third** and in the other **one-fourth** of the families of the one region are not found in the other; and this is an amount of difference that does not occur between any other two regions which are conterminous with each other. The most striking relation of the Palæarctic and Nearctic Regions is, therefore, not their resemblance, but their dissimilarity.

Again, the 12 families which thus differentiate the Palæarctic Region from the Nearctic comprise 22 genera and 57 species; and among them we find such characteristic groups of the Eastern Hemisphere as the accentors, the flycatchers, the starlings, the vultures, and the sand-grouse,—families entirely absent from the whole Western Hemisphere.

The 8 families which differentiate the Nearctic Region from the Palæarctic are even more important, since they contain 40 genera and 128 species; and include such characteristic New World types as the Mniotiltidæ, the Icteridæ, and the Tyrannidæ, containing between them nearly a hundred species. Now as there are only 417 species of land-birds in the whole Nearctic Region, we find that between **one-third** and **one-fourth** of the whole belong to *families* which are entirely foreign to the Palæarctic Region. It may be confidently asserted that none of the other regions can be so divided that the two parts shall show an amount of difference at all approaching to this. Yet it is proposed to unite these two regions because they are not sufficiently distinct. They are, however, very much more distinct than are the Ethiopian and Oriental Regions, though the former includes the isolated and peculiar Madagascar fauna. Less than **one-twelfth** of the Ethiopian families of land-birds are not Oriental, while only **one-ninth** of the Oriental families are not

Ethiopian ; showing that, by this test of the number of families which are not found in both regions, the Palæarctic and Nearctic are three times as distinct as are the Ethiopian and Oriental Regions.

If we now consider the genera which are characteristic of the one region as compared with the other, we shall find equally strong evidence of their diversity. In the Palæarctic Region we have 120 genera which are not Nearctic, out of a total of 174 ; so that a little more than two-thirds of the Palæarctic genera of land-birds are quite unknown in the Nearctic Region ; and these genera contain 472 species out of a total of 767. In other words, out of every 5 land-birds in the Palæarctic Region, 3 belong to *genera* which are not Nearctic.

Looking at the same problem from the other side of the Atlantic, the results are even more striking. Out of a total of 167 genera of Nearctic land-birds no less than 113 are not Palæarctic, the proportion being almost exactly two-thirds. These 113 genera comprise 282 species out of a total of 417 species; so that again almost exactly two-thirds of the Nearctic land-birds belong to *genera* which are not Palæarctic. This is a larger proportion than in the case of the Palæarctic Region ; and nothing can more forcibly bring before us the fundamental diversity of the two areas than the fact that, almost everywhere in the Nearctic Region, out of every three birds we might meet with, two would be generically unknown to the student of the Palæarctic avifauna. There is probably no such amount of difference as this between any two adjacent regions, except perhaps between the Oriental and Australian, the latter admittedly the most isolated on the globe.

I have now shown, by a careful comparison of their mammalia and birds, that the Palæarctic and Nearctic Regions, instead of being so much alike that they should be united to form a single region, are really exceptionally distinct. They are certainly much more distinct than are the Oriental and Ethiopian Regions, and are probably quite as distinct as are any two conterminous regions.

I feel confident, therefore, that any naturalist who will study the materials I have here brought together in a form to admit of easy comparison, will arrive at the conclusion that the system of Zoological Regions established by Dr. Sclater cannot be improved by the union of two such fundamentally distinct areas as are those which he has termed the Palæarctic and Nearctic Regions.

ALFRED R. WALLACE.

IV.

Some Current Problems in Experimental Psychology.

RECENT notes in NATURAL SCIENCE and in *Nature* seem to indicate that England is at last awaking to the fact that experimental psychology—which is an endowed science over practically the whole continent of Europe, and throughout the United States of America—has some claims upon her attention. It may not be amiss, at the present juncture, to put together a rough list of the problems most prominently upon the carpet; more especially as the statement of them may serve to dispel certain wrong ideas, as to the scope and subject-matter of the new discipline, which are unhappily prevalent in extra-psychological circles.

But first, as to definitions. *Psychophysics* is the science of the relation of "mind" to "body." *Experimental Psychology* is just psychology; the science which describes "mental" processes, and enumerates their conditions. The experimental method is not intended to oust introspection; accurately controlled introspection is experiment, and experiment is introspection made scientifically valuable, *i.e.*, universally valid. *Physiological Psychology* is an experimental psychology pursued by physiological methods, and with constant reference to the "physical substrate of mind." It is, therefore, narrower than experimental psychology proper, in that its methods are more restricted: it is wider than experimental psychology, in that it admits of the psychophysical reference, which does not obtain in psychology as such.

It is often said, whether by way of reproach or merely as fact, that experimental psychology is primarily or exclusively the psychology of sensation. But the truth or falsehood of such a statement depends altogether on the definition of sensation. (1) Some psychologists (like Münsterberg) regard "sensation" as the one ultimate constituent of mind. For them, "psychology" is, of course, equivalent to "doctrine of sensation." Only their use of the term must not be confused with the usage of physiology and of opposed schools of psychology. (2) Others (like Külpe) posit a two-fold basis of mind: sensation and affection (=pleasure-pain). (3) Others, again (like Sully), make every psychosis triple; its three elements being sensation, affection (=pleasure - pain), and conation (effort or activity).[1] Those who adopt the views of (2) or (3) have protested, and must continue to protest, against the restriction of their science to the description of and theorising upon a single psychical ultimate. And as more authors are drawn from their ranks than from those of (1), and the literature of affection and conation is quite extensive, while the term "sensation" tends to be used, even by psychologists of the first type, in its more narrow and usual sense, it would seem that the objection stated at the beginning of this paragraph can only be accounted for by the assumption of ignorance of general psychological literature on the part of those who raise it.

Still, there is no smoke without fire. How did the erroneous opinion arise in the first place? There are several reasons that might be alleged. (i.) An experimental psychology must logically begin with (technical[2]) sensation (*cf.* Wundt, *Vorlesungen*, 2nd ed., pp. 14, 15). (ii.) Chronologically, it did so begin. (iii.) Sensation-investigations tend to be assigned as theses for University degrees, because they are easier than are investigations into affection, conation, or the more complex mental processes. (iv.) This greater easiness is partly conditioned by a fact which deserves special mention: that language is the language of sensation and its derivatives; not of affection, conation, and their derivatives. For these processes gesture-language is the only direct means of communication. All spoken or written communication of them first translates them into terms of sensation and idea. (v.) There are, on the lowest estimate, over 50,000 irresolvable qualities of sensation. There are only two of affection, and only one of conation. Hence, even if sensations are grouped into modalities, the psychological literature of sensation must be far more bulky than that of affection and conation. (vi.) Physiologists—who have done much good service to experimental psychology, and service all the more valuable so long as psychology remained or remains without endowment—know, as a rule, a great deal about sensation, but little either of the literature of the other two claimants for recognition as conscious ultimates, or of that of concrete psychology (the "higher" mental processes). Other reasons might doubtless be added to these.

I have (1) not attempted to arrange the following rough list of current investigations. Indeed, classification would be impossible except in terms of a committal psychology. For the difference between the old and the new psychologies here is just this: that the old drew their parallel columns, and headed them "Intellect," "Feeling," and "Will"; while the new, however many or few the ultimates which it postulates, regards every complex psychosis as

[1] I omit, for brevity's sake, the various sub-forms of these views.

[2] "A sensation is that simple, conscious process which stands in a relation of dependence to definite nervous organs at periphery and centre."—Külpe, *Grundriss*, p. 30.

containing in it every elementary process, in greater or less degree. In place of the parallel columns is set a criss-cross of connecting lines. And though the scheme is generally accepted, the directions and number of the lines are still (as has been indicated above) matters of individual conviction. (2) Neither is the list to be considered as in any sense exhaustive. Investigations of elementary questions (of the intensity, quality, temporal and spatial relations of sensations, affections, conditions) are not included in it. And there are, doubtless, many recent investigations of compound processes which do not receive mention.

Those to which I desire to call attention are the following:—

(1.) *Recognition.*—The problem of direct and indirect recognition has been the subject of a good deal of discussion during the last few years. In his *Grundriss der Psychologie*, Külpe (*a*) propounds a new theory on the basis of experimental work done, and (*b*) indicates the path of future experimentation.—*Cf.* also an article on *Reproduction* in the *Philosophical Review.*

(2.) *Fluctuations of Attention.*—It is well known that we can attend to an unchanging impression only for a very short time. The suggestion had been made that this phenomenon was peripherally conditioned by fatigue of the sense-organ. A series of articles in the *Philosophische Studien* shows that the fluctuations are of central origin, and rehabilitates attention as a conscious process involving other than sensational elements.

(3.) *The Modes of Combination of Conscious Elements.*—(*a*) *Fusion.* The best account, theoretical and experimental, of Fusion is to be found in Külpe's *Grundriss.* Articles have been published at intervals since the appearance of the second volume of Stumpf's *Tonpsychologie.* Sensation-fusion is one of the most promising fields for experimentation now open. (*b*) *Association.* Articles on ideational association, in part based on Scripture's investigation in the *Philosophische Studien*, have appeared in *Mind*, *The Psychological Review*, *The American Journal of Psychology.* Emotional association is treated briefly in Lehmann's *Hauptgesetze.* Here, too, experiments are badly needed.—*Cf.* also (1), above.

(4.) *Memory.*—An elaborate monograph, on the basis of Ebbinghaus' *Das Gedächtniss*, has appeared in the *Zeitschrift für Psychologie und Physiologie der Sinnesorgane.*

(5.) *Rhythm and Subjective Accentuation.*—See *The American Journal of Psychology*, and an unfinished series of papers in the *Philosophische Studien.*

(6.) *Action* (= idea + voluntary act; a disparate association).—Some contributions have been made in the American journals to the analytic psychology of the simple reaction.

(7.) *The Psychological Basis of Visual Aesthetics.*—Two articles on Fechnerian lines (*i.e.*, dealing with the aesthetics of form) have been published in the *Philosophische Studien.*

To these may be added the following, as investigations rather suggested or begun, than in any sense concluded :—

(8.) *The Intensifying Effect of Attention.*—Does attention intensify its own content, or merely inhibit other content ?

(9.) *Apperceptive Completion.*—Within what limits do we overlook misprints, complete faulty stroboscopical images, etc. ?

(10.) *The Influence of Visual upon Tactile Space.*—How far is a space judgment in cutaneous terms possible ?

(11.) *Mental Fatigue.*—*Cf.* the *Amer. Journ. of Psych.*, the *Zeits. f. Psych.*, etc.

(12). *The Psychological Basis of Visual Aesthetics.* (Content.)

However incomplete, within the lines laid down for it, this list may be, it will at least serve its double purpose : it will indicate the nature of some of the current problems in experimental psychology, and prove that that science is not simply the science of sensation. It takes no account of recent work in social psychology, psychogenesis, mental pathology, or animal psychology.

E. B. TITCHENER.

V.

Notes on Ground-Ice.

EVERY student of geological text-books and many observers of nature must be aware of the fact that ice sometimes forms on the bottom of running streams, instead of on the top, as invariably happens with standing water. Sixty years ago the knowledge of this fact seems to have been almost confined to the unlearned, and its reality was denied by the natural philosophers of the day; it has now become one of the elementary facts of physical and geological science alike, and is only doubted by some few, like Mr. Leslie in his charming "Letters to Marco," who, though keen observers of nature, make no pretence to be regarded as scientific authorities.

The subject is referred to in every text-book of geology, principally from the point of view of the action of this form of ice in modifying the shape of the earth's surface, and the question of its mode of origin is treated in a more or less imperfect, where not inaccurate manner. The standard account, to which reference is often made, was published in 1833 by Arago,[1] whose paper is principally devoted to a proof of the reality of the phenomenon, which appears at that time to have been generally regarded as incompatible with the fundamental laws of nature. The theory advanced by him was that, owing to the swirls and eddies of the current, the whole body of the stream is reduced to freezing point,[2] and that in this water the stones and weeds on the bottom serve as so many nuclei for the ice crystals to form upon.

Within two years of the publication of this theory a totally different one was broached,[3] and supported by some careful and instructive observations. According to this the formation of ground-ice is due to loss of heat by radiation from the stones on the bottom, which are thus cooled below freezing point, and so give rise to the growth of ice crystals in a manner analogous to the formation of hoar frost.

These two are the theories found, in one form or another, in nearly every text-book, and of them the latter appears to enjoy the greater

[1] *Annuaire du bureau des Longitudes*, 1833, pp. 244–268.

[2] *See* Desire Leclerq, *Mem. Cour. Acad. Roy. Bruxelles*, vol. xviii. (1845), forob servations confirmatory of this.

[3] J. Farquharson, *Phil. Trans.* vol. cxxv., 329–343 (1835).

popularity, a result probably of its greater ease of comprehension, as much as of the observations to which it was conjoined. There are, indeed, certain facts which seem to support this theory, such as the general consensus of observers that ground-ice is only produced in clear water, and on cloudless nights, when radiation is most active; and Mr. Farquharson in his paper lays stress on the fact that it was not found near the piers of a bridge, close to an embanking wall, or under a grass-clad bank. This is, however, explicable in other ways than by radiation having been checked by these objects, and as regards the first part of the argument the coincidence may well be due to the fact that sharp frosts seldom occur in temperate latitudes except in cloudless weather, while the clearness of the water is as much a necessity of the first-named theory as a support of the second. Moreover, if there were any truth in the assumption, that the clear water of a stream flowing over a stony bottom is cooled to any important extent by radiation from the stony bottom over which it flows, this would be equally true in the case of standing water. But such we know is not the case, and it is the fact that the loss of heat takes place principally from the surface of the water, combined with its expansion and consequent decrease of density as the freezing point is approached, that makes our ponds freeze first on their upper surfaces.

Against the other theory, that the pebbles on the bottom merely act as nuclei on which the ice crystallises out from water cooled down below freezing point, it might be urged that this cannot occur with water such as is met with in nature, but only after it has been distilled or otherwise cleared of all dissolved air and solid particles. This, however, is not altogether the case. I have myself observed the cooling of water below freezing point when no special precautions had been taken. While camping in the desert of Western Rajputana it was a common experience to find, after a clear and cloudless night in January and February, that the water in my wash-hand basin was frozen over, and frequently frozen solid. On one occasion, after a cold night, I was surprised to find that the water was unfrozen, and, thinking that perhaps the night had not been so cold as I imagined—I had not then examined my thermometer—I plunged my hands into the water, which immediately became converted into a pasty mass of ice crystals and water. Here ordinary well water, in a basin which was only clean in the common sense of the word, had cooled below freezing point without solidifying; but the occurrence was an exceptional one, and it may well be doubted if it could take place as an ordinary event in the waters of a stream.

There is yet a third theory, originally published in 1816,[4] which appears to have been almost completely lost sight of since, that ground-ice is due to the presence of numerous minute crystals of ice in the ice-cold water; these are carried to the bottom of the stream

[4] T. A. Knight, *Phil. Trans.*, 1816, pp. 286–293.

by the eddies, and there, coming into contact with stones and weeds, are collected and frozen together into a tangled mass of spongy ice. It is probable that ice crystals are always present when ground ice is being formed, they are specifically mentioned by Knight,[5] by Eisdale,[6] who thought that they originated in the air and then fell into the water, and by Rae,[7] while the only observation which my limited opportunities have enabled me to make, tends to show that the accumulation of small ice crystals independently formed in the water of the stream is a most important factor in the production of ground-ice.

In May, 1888, I was encamped at Karzok, on the shores of the Tso Moriri, at an elevation of close on 15,000 ft. above the sea. The camp was pitched on the edge of a small oasis of cultivation, and the irrigation channel, which supplied the fields, flowed not far from the door of my tent. The night had been a cold one, and in the morning, while the ground was still hard with frost, I noticed that the water in the irrigation channel had risen and overflowed its banks; as this water was derived from the melting of snow on the hills, it should have been at its lowest in the early morning, and the rise of the water during the night made me look for the cause of so unexpected an occurrence. I found that a sheet of semi-opaque, whitish ground-ice had formed on the bottom of the channel and so raised the level of the water, and that the ice was still growing. As the depth of the channel was under a foot, the process was an easy one to observe, and I was able to notice that the water was full of minute crystals of ice, which were swept along by the current, and, coming into contact with the surface of the ice on the bottom, became entangled in the irregularly disposed crystals of which it was composed and frozen into one solid mass with them. Owing to a diversion of the stream, consequent on its rise of level, I was also able to observe the gradual formation of a continuous sheet of ice. At first the ice crystals accumulated against stones and weeds in the bed, and principally on the up-stream side, as was observed by Knight in 1816; but as the numerous small local clusters of crystals grew in size they coalesced to form a continuous sheet with an irregularly-mammilated upper surface.

From these observations it would seem that the earliest theory proposed comes so near the truth that the neglect it has met with is not justified. The crystallising out of water reduced to or slightly below freezing point is doubtless a cause, and may in some case be the most important one in the formation of ground-ice; but the process is aided to a much larger extent than is generally recognised by the entanglement and accumulation of ice crystals formed and floating in the water.

R. D. OLDHAM.

[5] *Phil. Trans.*, 1816, p. 286.

[6] *Edin. New Phil. Journ.*, vol. xvii., 167–171 (1834).

[7] *Nature*, vol. xxi., 538 (1889).

VI.

The Significance of the Bird's Foot.

TO say that birds have been evolved from reptiles is to utter one of the tritest of zoological commonplaces; but as to the nature of the particular reptilian stock which blossomed out into birds, there is by no means a complete accord among zoologists. Some have suggested a connection between the birds and the pterodactyles: a connection which, if it ever existed, must have done so before either class obtained the power of flight. For it is hardly possible that animals which had developed the pterodactyl form of flying organs would then proceed to change them into feathered wings. Others, led away by the resemblances between the *Ratitæ* and the ornithopodous *Dinosaurs*, have traced the pedigree of flying fowl from the latter through the former. But the striking resemblances between the feet of these groups may, in all probability, be set down as produced by similar needs and conditions, especially since both have the same reptilian origin. For even in mammals we find a very bird-like hind-limb, with coalesced metatarsals, in the Jerboa, which walks in the same manner as a bird when not performing its prodigious leaps. Conversely, there is a strong superficial resemblance between the hind-limbs of an ostrich and a horse.

Even Professor Fuerbringer, however, thinks that the first birds were probably terrestrial, afterwards diverging into climbers on rocks and trees, and inhabitants of swampy regions, the latter stock giving rise to waterfowl.

It is not without considerable diffidence that I venture to propose a different theory, namely, that birds originated from an arboreal reptile, which had acquired tree-haunting habits before it began to develop wings, and that all terrestrial and aquatic forms of bird-life can be derived from arboreal ancestors.

If we survey the various divisions of the vertebrates, we shall find, almost invariably, that the first steps towards flight are taken by already arboreal forms. Such forms, taking short flights by means of a skinny parachute, are found among reptiles, in the "flying" geckos (*Ptychozoon*), and the "flying" dragons (*Draco*). Among mammals, we may cite the "flying" Sciuridæ, the Anomalures, and especially *Galeopithecus*, which, with its interfemoral membrane and long webbed fingers, plainly indicates the way in which the bats probably developed. The latter animals, possessing true flight—in fact, they are the most aërial of all vertebrates—still show, in their tree- and rock-frequenting habits, and activity in climbing, traces of their scansorial ancestor. In mammals, in this way, we can trace an almost complete transition from a terrestrial to an aërial life, the intermediate stage being spent in the trees.

It will, however, doubtless be objected, that the flying-fish are the animals which present the nearest approach to true flight among the parachutist vertebrates. Indeed, after watching these creatures, one is inclined to agree with Pettigrew, that they really do fly for short distances; and we know that the power of flight is in some birds quite limited.

Darwin, also, points out that there is no difficulty in imagining that it might be of advantage to a penguin-like bird, first to flap along the surface of the water like the logger-head duck (*Micropterus*), and ultimately to rise in the air.

But against this it may be urged that aquatic animals do not tend towards complexity of epidermic clothing, as witness the hairless *Cetacea* and *Sirenia*; so that it is difficult to see how feathers, those most complex of epidermic structures, could have arisen on an aquatic animal. Besides which, I hope to be able to show that the evidence is all in favour of aquatic birds being descended from terrestrial, as indicated above, and not *vice versâ*. This brings me to the point contained in the title of this paper. The avian foot is, in its way, almost as characteristic as the fore-limb; and its typical form is one adapted, by its backwardly-directed hallux, for grasping boughs. This form is found in *Archæopteryx*, and in many important existing groups, to wit, Passeres, Pigeons, and Herons, and other modifications may easily be derived from it. Thus, *zygodactylous* birds become so by a gradual shifting backwards of the fourth digit, a change which is apparently still in process in the owls, which always perch in the *zygodactyle* position. An analogous turning back of the second toe gives the *heterodactylous* foot of the trogons. As this backwardly-directed hallux is unnecessary for terrestrial and aquatic birds, we find in these a tendency towards its disappearance; and in some groups the process can be traced .Thus, in the Gallinæ we find the Curassows and Megapodes with a well-developed thumb, while in the terrestrial game-birds it is small, elevated, and almost functionless; indeed, I have noticed that domestic fowls, when roosting, turn the hallux forwards. It is noteworthy that the Megapodes, with their grasping feet, also display the reptilian character of hatching their eggs otherwise than by incubation, and the young emerge from the shell in an almost adult condition. Similarly, among the *Anseres*, we find that in *Anseranas*, where the webs of the feet are least developed, the hallux is well-developed and incumbent, whereas the rest of the family show it in a nearly or quite functionless condition. Likewise those archaic Anseriformes, the

Screamers, combine with their slightly-webbed feet a normal hallux, so that in this group there is a fairly clear indication of a transition from semi-arboreal land-birds to waterfowl, which may help to explain the tree-nesting habits of many of the ducks, such as *Dendrocygna*, *Aix*, *Clangula*, etc.

Among birds of the family Limicolæ, the hallux is on the point of disappearance; in many plovers it is absent, and where present very small and useless. Among the gulls, which are usually considered as offshoots of the terrestrial Limicoline stock, though usually present in a functionless condition, this toe is on the very point of disappearance in the common Kittiwake (*Rissa tridactyla*), some individuals of which species have it, while others have only a mere tubercle. Here, again, it is noteworthy that *Dromas*, probably a connecting link between Gulls and Plovers, and therefore presumably more archaic than either, exhibits semi-palmate feet with a fair-sized posterior toe.

The arboreal pigeons have a typical grasping foot, while in their terrestrial relatives the Sandgrouse it is disappearing, being quite absent in the highly-specialised *Syrrhaptes*.

Few important groups exist in which the hallux is entirely wanting, the most noteworthy among Carinates being the Bustards; but the affinities of these to hallux-possessing forms are obvious. In many birds usually regarded as tridactylous, subcutaneous vestiges of the missing toe are to be found, notably in some Woodpeckers and Albatrosses, thus actually proving what is easily inferred, that the toe has disappeared in these forms. It is noteworthy that in almost every case where a hallux appears at all, it retains to the last its posterior direction, thus showing its original function. This may be seen even in some Ratitæ, *e.g.*, in *Apteryx*.

The exceptions to this rule may usually be easily explained. The forwardly-directed first toe of some Swifts is obviously a special adaption, as also are the versatile halluxes of the Coliidæ and Goatsuckers; while the hallux of the Steganopodes, often stated to be turned forward, really has an inward or backward direction, and functions in perching in the ordinary way, as anybody may observe in living birds. These birds are, still, less attached to the water than most aquatic birds, and their semi-arboreal habits have no doubt descended to them directly from an ancestry which they share with the Herons.

It may be argued that many arboreal birds may have been originally terrestrial, just as certain geese (*e.g.*, *Cereopsis*) have left the water for the land. But we know that terrestrial life leads sooner or later to a reduction of the toes, and that the hallux is the first to disappear in almost every case, so that it would have had to be re-acquired to fit a ground-dweller for a life in trees—and there is, as Garrod has already pointed out, no reason to believe that an organ originally lost is ever reproduced.

And even the highly-specialised and pre-eminently arboreal Passeres are evolving terrestrial forms in the Larks, waders in the Wagtails, and even waterfowl in the Dippers—none of which have as yet had time to lose the typical foot of their order; and thus avian history is repeating itself.

It would seem, therefore, that this highest group of birds is, in virtue of its habitat and foot-structure, in reality one of the most primitive. And this is paralleled among the Mammalia by the pentadactylous condition of the otherwise highly-organised Primates.

If, then, as I hope, I have given reason to believe that the arboreally-adapted form of foot is the one we should naturally expect to find in the ancestors of the birds, this feature gives, I think, an additional claim to *Archæopteryx* to be regarded as one of those ancestors, rather than as a side-branch of the avian tree.

Its teeth, the free and clawed digits of its hands, and its long tail without pygostyle, fulfil the requirements of a schematic primitive bird, and if its grasping feet may be added to the design, we may fairly say that in the Solenhofen fossils we have a creature which stands as nearly as possible upon the central line of avian development in past ages.

Frank Finn.

SOME NEW BOOKS.

THE MONOGRAPH ON SALPA.

THE GENUS SALPA. A Monograph, with 57 plates. By W. K. Brooks, Ph.D., LL.D., Professor in the Johns Hopkins University. Memoirs of the Biologica Laboratory of the Johns Hopkins University, II. Baltimore: The Johns Hopkins Press, 1893.

SALPA is itself so interesting an animal and belongs to so interesting a group that the results of Professor Brooks's researches deserve at once a fuller and a less technical account than is given usually in a review. The account need not be technical, for all morphologists who take a special interest in the Tunicates will have to pore over this magnificent memoir. Even to those who pay no special attention to them, the Tunicates are interesting because they seem to possess, more certainly than any other group, indications that they represent the stock from which the vertebrate animals were derived. But in addition to this general interest, Dr. Brooks has brought before us matter so surprising that it may well attract the notice of all who care for the problems of nature.

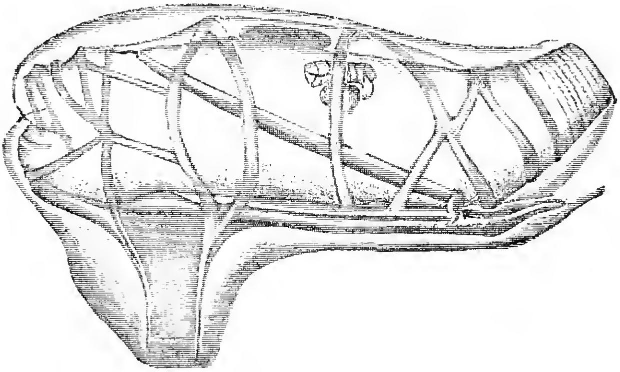

FIG. 1.—*Salpa pinnata*: a specimen of the aggregated form seen from the left side.

Salpa is a transparent swimming Tunicate, which may be compared to a barrel, open at both ends. It is, in fact, an enormous Pharynx which swims through the water, gulping great mouthfuls at every contraction of its muscles. A rod-like gill stretches from above the wide open mouth in front, through the hollow of the barrel, to below the posterior aperture behind; but this is so narrow that it offers no obstruction to the flow of water through the animal. Along the ventral line of the inside of the barrel runs a ciliated, mucus-secreting band, which is the homologue of the endostyle in ascidians and *Amphioxus*. At the posterior end of the barrel, in a thick mass, are contained the viscera, and this mass is the only part of the animal which is not transparent. Representing the hoops of the barrel are a number of muscular bands by the contraction of which the water is driven through the body. The whole animal is surrounded by a thick, tough, transparent "mantle."

The food of *Salpa* consists of minute organisms like diatoms, radiolarians, and so forth, and as these are practically unlimited in quantity on the ocean surface where *Salpa* lives, *Salpæ* are often found swarming in numbers beyond description. They vary in size from a quarter of an inch to eight inches. Though most abundant in the tropics, they are found from further north than Scotland and Norway to beyond Cape Horn and the most southerly parts of Australia. "They are abundant," says Dr. Brooks, "only after the water has been for some time undisturbed by winds: and as prolonged calms are most frequent in warm seas, these waters are most favourable for the development of these animals, which multiply with most astonishing rapidity. The smaller species are often so abundant that for hundreds of miles any bucketful of water dipped up at random, will be found to contain hundreds of them. In such places collecting with the surface net becomes impracticable, for almost as soon as the net is dropped into the water, it becomes choked with a mass so that nothing can enter it."

Since the time of the poet and naturalist Chamisso, it has been known that there are two generations in the life cycle of *Salpa*. These are a generation of solitary individuals, and a generation of

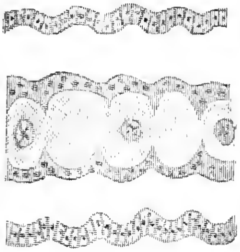

FIG. 2.

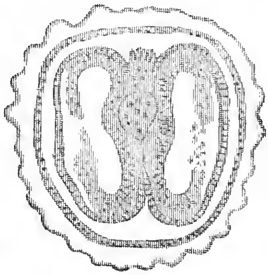

FIG. 3.

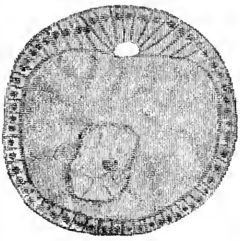

FIG. 4.

FIG. 2—Chain of germ-cells surrounded by follicle-cells, lying in a blood canal.
FIG. 3.—Section through a young embryo.
FIG. 4.—Fertilised egg-cell surrounded by follicle-cells.

individuals aggregated into chains or clusters. The specific characters of the two generations differ from each other so widely, that without rearing them there is no possibility of determining which simple and solitary forms belong to each other. The solitary *Salpa* is born from an egg which is carried within the body of the aggregated *Salpa*, and the embryo, by means of a nutritive placenta, is nourished during its development from the blood of the aggregated form. The aggregated *Salpæ* are produced asexually by budding from a stolon within the body of the solitary form. The eggs arise at an exceedingly early stage in the development of the animal. Thus the curious result happens that three generations are simultaneously present in the same animal. A solitary *Salpa* contains a developing chain of the individuals of the aggregated form, and within these are already present the eggs which are to give rise to the next generation of solitary forms. Actually, the germ-cells can be seen in a solitary form before the stolon is visible which is to give rise to the generation of individuals in which the germ-cell will develop. As the stolon forms, it includes within it the mass of germinal cells; and as the stolon elongates to form the chain of individuals, the mass of germ-cells also elongates and becomes pulled out, so that a single egg-cell is shut off in each individual of the aggregated series. This chain of eggs is enclosed in a chain of follicle-cells, as in Fig. 2, which, however, does not show the ventral band of thick epithelium which ultimately gives rise to the testes. From these follicle cells short fertilising ducts grow out to the wall of the cloaca of each individual of the chain. Through these ducts fertilisation takes place, and each salp of the chain thus comes to contain a fertilised egg, which is to give rise to a solitary individual. In Fig. 1 is shown an individual of the chain-salp of *Salpa pinnata*, with the developing embryo attached to the wall of the cloaca. The egg and the embryo in its youngest stages are really outside the wall of the cloaca, in one of the blood sinuses of the chain-salp, but attached to the cloaca by the fertilising duct which opens into the cloaca. As the embryo grows it pushes into the wall of the cloaca, without, however, breaking through, and so becomes suspended in a sac, which is really the in-pushed wall of the cloaca, and which opens into the blood sinus. This sac remaining open to the blood sinus of the chain-salp, expands considerably, and becomes the placenta, by which the embryo continues to get its nourishment from the blood of the chain. The edge of the cloaca, round the place where the embryo is pushing in, grows in as a double fold, the hollow between the layers of which is, of course, in continuity with the blood space in which the embryo was formed. This double fold comes to form a special sac, the amnion or embryo-sac, which opens into the cloaca by a small pore, the space left by the edges of the fold not completely meeting each other. Thus a horizontal section cut through, such an embryo as hangs into the cloaca in Fig. 1, would pass first through the outer wall of the amnion, next through the blood space, thirdly through the inner wall of the amnion, fourthly through the brood-pouch, which is part of the cloaca of the chain-salpa, next through the epithelial capsule, then through the embryo (*see* Fig. 3). The embryo-sac, however, does not increase in size, and the growing embryo rapidly pushes itself through the small pore, and comes to hang directly into the cloaca.

Within these complicated membranes a process of a most astonishing nature has been going on. The fertilised egg-cell was at first surrounded by a layer of follicle-cells, which, themselves being derived from the germinal cells, differ from the egg only in not being actually developed into mature eggs and becoming fertilised (Fig. 4). The egg-cell divides slowly, the follicle-cells divide rapidly, and many of them push their way in towards the centre of the mass, and actually push apart those cells which result from the division of the egg-cell. During this time constant migration of nuclei takes place from the ingrowing follicle-cells to the cells which have come from the egg-cell. No doubt this is a process of nutrition, not very different in kind from some known methods, although it is at least curious to find nuclear matter being added from an extrinsic source to the developing embryo. If it be remembered that most now believe that the nucleus of a fertilised embryo is derived equally from the nuclei of the male and female generative cells, that this nuclear matter is the bearer of the inherited qualities of the embryo, and that by subsequent assimilation and growth it gives rise to the entire nuclear matter of the new organism, then it will be sufficiently astonishing to find the nuclear matter of any cells serving simply as nutritive material. But, if this is difficult to understand, what is to be said of the other process, by which the embryo is, so to say, broken in pieces during its development? For what else is the separation of the segmentation spheres by the intruding follicle-cells? Driesch and Wilson have shown cases where the separation of the first two spheres by artificial means resulted in the formation of twin embryos.

Here is a natural parallel, with the remarkable difference that not many embryos, but only a single embryo comes from the separate pieces, which, after pursuing for a time a separate course, re-unite. But more astonishing matter remains. The actual embryo is first blocked out in follicle-cells.

"These form layers and undergo foldings and other changes which result in an outline or model of all the general features in the organisation of the embryo. While this is going on, the development of the blastomeres is retarded, so that they are carried into their final positions in the embryo while in a very rudimentary condition. Finally, when they have reached the places which they are to occupy, they undergo rapid multiplication and growth, and build up the tissues of the body directly, while the scaffolding of follicle-cells is torn down and used up as food for the true embryonic cells."

"An imaginary illustration may help to make the subject clear. Suppose that while carpenters are building a house out of wood that brickmakers pile clay on the boards while they are carried past, and shape the lumps of clay into bricks as they find them scattered through the building where they have been carried with the boards. Now, as the house of wood approaches completion, imagine that brickmakers build a brick house over the wooden framework, not from the bottom upwards, but here and there wherever the bricks are to be found, and that as fast as parts of the brick house are finished the wooden one is torn down. To make the analogy complete, however, we must imagine that all the structure which is removed is assimilated by the bricks, and is thus turned into the substance of new bricks to carry on the construction."

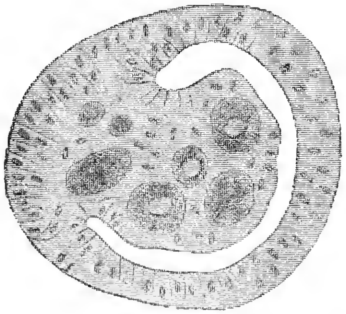

Fig. 5.—The segmentation spheres lying in a mass of follicle-cells that have grown in between them.

Fig. 5 shows a stage where the cells resulting from the early divisions of the egg-cell have been separated by the intruding follicle-cells. Figures showing the outlining of the embryo by the follicle-cells would be too complicated to reproduce without elaborate explanation and colouring, as in the beautiful illustrations of Dr. Brooks's monograph. But it must be repeated that, down to details like the structure of the nervous system, this system of preformation in follicle-cells occurs. The fate of all the structures formed of follicle-cells is the same. They degenerate, forming food for the true embryonic cells. Former observers had described something like this. Salensky, for instance, stated that the embryo of *Salpa* began as a true embryo, but afterwards the accessions from the follicle wall turned the embryo into a bud. He believed, therefore, that its development was to be compared in no way with ordinary embryological processes. Dr. Brooks considers that, however abnormal, it is a true embryo, and the appearance of budding is illusory. Certainly his figures bear out this view completely.

Dr. Brooks believes that comparative embryology has established that the ancestors of all the Tunicates once possessed small eggs with little or no food-yolk, and that these small eggs divided completely, giving rise first to a mulberry-shaped mass and then to a hollow sphere of cells. By the inpushing of the cells at one point they gave rise to a little two-walled sac or gastrula. In many groups of vertebrates this simple form of development becomes impossible; for the egg-cell becomes so loaded with inert food-yolk that it does not divide completely, but the shape of the embryo is modified precisely in proportion to the amount of food-yolk present. The yolk is not distributed in the same way in all the animals possessing it. In some

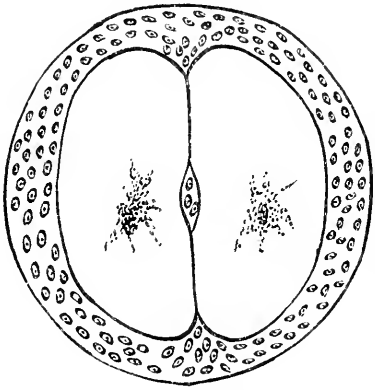

FIG. 6.

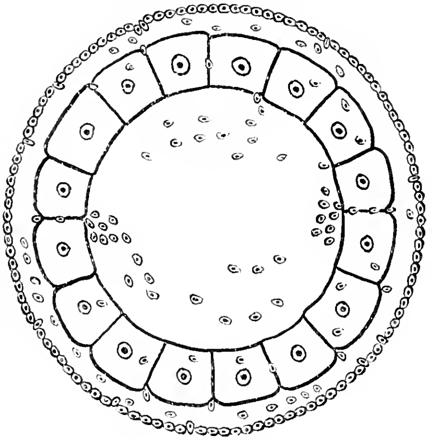

FIG. 7.

FIG. 6.—Egg of *Distaplia*: the first division has occurred, and follicle-cells are growing in between the segmentation spheres.

FIG. 7.—Diagram of a blastosphere where follicle-cells are passing into the segmentation cavity.

cases it is restricted chiefly to the cells which are to form the alimentary canal. In others, as anyone who has examined a young tadpole must know, all the cells are packed with yolk-spheres. In *Pyrosoma*, a near ally of *Salpa*, there is a large amount of food-yolk, and that is massed not in the future digestive-cavity but in the body-cavity. But the food-yolk is aided by follicle-cells, which push their way into the developing cells and are absorbed by them. Dr. Brooks suggests a method by which the peculiar arrangement in *Salpa* might

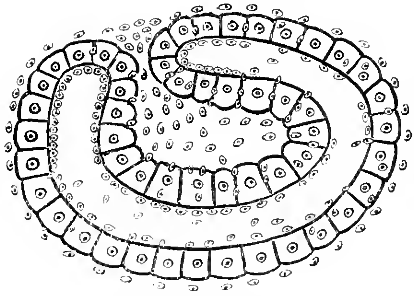

FIG. 8.

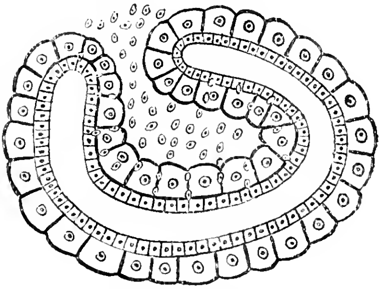

FIG. 9.

FIG. 8.—Diagram of invagination in an embryo such as that of Fig. 7.

FIG. 9.—Diagram of the gastrula of an embryo in which the follicle-cells form an epithelium.

have come about. Fig. 6 represents an actual stage in the development of *Distaplia*, which has cells bloated with food-yolk, but still able to divide completely. Two segmentation spheres are represented, surrounded by a number of follicle-cells, some of which are pushing their way in between the segmentation spheres, and which are absorbed as food. Fig. 7 represents an imaginary stage in the development of a form which has lost food-yolk, and which, in consequence, has a large hollow segmentation cavity into which follicle-cells are migrating from the layer of follicle-cells surrounding the embryo. In Fig. 8 is represented the invaginating stage of such an embryo. The follicle-cells are, of course, inside the segmentation cavity, but they also follow the invagination, and fill the hollow that usually forms the digestive tract. Now in Fig. 9 is represented a similar stage, but in a case where the follicle-cells, instead of migrating irregularly, arrange themselves as a regular epithelium. In it is to be seen the ordinary invaginate gastrula, but the cells derived from the follicle arrange themselves as a regular cast of this. In subsequent development it is easy to see that the follicular epithelium might follow all the developments and changes of the real embryonic cells, so that each fold of tissue would be formed not only of embryonic cells, but of follicle-cells closely adherent. Dr. Brooks supposes that *Salpa* had such a history, and that, when this condition of things was reached, the development of the embryonic cells began to lag behind the development of the follicle-cells, which originally merely followed the course of the cells they came to anticipate. In Fig. 10 is shown the case of an embryo in which the invagination has taken place in follicle-cells, but where the real embryonic cells are so delayed that they appear merely as scattered segmentation spheres, and this last figure is merely a diagrammatic representation of what actually occurs in *Salpa*, as may be seen by comparison with Fig. 5.

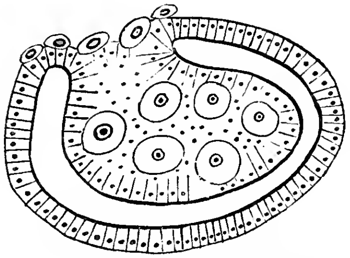

FIG. 10.—Diagram of an embryo in which the segmentation spheres delay development.

There has already appeared in NATURAL SCIENCE, vol. iii., p. 223, a brief account of the interesting views to which the development of *Salpa* has led Dr. Brooks. As that account was based on three chapters of this monograph which appeared separately, it is necessary now only to remind readers that Dr. Brooks has come to the interesting conclusion that a simple pelagic form, of which *Appendicularia* is the nearest living representative, is the common ancestor of the Ascidians and the Chordates; and that consequently there can be only among such organs as are found in simple transparent, surface-living creatures any homologies between vertebrates and invertebrates; arguments linking annelids, crustacea, and so forth with vertebrates, because of similarities in segmentation, body-cavity, etc., are dismissed as empty shadows of morphological dreams.

In this short attempt to bring to the notice of the general scientific public some of the more interesting results of Dr. Brooks' work, it has been impossible to touch upon many of the more complicated and technical matters which all specialists will have to study with attention in this great contribution to scientific literature.

FERNS.

THE STUDY OF THE BIOLOGY OF FERNS BY THE COLLODION METHOD, for advanced and collegiate students. By G. F. Atkinson, Ph.B. 8vo. Pp. xii. and 134. New York: Macmillan & Co., 1894. Price 8s. 6d. nett.

THE author, who is associate professor of cryptogamic botany in Cornell University, Ithaca, N.Y., was led to the preparation of this work by the success which attended his efforts in applying in his classes the "collodion method" to the preparation of the very delicate tissues of ferns, and especially to the infiltration of prothallia, without shrinkage. The first part of the book, occupying nearly three-fourths of the whole, is descriptive, and is an account of the history of development and anatomy of Ferns in the limited sense of the homosporous leptosporangiate Filicinæ. It is profusely illustrated by admirable figures, all reproduced from preparations made by the author or his pupils by the method referred to, and serving at the same time as a first-class recommendation of that method. Chapter I. deals with the gametophyte, from the germination of the spore to the fertilisation of the archegonium; while the sporophyte is the subject of the five following chapters. Chap. II., on the embryo, contains a very fine figure (fig. 49) of the young embryo of *Adiantum concinnum*. In Chapters III. and IV. the morphology and anatomy of the stem, root, and leaves are illustrated, while Chapters V. and VI. form a valuable contribution to our knowledge of the structure of the sporangium in the different families and their manner of dehiscence, with the distribution of the spores. Under '*Substitutionary Growths*' (Chap. VII.) we find an account of the development of the buds or bulbils on the pinnules or in the axils of the leaf of Aspleniums and other ferns where sporophytic budding occurs. Part I. concludes with a chapter on the Ophioglosseæ, which are introduced, not because of any near relation to the Filices, but because fresh material is easily procurable, while its members present excellent subjects for comparative study.

Part II., *Methods*, comprises notes on technique (preparation of the collodion, etc.), and hints for the preparation, infiltration, sectioning, fixing and examination of the prothallia and other organs of which the structure or development is to be studied.

The book is not a large one, considerable space is given to figures, and the text is not crowded; it is, therefore, not exhaustive, but merely an admirable and readable illustration of what has been done, and done well, by a certain method, and a guide to further work on the same lines. The general appearance of the book is quite up to Messrs. Macmillan's standard, and when we remember that every one of the 163 figures is new, the price cannot be considered exorbitant.

Flowering Plants.

An Introduction to Structural Botany (flowering plants). By D. H Scott, M.A., Ph.D., &c. 8vo. Pp. xii. and 288, with 113 figures. London: A. & C. Black, 1894. Price 3s. 6d.

This book, which "is intended as a first guide to the study of the structure of plants," forms a new departure in elementary botanical works. It stands out from the ever-increasing crowd of guides, text-books, and manuals in virtue not only of originality of design, but also of the fact that the subjects treated have been specially investigated for the purpose of the book, so that we have not the mere compilation of a book-man, but an account based on the results of the author's own observation. Three plants, the wallflower, white lily, and spruce-fir, are selected as illustrating respectively the dicotyledonous, monocotyledonous and gymnospermous types of seed-plant, and in as many chapters the author gives us a clear, well-arranged, and concise account of their external characters, the structure of the stem, leaf, root, flower, fruit, and seeds, and the development of the reproductive organs and embryo. There is also a shorter chapter on the physiology of nutrition. When the student has honestly worked through these chapters and seen, with the help of a competent teacher, a good series of preparations illustrating the various points of anatomy, etc., he will be well-grounded in structural botany, and ready for more detailed study and investigation, with the further advantage of having nothing to unlearn. The importance of the practical demonstration of structural features is insisted on in the preface, and with good reason, as the excellence of the figures might tempt the teacher to dispense with a microscope, especially as his sections will probably often be inferior to those so ably drawn by Mrs. Scott. Many of the figures are new, a welcome change from the well-worn "after Sachs"; several good ones have been borrowed from Strasburger; and Payer's diagrams illustrating the development of the flower of the wallflower and lily have been successfully reproduced by process. Almost the only feeble one is the last, a seedling of *Picea*, and after Kerner too! Messrs. Black have made a valuable addition, well produced in handy form, to their list of scientific publications.

Geographical Distribution of Plants.

Manuel de Geographie botanique. Par Dr. Oscar Drude, traduit par Georges Poirault, et revu et augmenté par l'auteur, avec 4 cartes en couleurs, et 3 figures dans le texte. Livraisons 2, 3. 8vo. Pp. 49–128. Paris: P. Klincksieck, 1893. Price of each part, 1 fr. 25. Subscription price, to complete work (12 or 13 parts), 15 francs.

In reviewing the first part of this translation and re-edition, which appeared last June, we commended the idea and also the italicised notice in the advertisement which stated that *the parts would rapidly succeed each other*. This promise has not been very well kept, which seems a pity, as there can be no doubt as to the value of the work.

In parts 2 and 3 now to hand, Section III., on biological varieties of organisation determined by geographical and topographical factors, which is an account of forms and zones of vegetation, brings us to the end of the first part of the book, and we proceed on page 40 to the second, in which the author brings together evidence to prove that the areas now occupied by plants have been determined by geological evolution, by the superficial structure of the globe, and by climate. The tendency to dispersive migratory power, the development of special floras or faunas as the result of geographical isolation, are considered, and insular floras and those of high mountain chains and deserts adduced in evidence.

Insular floras supply proof also of the date of issue of parts 2 and 3, which is given on the cover as 1893. On page 114, however, we find a reference to a review of the subject by Mr. Hemsley, which, as correctly stated in a foot-note, appeared in *Science Progress* in March of the present year. We trust that there may be no delay in subsequent issues to necessitate such falsification of date.

Lichens.

A Monograph of Lichens Found in Britain, being a Descriptive Catalogue of the Species in the Herbarium of the British Museum. By the Rev. James M. Crombie, M.A., F.L.S., &c. Part I. 8vo. Pp. viii., 519, with 74 figures in the text. London: Printed by order of the Trustees, 1894.

The ordinary person, or even the botanist who is not a lichenologist, will marvel at the number of British Lichens, and the more when he is reminded that the present volume is concerned with only half of the known British species. The remainder of the work, Mr. Carruthers tells us in a prefatory note, is so advanced that it may be expected to appear next year, and will contain a complete index to all the genera and species. The re-arrangement of the group in the Herbarium of the British Museum, and the incorporation of a great number of specimens, showed the necessity of a revised catalogue, while the extensive series, including a large number of authentic specimens from the principal workers, supplied material, in many cases unique, for determining species and geographical distribution in the British Isles. The book, which is systematic, and nothing else, is well arranged, and forms a valuable addition to the list of British Museum catalogues, as well as to the literature of Lichens.

Considering the extreme technicality of the descriptions, the glossary is somewhat inadequate, and we hope Mr. Crombie will see his way to make it more complete in the second volume. In the case of common species it seems hardly necessary to give in addition to the distribution the localities of all the specimens in the British Museum (which, we presume, is the meaning of *B. M.*, though it is not so stated); we think the space might be used to better purpose for more illustrations; figures are a great help to the proper understanding of descriptions, and the seventy-four provided is not a large number for so important a work, and so difficult a group. A good morphological introduction embodying the latest views and the results of modern research on these interesting little plants, the nature of which has been the subject of so much discussion, would have made the work more complete, and increased its value.

The Birds of Norway.

Bird Life in Arctic Norway. By Robert Collett, Foreign Member, Z.S., Professor of Zoology in the University of Christiania. Translated by A. H. Cocks, M.A., F.Z.S. 8vo. London: R. H. Porter, 2s. nett.

Ornithologists owe a debt of gratitude to the author of this charming essay, and scarcely less to its very competent translator, for the graphic pictures of northern bird life which it brings before them in a cheap and serviceable form. It was a happy thought that inspired Professor Collett to publish a Norwegian edition of his original essay (read before the second International Ornithological Congress at Buda-Pesth in May, 1891), since his own countrymen cannot fail to appreciate the value of his arduous labours in the elucidation of Scandinavian zoology; but it would have been a decided misfortune if the circulation of this essay had been limited to the Continent. Mr. A. H. Cocks has himself an enviable knowledge of boreal bird life, and his translation of his friend's work has been accomplished with a skill and accuracy that merit the highest praise. The preface supplies a tersely-written description of the physical features of Northern Norway, which will be acceptable even to those of us who have spent some of our happiest days in rambling over the mountain wastes included in this too brief survey. Professor Collett considers that Arctic Norway should be studied in three natural divisions, (1) the coast district and the belt of islands girding the coast up to North Cape; (2) the deep fjords of the Arctic Ocean and the adjacent river basins in East Finmark; (3) the interior plateaux of Finmark. The first chapter supplies a picturesque sketch of the breeding habits of several species of sea-fowl, which will be perused with none the less pleasure if the details supplied are already familiar to the majority of readers. The woodcuts of the young of *Alca torda*, *Fratercula arctica*, and *Rissa tridactyla* are quite gems in their own way, being admirably executed. The staff of the Museum at Tromsö come in for some well-deserved recognition, while Professor Collett reminds us of the salient features of bird life on the pretty little island which gives its name to the capital of Finmark. Everywhere is heard, he says, the wild cry of the Fieldfare (*Turdus pilaris*); in every meadow we commonly find a pair of Blue-headed Wagtails (*Motacilla flava*); from the thickets in the gardens, and from the willow bushes in the moister places may be heard the best songster of the Arctic district, the Blue-throated Warbler (*Cyanecula suecica*); Redwings and White Wagtails, Bramblings and Mealy Redpolls are equally characteristic of this region. The second chapter deals with bird life on the Porsanger Fjord, which affords Professor Collett an excuse for detailing the habits of the lovely little Red-necked Phalerope (*Phalaropus hyperboreus*). "Often they may be found in flocks on the sea far from land, rocking upon the surface in the strongest swell, like small specks of foam. But in the small tarns up in the interior of the country, between the leaves of *Comarum*, *Menyanthes*, and *Hippuris*, we may be able to find their nest, or meet with the four delicately-formed, brownish-yellow, young in down, being conducted by one of the parents among the water plants. This one of the parents is, as is well known to the majority of my readers, always the male. With the utmost indifference to danger, he runs, anxiously screaming, directly in front of our feet, to divert our attention from the eggs or the small young. The females on the contrary, which are a little larger, and purer coloured, keep themselves to themselves during the nesting season, and generally form the little flocks which we have seen floating about on the small pools of water, or in the sea close to shore, far removed from the burden of family life. Here the plainly-coloured male is the weaker sex, which must wholly and entirely undertake the hatching of the eggs, and the bringing up of the young. This trait is by means peculiar to this species, although hardly in any other case to so great an extent as the present, where it also takes expression in the colour of the male. It is more or less conspicuous with most of our arctic waders of the Stint and Sandpiper families." Many other paragraphs are equally to the point, and will be read with keen enjoyment by every-one. Before taking leave of Professor Collett's delightful pamphlet, which we lay aside with unfeigned regret, it is only right that attention should be drawn to the brief, but important, appendix furnished by Mr. A. H. Cocks at the suggestion of Mr. Sclater. Herein we find an admirable list of the Birds of Norway, very properly arranged in accordance with the rules of the B.O.U. The total number of birds, we are told, hitherto found in Norway is 278, while no fewer than 212 species have nested, or are believed to have nested, in that country. But, although the number of breeding species is so large, the number of non-breeding visitors is only estimated at 66; of these, no fewer than 40 are accidental visitors—a curious contrast to the avifauna of Great Britain. In view of a second edition being required, as we trust it speedily may be, we would suggest to Mr. A. H. Cocks the extreme desirability of supplying some details of the supposed occurrence of such rare visitants as Barrow's Goldeneye (*Clangula islandica*) and the Greater Shearwater (*Puffinus major*). If the occurrence of these species in Scandinavia is really fully authenticated, there should be no reserve in withholding the particulars from British naturalists, to many of whom the transactions of foreign societies are inaccessible.

H. A. MACPHERSON.

FOR BEETLE-HUNTERS.

L'AMATEUR DES COLÉOPTÈRES. Par Henri Coupin. Bibliothèque des Connaissance Utiles. Pp. viii., 352, 217 figures. Paris: J. B. Baillière & Fils, 1894.

THIS is a very good, practical book. It opens with a chapter describing the various implements for the capture of beetles and giving instructions for their use. The British entomologist will, perhaps, get some comfort from the fact that his French co-worker, like himself, needs to be warned to ignore the rude remarks "des petits paysans" on his equipment and pursuits. A list of the principal families of beetles follows, with notes on the food, habits, and localities of each. A short account of their structural characters might, we think, have been added, with advantage to the reader. Then follow nineteen chapters, each devoted to some special locality for collecting; we have directions for "la chasse sous les pierres," "dans les jardins," "au bord de la mer," "dans la maison," "dans les animaux putréfiés" (an inviting locality), etc. The beetles which the collector is likely to find in each habitat are mentioned, and figures are given which will enable him to make out many of the common species. This method of treatment by localities is fresh and attractive; the worker will soon feel the need of a systematic treatment of the subject, but this, we feel sure, is a result aimed at by the author. The habits of many genera are noticed, and we are specially glad to remark that the author directs the attention of the beginner to the collection and study of larvæ and pupæ. Some coleopterists seem to ignore the fact that the beetles are metabolous insects.

These chapters on collecting are followed by one upon the preservation and arrangement of the collection. The author recommends phenic acid, if used with care, as a reliable preservative for the cabinet. He advises collectors not to mount their insects touching the drawer-bottom except for purposes of exchange with Englishmen; we are glad to think that this fashion is passing away amongst us, and that our continental comrades would now find the insects in our best collections well raised on the pins. The final chapter is devoted to "les collections picturesques." The author gives examples, with figures, of the ornamental necklaces, etc., which South American and other tribes make from the elytra of brilliant tropical beetles. He wishes that Europeans would follow the example of these savages, and make use of metallic beetles "dans les élégances féminines." Some of us would rejoice at this if there were any hope that it would stop the slaughter of birds for millinery.

FOR MR. WILLIAM SIKES.

HABITUAL criminals will turn with interest to the report on the best means available for their identification, which has just been issued by H.M. Stationery Office at a price (10d.) calculated to put it within the reach of the most unsuccessful. Mr. Francis Galton's method of identification through the impressions of the finger-tips is regarded as the most scientific and accurate, and is recommended for the final test in each case. But, owing to the difficulty of classifying a very large collection of such impressions for the purpose of ready reference, it is suggested that the primary classification of prisoners should depend on measurements of the length and breadth of the head, the length of the left middle finger, of the left forearm, and of the left foot. The Committee are strongly of opinion that it is essential to the complete success of the registry to secure the services of an expert practised in the methods of scientific anthropometry, and, if possible, one who has had practice in training other persons in making scientific measurements. A scientific adviser would be required and would be able to settle such questions as the limits to be adopted in England for the classes of large, medium, and small, and the amount of variation to be allowed for in individual measurements; he would be able to superintend the training of warders in taking measurements, and he would instruct the officers in charge of the registry in the decipherment and classification of finger-prints. He might also be able, after experience of the working of the scheme, to suggest modifications. On every ground, then, the Committee think it desirable that the English Anthropometric Office should, from the first, have the advantage of scientific guidance not inferior to that which the French Service d'Identification enjoys in having M. Bertillon at its head.

In the "Revue de Géographie," Paris (Jan., 1894), M. J. Girard has a paper on the Mouths of Rivers, dealing especially with modifications in form due to the velocity of the water, deposition of sediments, and waste or growth of banks. In the same number, and continued from December, Professor Malotet writes on the sandy plain of French Flanders.

Mr. Edward Stanford has just issued a new edition of his "London Atlas of Universal Geography." The maps of Europe, England, Scotland, and Ireland, and Switzerland, have been redrawn, a fine sheet map of London has been added, and the following maps are new: Channel Islands, Canaries and Madeira, Asia Minor, and the Euphrates Valleys, north-west frontier of India and the Pamirs, Siam, Madagascar, Argentine Republic, and New Guinea. The atlas is too well known to need any recommendation, and, containing 100 maps, is published at £12.

We have received from Mr. Welch, 49 Lonsdale Street, Belfast, a catalogue of photographs of Irish views of geological interest. Several of these photographs have been taken at the suggestion of Professor Grenville Cole and Mr. M'Henry, who have supplied the geological information given in the catalogue. The photographs are issued as platinotypes or silver prints, and can be had in three sizes.

Messrs. Friedländer & Sohn, 11 Carlstrasse, Berlin, N.W., by request of the German Zoological Society, have in hand an "International Directory of Zoologists." This will include zoologists, collectors, draughtsmen, preparers, modellers, and dealers, and will be compiled by Professors F. E. Schulze of Berlin, and H. Ludwig of Bonn. They will be glad to receive names, which should be sent at once.

NEWS OF UNIVERSITIES, MUSEUMS, AND SOCIETIES.

The following appointments among Botanists have recently been made:—Dr. Hans Molisch to the Professorship at Prague vacant through the death of Dr. Weiss: Dr. L. Tost to be extraordinary Professor in the University of Strassburg; Arturo Baldini to be Curator of the Botanical Gardens at Bologna; Dr. Fr. Schult to be extraordinary Professor in Kiel University; Mr. M. A. Carleton, lately assistant in the Agricultural College at Manhattan, Kansas, to be assistant in the Division of Plant Pathology at Washington, D.C., where he will pay special attention to the rusts of cereals and other plants; and Mr. J. Percival, who has for the last few years been lecturing on subjects of agricultural interest for the Surrey County Council, to be Professor of Botany in the new Kent and Surrey Agricultural College at Wye. We also note that Professor Julius Wiesner has returned from his travels in Java.

The United States Government have appointed Mr. F. L. Scribner, recently director of the Tennessee Agricultural Experiment Station, to a newly-created post chiefly connected with the investigation of grasses and forage plants. Such an official is an admirable invention; but why should he be handicapped at the outset by being labelled "Agrostologist"?

Dr. Kumm has been appointed Curator of the natural history collections in the West Prussian Provincial Museum at Dantzig.

Among the names of those nominated by the Council of the Royal Society for election we notice those of Mr. W. Bateson, Mr. G. A. Boulenger, Mr. R. Lydekker, and Dr. D. H. Scott. It is not likely that anyone whose opinion is worth having will cavil at this year's selection. Still we cannot help regretting that no geologist has been nominated.

Mr. Charles Baron Clarke has been selected for the new President of the Linnean Society in succession to Professor Charles Stewart. A more satisfactory selection could scarcely have been made.

The ruling of the Chairman that Mr. Thiselton Dyer's motion expressing approval of the Gresham scheme was out of order, has probably saved the Convocation of the London University from making a sad exhibition of business incompetence. At the previous meeting, Convocation carried a resolution referring the whole question of the constitution of the University to a joint committee representing both the Senate and Convocation. This proposal has been accepted by the Senate, and the Committee has been appointed. Mr. Thiselton Dyer's resolution simply re-opened the whole question before the Committee's report had been received. This course would have been disrespectful to its own committee, and practically a breach of faith with the Senate. The main result of this precipitate haste would have been to alienate many votes that would have been given for the resolution had it come on before the appointment of the Committee, or would be after the report is received. In the present condition of politics, no immediate steps are likely to be taken by the Government in giving effect to the recommendations of the Gresham Committee; so that the delay can do no harm, especially as the matter is mainly one of detail; for both sides agree that a single teaching university for London is the one thing needed.

A MUNIFICENT benefactor, this time a private individual, has been found for University College, Liverpool, in the person of Lord Derby, who has given £10,000 to endow a Chair of Anatomy.

THE sum of £1,000 has been placed by the Goldsmiths' Company at the disposal of the governing body of the Imperial Institute for fitting up and equipping a department of scientific and practical research. This will deal with the investigation and practical valuation of new and little-known natural products received from India and from the colonies composing the Empire. We understand that this extension of the Institute's activity will not be allowed to interfere with the social evenings and smoking concerts, or with the special "grand illumination" of the galleries every night.

ANOTHER City company, the Grocers', has offered three research scholarships, value £250 each, open only to British subjects, as an encouragement to the making of exact researches into the causes and prevention of important diseases. Meanwhile Chelsea and Victoria Street send out their protest, and the Russian moujik naturally believes that cholera is exported to him from England.

AT Oxford, Congregation has unanimously passed the resolution: "That it is expedient to establish new degrees, to be granted after a course of special study or research, to members of the University who have passed the examinations qualifying for the degree of B.A., and to persons not being graduates of Oxford who have given satisfactory proof of general education and of fitness to enter upon a course of special study." What these degrees shall be entitled is not yet decided, nor does it much matter; to have the degrees at all is a great point gained.

A STATION for the investigation of marine zoology and botany is being founded at Cumbrae, under the personal supervision of Mr. David Robertson, "the naturalist of Cumbrae."

MR. THOMAS BROCK, R.A., has finished his sketch—model for a statue of the late Sir Richard Owen—which is to be placed in the Natural History Museum. The statue will represent Owen in his robes as Hunterian Professor of the Royal College of Surgeons, and a representation of a bone of *Dinornis* will be placed in his hand to commemorate one of his most remarkable successes.

THE anniversary meeting of the Royal Geographical Society will be held on the 28th of May. The only important changes of Council expected will be the election of Major Leonard Darwin as secretary, in the room of Mr. D. W. Freshfield, and Sir John Kirk as foreign secretary, to replace the late General Sir C. P. Beauchamp Walker. The Society's awards have been distributed as follow:—The Founders' Medal to Captain H. Bower, for his remarkable journey across Tibet; the Patrons' Medal to Elisée Reclus, for his valuable service to geography, chiefly by the publication of his "Nouvelle Géographie Universelle," in 21 volumes; the Murchison Grant to Captain Joseph Wiggins, for his work in the waters of Northern Siberia; the Back Grant to Captain H. J. Snow, for his maps of the Kuriles; the Gill Memorial to G. E. Ferguson, for survey work on the West Coast of Africa; and the Cuthbert Peek Grant to Dr. J. W. Gregory, for his journey and observations in the Baringo and Mount Kenia district.

AT the annual general meeting of the British Ornithologists' Union, held on May 9, Lord Lilford was re-elected President. The report of the Council gave a flourishing account of the finances. It was agreed that a new (seventh) series of the "Ibis" should be commenced in 1895, with the thirty-seventh volume, and that Dr. Sclater and Mr. Howard Saunders should be appointed joint editors.

The scientific women of America have formed themselves into a National Science Club, of which Mrs. Ada D. Davidson, who was in evidence at the World's Fair (NATURAL SCIENCE, vol. iii., p. 341), is president. At the annual meeting recently held in the hall of the National Museum, Washington, she gave an address and read a paper on Trilobites. Further lectures will be given in the same place, under the auspices of the Science Club.

LETTERS have recently been received from Mr. Scott Elliott, who writes from the west of the Nyanza, and is probably by this time in Ruwenzori. He had crossed the Kagira River, so that he apparently intends to keep well to the south of Bunyoro and the country raided by Kaba Rega. The fighting with this potentate is really all in Mr. Scott Elliott's favour, as it will keep Kaba Rega too much employed to be able to raid to the south. The re-establishment of a station in Soru will also aid, and appears to be a confession of the great mistake committed by Sir Gerald Portal in reversing Captain Lugard's policy. Further news regarding the fate of Prince Eugenio Ruspoli, the son of the Syndic of Rome, has come to hand, and confirms the story of his having been killed by an elephant. The accident happened in the valley of the Omo, one of the two rivers that flow into the north end of Lake Rudolph, so that Prince Ruspoli had got further into one of the most interesting countries in Africa than any previous explorer. If adequate observations have been taken and maps prepared, Prince Ruspoli's life will not have been spent in vain. Another expedition is just starting for this district, under command of Dr. Donaldson Smith, of Philadelphia, accompanied by Mr. F. Gillat and a well-trained zoological collector. The expedition will start from Bulhar, on the Somali coast, cross the Haud to Milmil, and thence strike through the Galla country to the north end of Lakes Rudolph and Stephanie. The expedition will be so powerfully equipped that it need have little to fear from opposition by the natives. It ought to yield rich results to science. It is understood that Dr. J. W. Gregory would have accompanied the expedition had his health permitted. Mr. Coryndon, of the black "White Rhinoceros" fame, is now well on his way to his collecting camp somewhere between the north end of Lake Tanganyika and the eastern margin of the great forests of the Upper Congo.

A STEREOSCOPIC photomicrograph of the diatoms *Heliopelta* and *Coscinodiscus* forms a frontispiece to the fourteenth volume of the *American Monthly Microscopical Journal.* These pictures, which are taken by Dr. W. C. Borden, of Newport, R.I., are intended to show the superiority of stereoscopic as opposed to ordinary photomicrographs for the representation of certain microscopic objects. In the same number of the journal (vol. xiv., no. 12), Mr. K. M. Cunningham calls attention to a remarkable collection of photomicrographs, formed by Dr. Henderson, of Mobile, between the years 1860 and 1870. Most of these were taken on wet, or collodion, plates, with Dr. Herapath's ¼-inch lens, "Ross," and, after 30 years, the silver prints are, in some cases, perfectly preserved. It is to be remembered, as Mr. Cunningham points out, that these photomicrographs must have been taken by sunlight, and not with the approved methods furnished by the electric light or lamp.

WE regret to have to record the deaths of Dr. Joseph von Szabo, of Budapest, which occurred on the 10th April last; of the veteran geologist, August von Klipstein, who died at Giessen on 16th April, aged 93 years; and of Dr. J. Schmalhausen, the Professor of Botany at Kieff.

CORRESPONDENCE.

The Threefold Division of the Drift.

In the appreciative review of the late Professor Carvill Lewis's Glacial Geology of Great Britain and Ireland, which appeared in your May number, Professor Lewis is credited with removing, among other stumbling blocks, that of the supposed threefold division of the drift. "He showed that the old view of the threefold classification of the drift into an upper and a lower boulder clay, separated by sands, is absolutely untenable; that even within very short distances this supposed sequence is often reversed, and we may get the boulder clay in the middle, with sands above and below."

Will you permit me to point out that from a very early period of my study of the drift, my observations led me to doubt the correctness of such a classification. In all the Glacial papers published by me since 1873, and they have been pretty numerous, I have contended for the unity of the Glacial Period in Britain, and have stated again and again that the so-called Lower Boulder Clay, Middle Sands and Gravel, and Upper Boulder Clay do not represent two Glacial Periods, divided by an inter-Glacial Period, but are continuous deposits. The arguments quoted from Professor Lewis are such as I have frequently used, and that at a time when I was practically alone in my opinion. Professor Lewis told me personally that he agreed with many of my glacial views, and the evidences of the fact can be seen in the book itself.

It follows from this that there is a possibility, however remote, of an "orthodox" geologist being right, though he may think there is something still to be said in favour of submergence.

Allow me to add that I have read the work of Professor Lewis, whom I held in esteem, with great interest, and think that his field notes and elucidatory remarks are of very great value, showing extensive and accurate observation put into a form that can be used by any competent geologist, whatever may be his views. What is still more rare, they exhibit an open and truthful mind, that does not blink facts, whichever way they may seem to tend.

Park Corner, Blundellsands. T. Mellard Reade.

May 1, 1894.

Mr. William Taylor (Llanbryde, Elgin) writes deprecating the tone of our review of Mr. E T. Newton's memoir on the Fossil Reptiles of the Elgin Sandstones (*suprà*, p. 305). He remarks that the Naturalists of Elgin are grateful to Mr. Newton and the Geological Survey for the labour they have bestowed upon the subject, and points out that no unconformity has yet been discovered between the reptiliferous beds and those containing Palæozoic fishes. He asks, "might not *Elginia* and *Gordonia* be Permian?" He then comments upon the lamentably frequent tendency of professionals to ignore the work of local observers, and adds: "We cannot help pointing out that Patrick Duff, of Elgin, was right about the Parallel Roads of Glenroy, while Darwin was wrong. Duff was right in saying that *Dendrodus* was the tooth of *Holoptychius*, and Owen was wrong. Professor Judd said that fossil reptiles would not be found south of a certain line of fault: Dr. Gordon, of Elgin, declared they would be so found, and he has proved to be correct."

TO CORRESPONDENTS.

All communications for the Editor *to be addressed to the* Editorial Offices, 5 John Street, Bedford Row, London, W.C.

All communications for the Publishers *to be addressed to* Macmillan and Co., 29 *Bedford Street, Strand, London, W.C.*

All Advertisements *to be forwarded to the sole agents,* John Haddon & Co., *Bouverie House, Salisbury Square, Fleet Street, London, E.C.*

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An asterisk (*) indicates that a figure is given.